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

TSG6

NTSC MULTIBURST AND VIDEO SWEEP TEST SIGNAL GENERATOR MODULE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
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070-2528-00
Product Group 20

Serial Number ____________

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WARNING

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

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OPERATORS SAFETY SUMMARY

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

TERMS

In This Manual

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

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

As Marked on Equipment

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

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

SYMBOLS

In This Manual

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

As Marked on Equipment

DANGER — High voltage.

Protective ground (earth) terminal.

ATTENTION — refer to manual.

Grounding the Product

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

Use the Proper Power Cord

Use only the power cord and connector specified for your product.
Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Servicing information.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your product, and which is identical in type, voltage rating, and current rating.

Refer fuse replacement to qualified service personnel.

Do Not Operate In Explosive Atmospheres

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

Do Not Remove Covers or Panels

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

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

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

Use Care When Servicing With Power On

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

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

Power Source

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

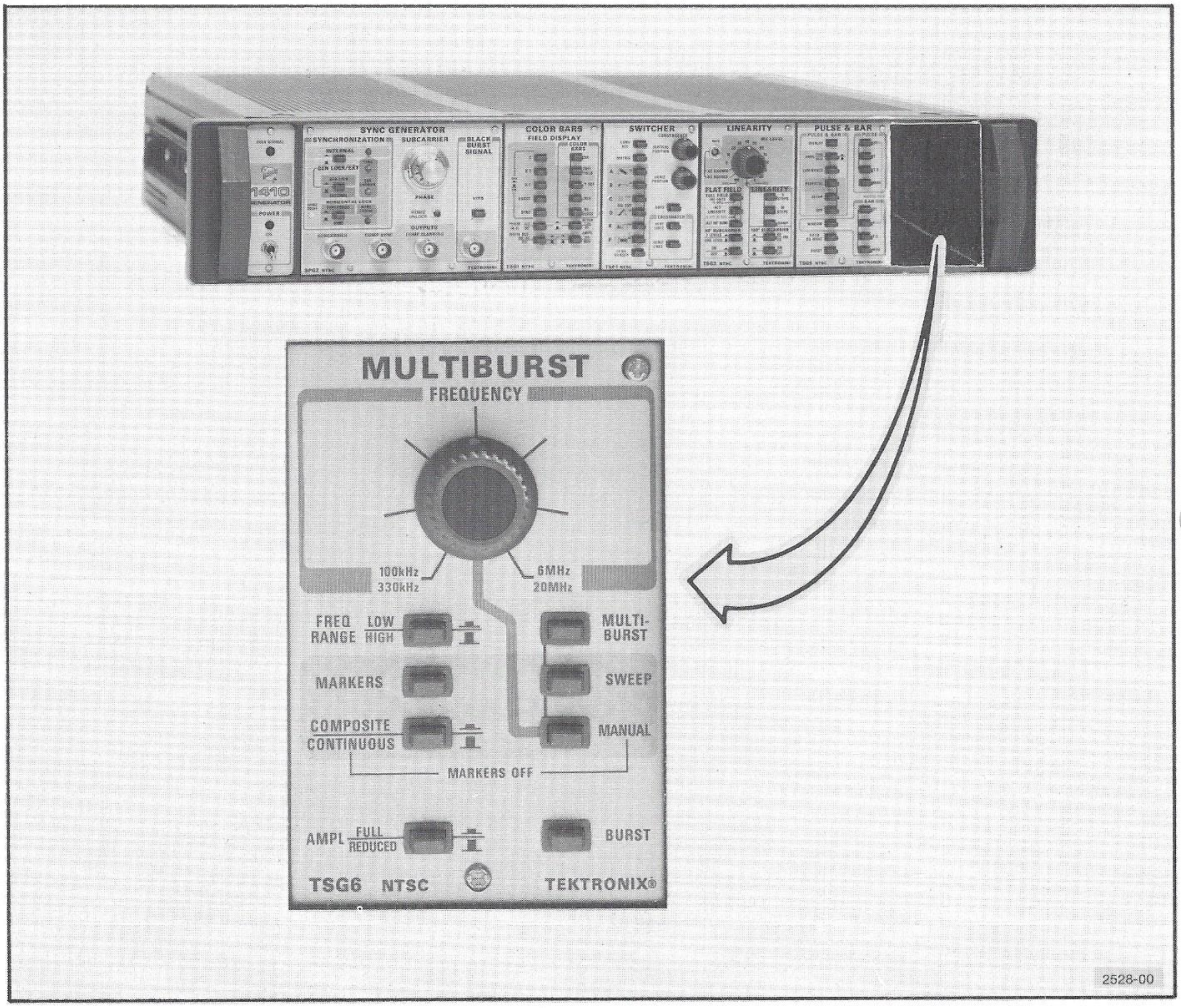


Fig. 1-1. The TSG6 NTSC Multiburst & Video Sweep Test Signal Generator Module.

PART I
OPERATORS INFORMATION

OPERATING INSTRUCTIONS

DESCRIPTION

The TSG6 is an NTSC Multiburst & Video Sweep Test Signal Generator for use in the 1410 (NTSC) Generator mainframe.

Main features for the TSG6 Multiburst generator are as follows:

- Multiburst test signals which are: (A) amplitude modulated to produce controlled rise and falltime burst packets, and (B) phase modulated to enhance the ability to detect peak-to-peak burst-packet amplitudes.
- Manual or swept frequency signals.
- REDUCED or FULL AMPLitude signals.
- A LOW and HIGH frequency band in MULTIBURST, MANUAL, or SWEEP (field sweep) mode.
- COMPOSITE video or CONTINUOUS sine-wave operation.
- Front-panel on/off switch for color BURST in COMPOSITE mode.
- Last burst variable mode, with the frequency of the last burst in multiburst controllable via the manual Frequency dial.
- Multiburst VITS remote enable.
- Markers for amplitude reference in MULTIBURST and MANUAL modes.
- Markers for frequency and amplitude reference in SWEEP mode.

FRONT-PANEL CONTROLS

Refer to Figs. 1-2 through 1-5 while reading about the control functions. Fig. 1-2 shows the front-panel controls. Figs. 1-3 through 1-5 show the various output waveforms and displays obtained when the TSG6 is operating in the modes described in the illustrations.

(1) FREQ RANGE

Selects frequency limits in field SWEEP and MANUAL modes; selects burst-packet frequencies in the MULTIBURST mode. Figs. 1-3, 1-4, and 1-5A through 1-5E show various displays obtained when using the LOW and HIGH frequency ranges.

(2) MARKERS

Inserts amplitude/frequency markers in the SWEEP mode and amplitude markers in the COMPOSITE/MANUAL mode. See Figs. 1-4, 1-5A, 1-5C, and 1-5D for examples of "markers on" displays.

(3) COMPOSITE/CONTINUOUS

Determines whether sync, blanking, and a pedestal will be added to the sweep and manual signals.

COMPOSITE: Sync, blanking, and a pedestal are added to the sweep and manual signals. See Figs. 1-4, 1-5A, 1-5C, and 1-5D. In the MULTIBURST mode (see Figs. 1-3 and 1-5E), these components are present regardless of the COMPOSITE/CONTINUOUS switch setting.

CONTINUOUS: Sync, blanking, and the pedestal are removed from the sweep and manual signals. See Fig 1-5B.

(4) AMPLitude

Selects FULL or REDUCED amplitude in all operating modes. See Figs. 1-3, 1-4, and 1-5A through 1-5C for examples of FULL AMPLitude displays. In the REDUCED position, both sine-wave and luminance components are reduced. See Figs. 1-5D and 1-5E.

(5) FREQUENCY

Determines frequency of sine wave in MANUAL mode and last burst in last burst variable mode. Figs. 1-5A and 1-5B show examples of MANUAL mode.

(6) MULTIBURST

Selects line-rate discrete-frequency packets with reference insertion levels. See Figs. 1-3 and 1-5E.

NOTE

MULTIBURST, SWEEP, and MANUAL are self-canceling switches.

(7) SWEEP

Selects field sweep. See Figs. 1-4, 1-5C, and 1-5D.

(8) MANUAL

Selects fixed-frequency sine waveshape with frequency determined by the front-panel FREQUENCY control and FREQ RANGE switch. See Figs 1-5A and 1-5B.

(9) BURST

Determines whether color burst will be inserted on composite video. See Figs. 1-3, 1-4, 1-5A, 1-5C, 1-5D, and 1-5E.

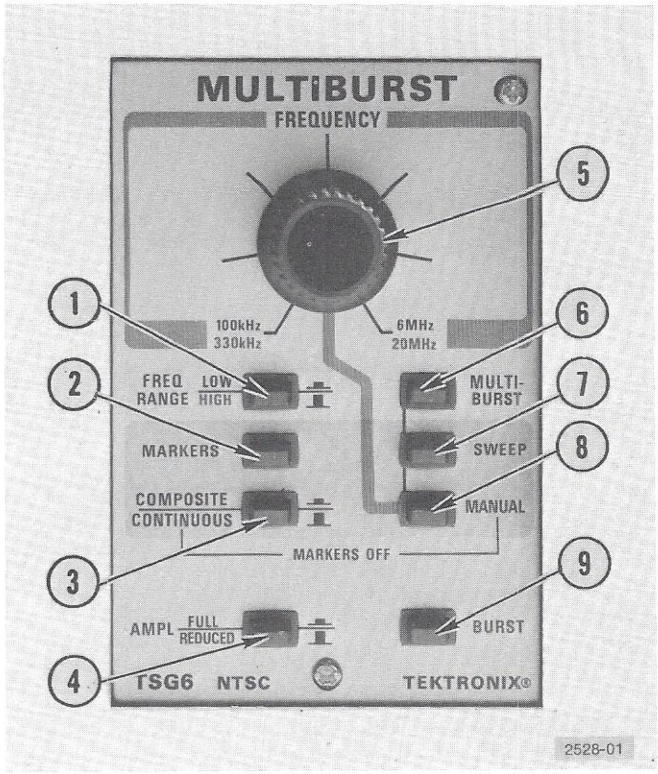
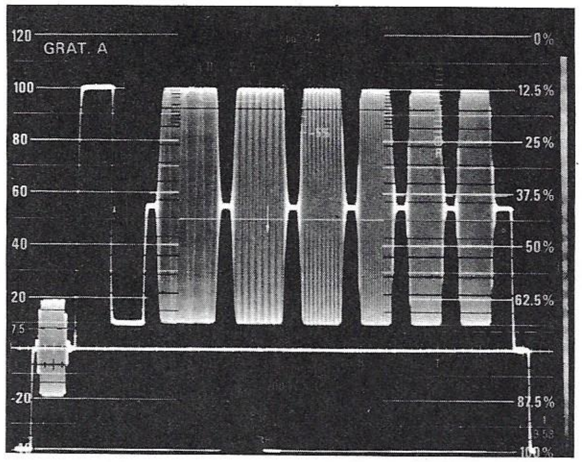


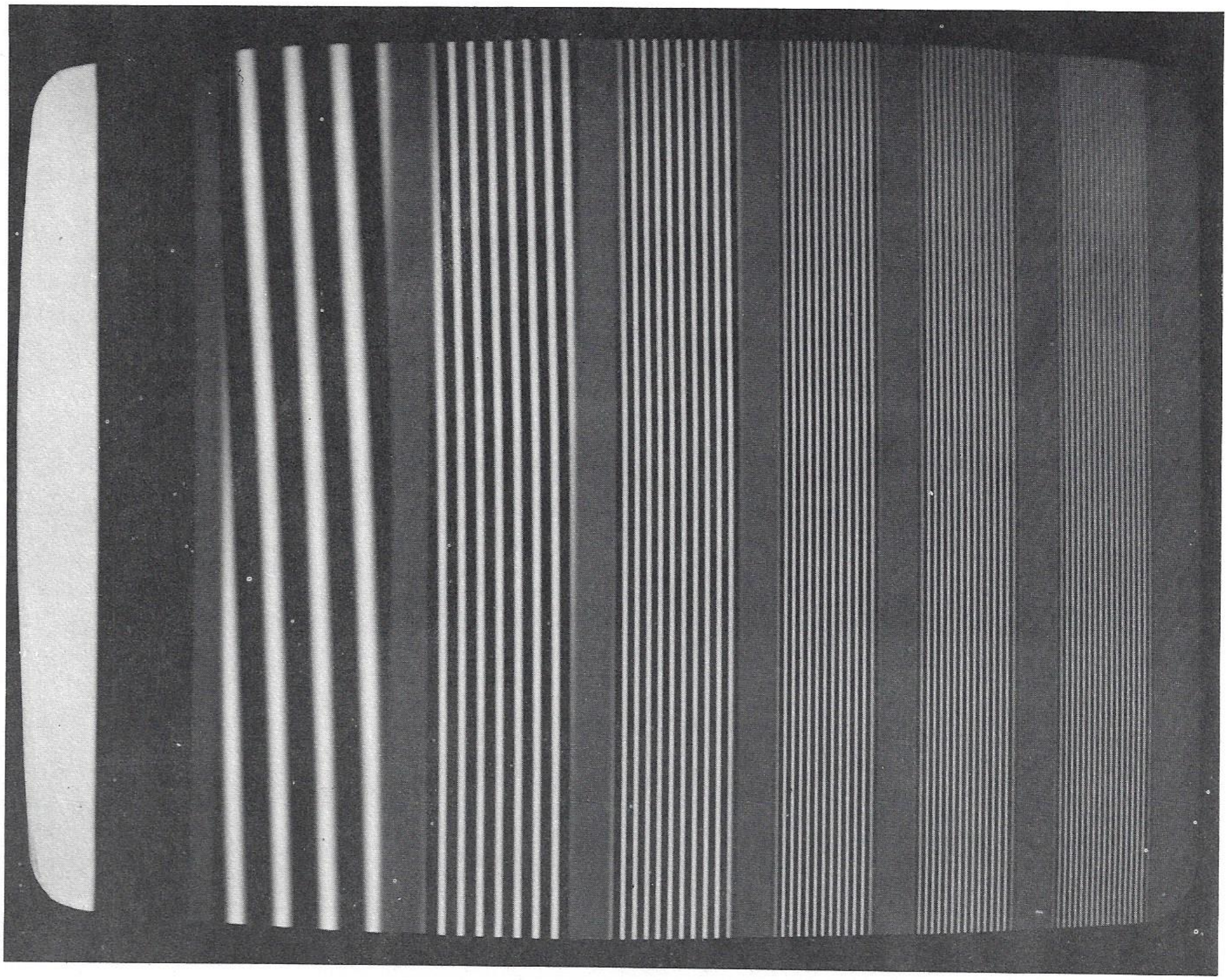
Fig. 1-2. TSG6 Front-Panel Controls.

NOTE

For internal jumper options, refer to Part II—Service & Installation portion of this manual. Any changes in jumper positions must be made by qualified service personnel only.



(A) TEKTRONIX 1480 Waveform Monitor display. Sweep rate: 5 μs/div.



(B) Monochrome picture monitor display.

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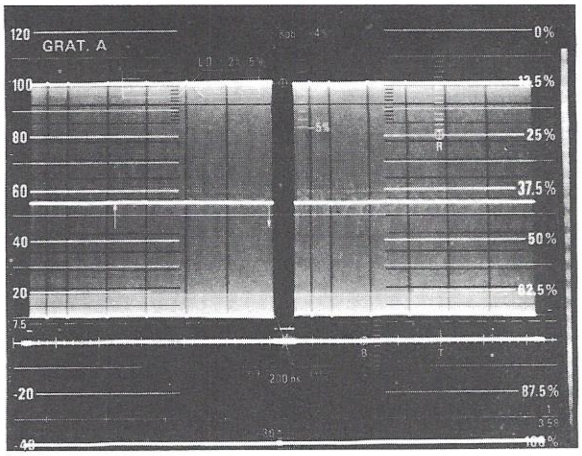
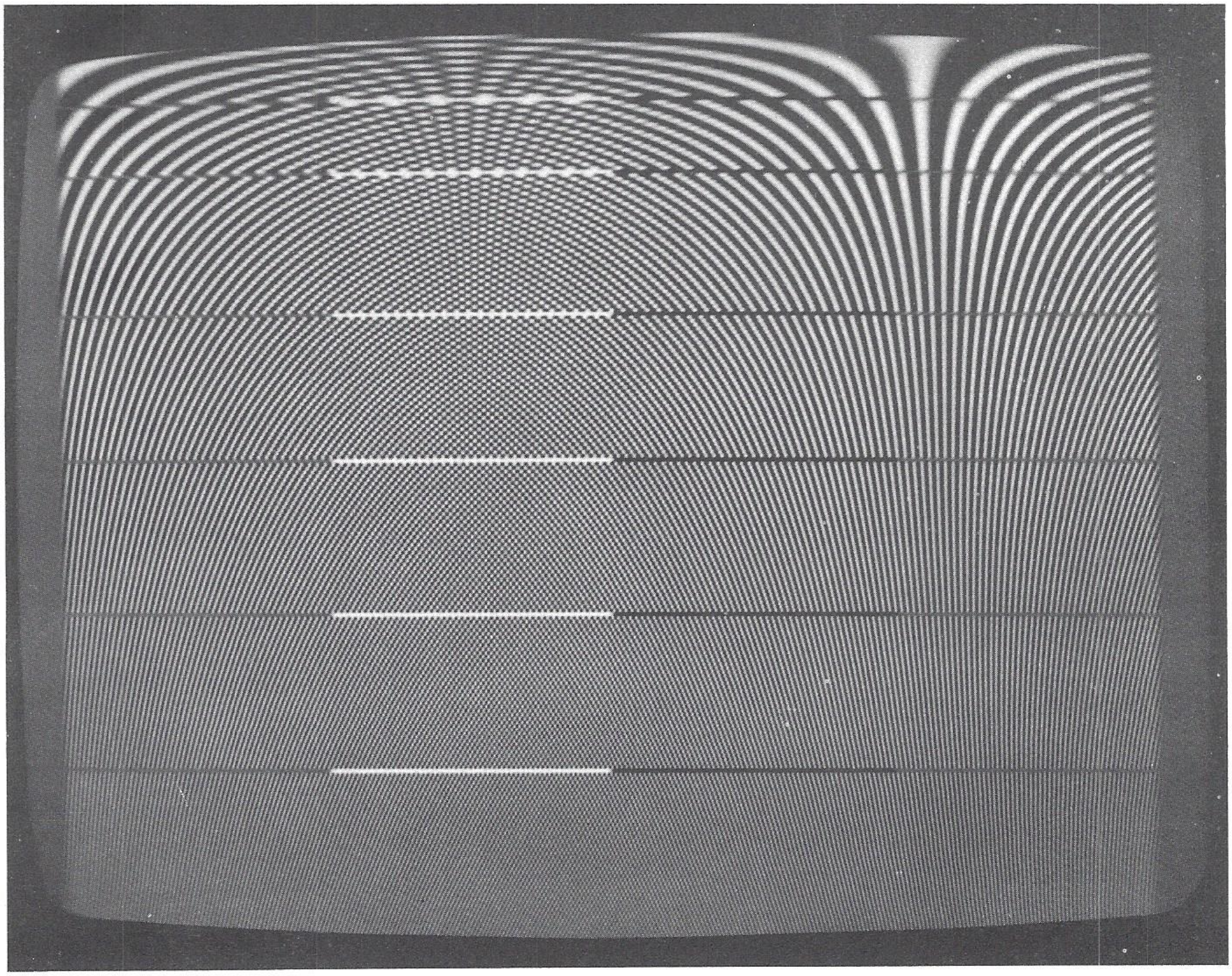
Fig. 1-3. TSG6 low range, full amplitude, composite multiburst, burst on, output signal.



(A) TEKTRONIX 1480 Waveform Monitor display. Sweep rate: 2 Field.



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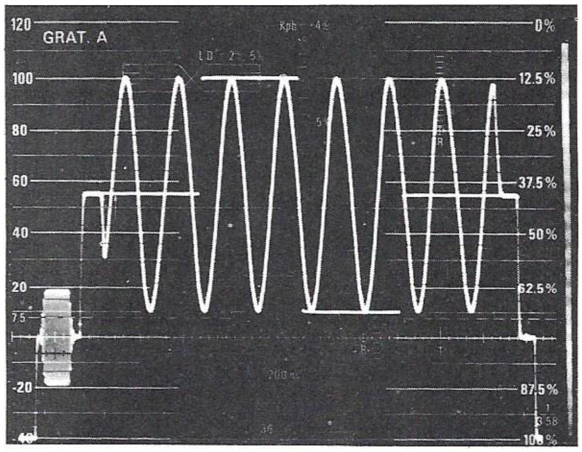
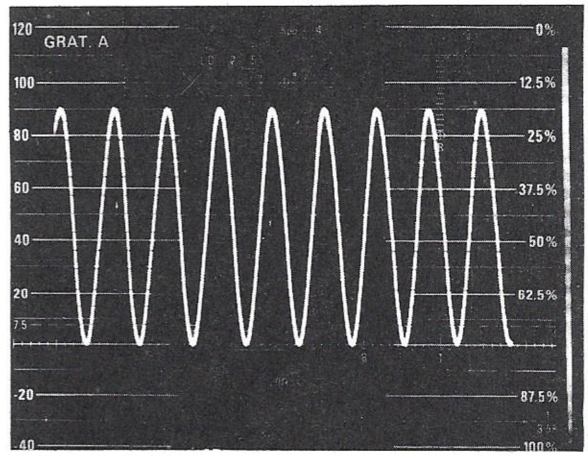
(B) Monochrome picture monitor display.

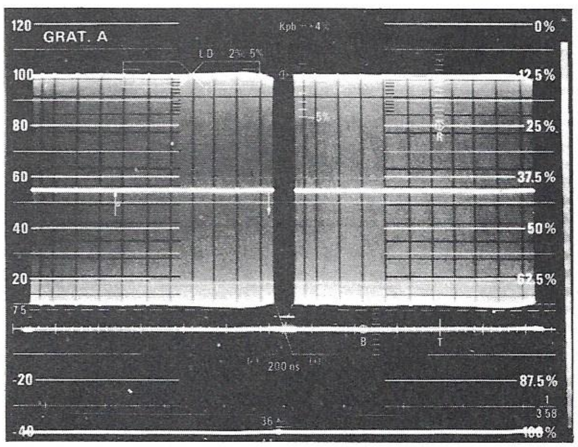
Fig. 1-4. TSG6 low range, full amplitude, composite sweep output signal; markers and burst on.



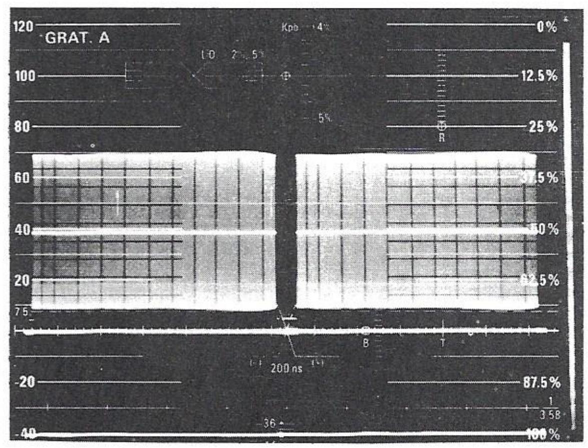
(A) Low range, full amplitude, composite manual mode; markers and burst on. Sweep rate: 5 μs/div.



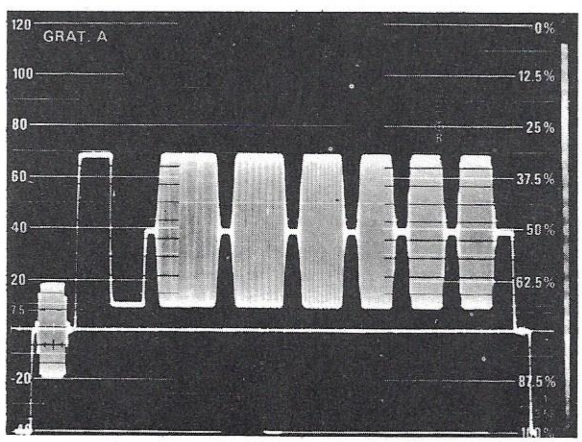
(B) Low range, full amplitude, continuous sine wave, manual mode. Sweep rate: 5 μs/div.



(C) High range, full amplitude, composite sweep mode; markers and burst on. Sweep rate: 2 Field.



(D) High range, reduced amplitude, composite sweep mode; markers and burst on. Sweep rate: 2 Field.



(E) Low range, reduced amplitude, composite multiburst, burst on, output signal. Sweep rate: 5 μs/div.

2528-04

Fig. 1-5. TSG6 output waveforms displayed on a TEKTRONIX Waveform Monitor that was modified to provide wideband frequency response. The TSG6 front-panel controls and waveform monitor sweep rate were set as described below each waveform.

REMOTE FUNCTIONS

The following remote functions are enabled through the 1410 rear-panel Remote J41 connector. Enabling is accomplished by ground closure.

MULTIBURST

Enables multiburst. Disables the front-panel MANUAL and SWEEP pushbuttons.

LAST BURST VARIABLE

If enabled, this allows the front-panel FREQUENCY control to be used for adjusting the last burst packet frequency in the MULTIBURST mode. The range of adjustment is reduced relative to normal operation (this also applies to MANUAL mode). This feature allows the operator to set the frequency of the last burst with a frequency counter when used in conjunction with the CALIBRATE remote function.

CALIBRATE

If enabled, this forces the module into CONTINUOUS operating mode. If MULTIBURST is selected from the front panel, then a continuous sine wave is obtained with the frequency of the last burst packet. If in SWEEP mode, a continuous unblanked sweep is obtained. This line disables all VITS keying.

VITS (Vertical Interval Test Signal)

The VITS Key enables multiburst during the vertical interval. During this interval, the VITS Key disables the front-panel MANUAL and SWEEP pushbutton positions. Fig. 1-6 shows the multiburst VITS signal that was enabled by the VITS Key.

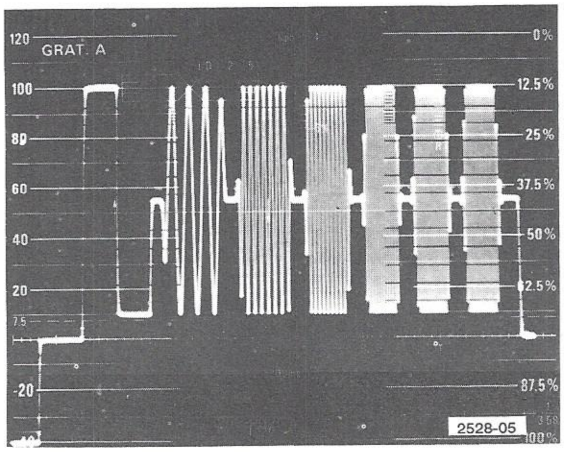


Fig. 1-6. Low range, full amplitude, composite multiburst VIT signal with burst off.

The VITS Key may originate from any one of three sources:

1. Internally from the TSP1 Test Signal Switcher, if installed.
2. Remotely via the 1410 rear-panel J41 Remote connector.
3. Internally from the black burst board (in SPG or TSG module).

Refer to the 1410 and TSP1 Instruction Manuals for more information concerning VITS enable.

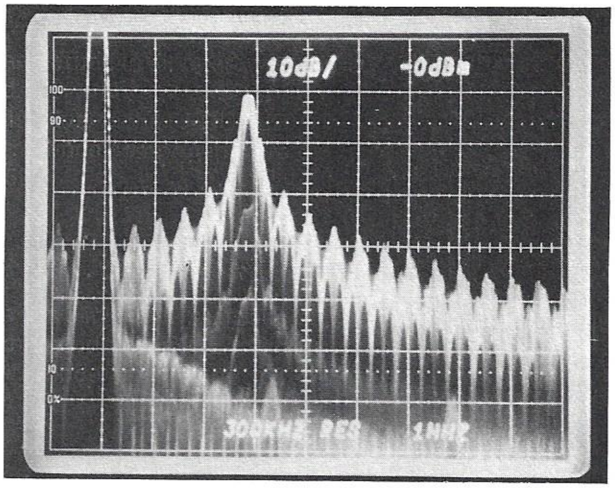
APPLICATIONS

NOTE

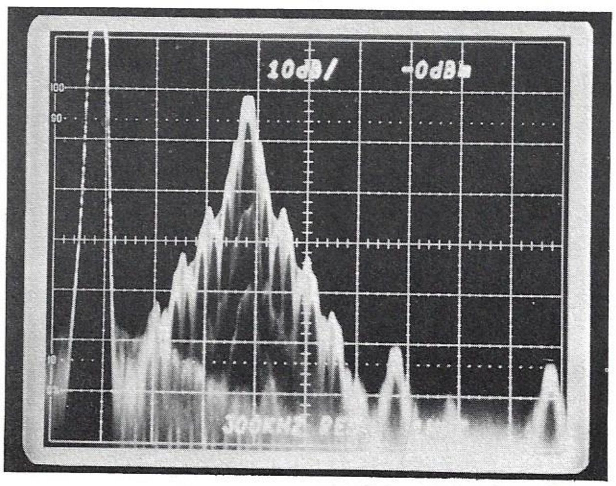
The waveform monitor displays in this section were obtained using a TEKTRONIX 1480 MOD W5F Waveform Monitor. This monitor was modified to provide wideband frequency response.

The TSG6 is a generator for analysis of devices or systems by frequency-domain techniques. It provides sine-wave excitation from 100 kHz to 20 MHz at a level of 643 mV or 428 mV into a 75-ohm load. The sine wave is function-generated to allow for rapid frequency variations required in multiburst operation. Attempt has been made to provide a sine wave with harmonic content commensurate with specified sweep flatness. Many ambiguities associated with system measurements made with multiburst in the past will be reduced through improvements made in the TSG6 multiburst. Harmonics due to the function-generation process have been reduced by design of a custom hybrid integrated circuit and refinements in the triangle-generation circuitry. However, the multiburst is still a sequence of discrete burst packets.

The spectrum of the multiburst signal consists of the convolution of the spectrum of the sine wave (ideally an impulse) and the spectrum of the gating waveform. In conventional multiburst this approximates a step function with a sinx/x spectrum. This multiburst, when viewed on a spectrum analyzer, will yield an amplitude spectrum of (sinx/x) squared shape. A TSG6 was modified to generate a single-frequency multiburst with risetimes of less than 50 ns and 4 μs durations. The resulting spectrum is shown in Fig. 1-7A. The same signal with risetime of 400 ns is shown in Fig. 1-7B. The reduction of skirt energy is graphically illustrated. The benefit of controlled risetime is further illustrated by Fig. 1-8A, the spectrum of the standard TSG6 low-range multiburst.



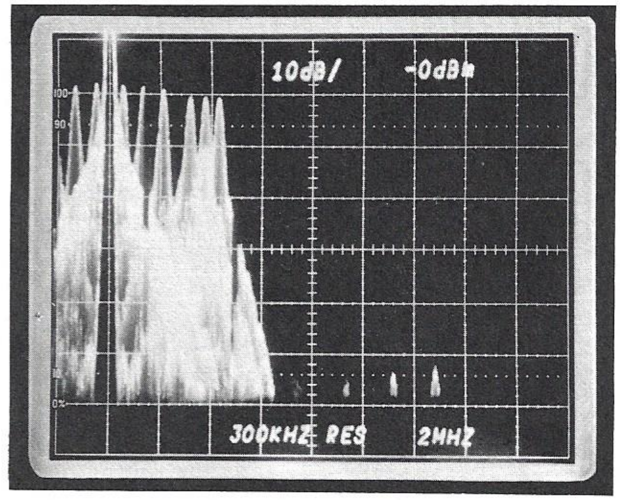
(A) Fast risetime of <50 ns; 4 μs duration.



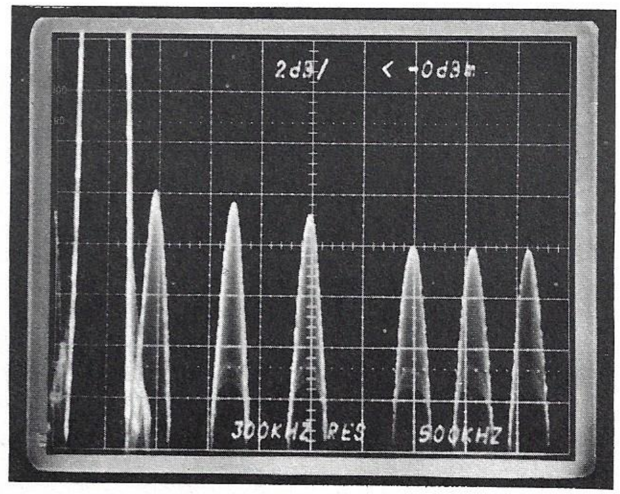
(B) Controlled risetime of 400 ns, 4 μs duration.

2528-06

Fig. 1-7. Spectrum analyzer displays of single-frequency multiburst signals.



(A) Unmagnified display.



(B) Magnified display. Packet duration (left to right): 7 μs, 6 μs, 5 μs, 4 μs, 4 μs, and 4 μs

2528-07

Fig. 1-8. Spectrum analyzer displays of a standard TSG6 low-range multiburst signal.

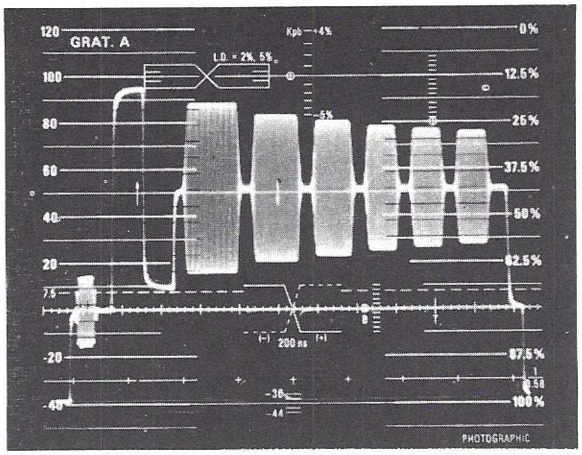
The TSG6 Multiburst is optimized for use with a waveform monitor, allowing lower frequency burst packets more time during the active line. When viewed on a spectrum analyzer this may result in misinterpretation of the flatness of the multiburst. Fig. 1-8B is a magnified version of the spectrum of a TSG6 low-range multiburst as viewed on a TEKTRONIX 7603 Oscilloscope with 7L12 Spectrum Analyzer at 2 dB/div. The burst packet is not of sufficient duration to obtain steady-state response of the analyzer. *The different packet widths result in more amplitude at the lower frequencies.* A PROM set is available to generate multiburst with six equal 4 μs duration burst packets where this is the primary purpose of the TSG6 (see Operating Mode Selection in the Installation section).

There are a wide range of applications in video facilities for frequency-domain measurements within the capabilities of the TSG6. The following are a sampling of such uses.

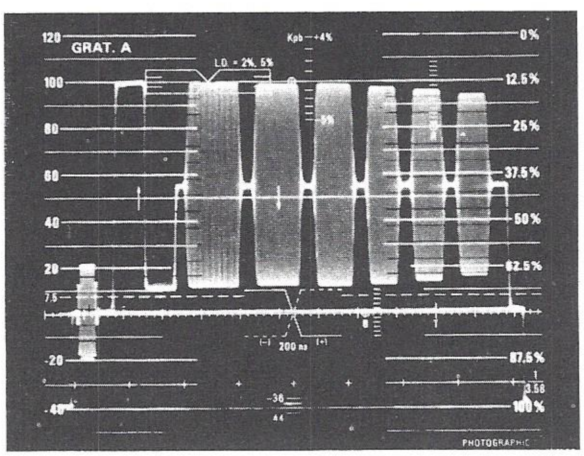
Cable Equalization

The transmission of video information over long lengths of cable degenerates the signal through frequency-dependent losses of the cable. One application of the high-range multiburst is to set equalization controls on distribution amplifiers with provisions for compensating cable losses. The TSG5 T/2 pulse is also needed to assure that the group delay after equalization is correct.

This application is demonstrated in Figs. 1-9A and 1-9B. Figure 1-9A is a photograph of losses through 500 feet of an unbalanced 75-ohm video cable. Fig. 1-9B illustrates the correction achieved by a cable-equalizing video distribution amplifier. This application can also demonstrate the use of the last burst variable mode of the TSG6. The standard high-range multiburst covers the range of 1.25 MHz to 12 MHz. Last Burst Variable operation allows adjustment of the last burst frequency from 14 MHz to 20 MHz. Fig. 1-10A is the equivalent of Fig. 1-9A with the last burst set at 15 MHz. Fig. 1-10B is the equalized output with last burst set at 15 MHz. Verification of 15 MHz last burst was done by grounding the TSG6 Calibrate Remote input and measuring the TSG6 output on a frequency counter.



(A) Uncompensated waveform obtained at output of cable.



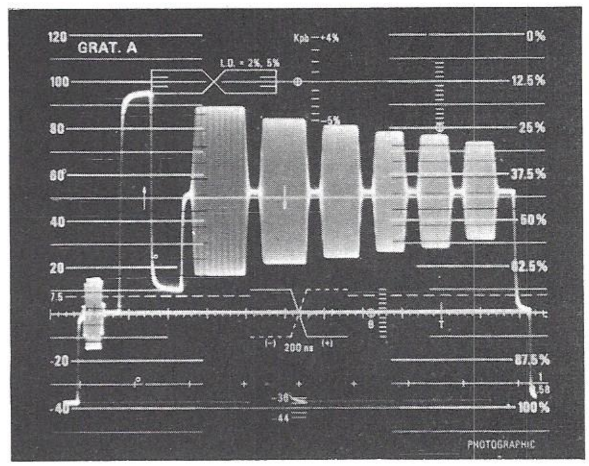
(B) Compensated waveform obtained at output of cable equalizer.

2528-08

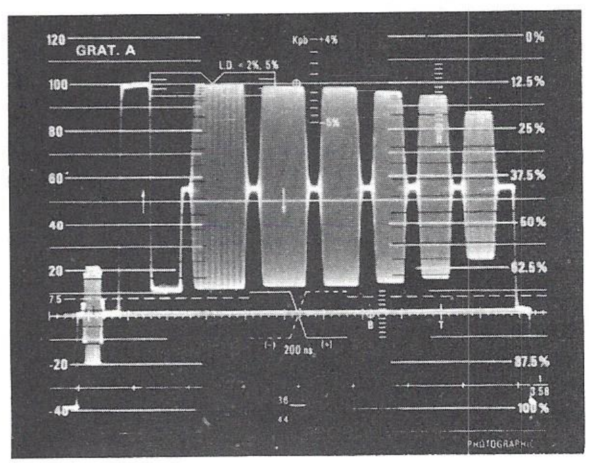
Fig. 1-9. Effect of 500 feet of unbalanced 75-ohm video cable on the high-range multiburst signal. Waveform (B) shows the signal compensated for cable losses by using a cable equalizer.

Video Test Equipment Verification

The TSG6 has been used to evaluate and verify performance of television test equipment. One application provides an illustration for use of low-range field and manual sweep with markers for both frequency and amplitude reference. The TEKTRONIX 1450 is a precision television demodulator. Calibration of the demodulator is performed in conjunction with a precision test modulator. Test signals can be modulated to intermediate frequency or radio frequency and demodulated through the 1450 mainframe or corresponding down converter. The TSG6 is used to sweep the mainframe and combination mainframe-down converter. The 1450 has provisions for



(A) Uncompensated.



(B) Compensated.

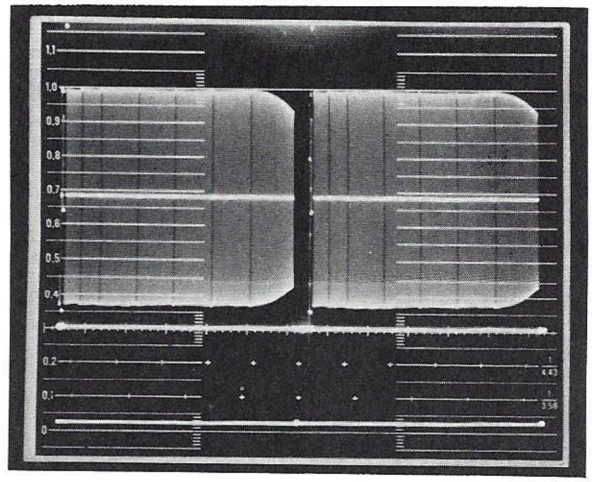
2528-09

Fig. 1-10. Same conditions as Fig. 1-9 except last burst variable mode was used. Last burst frequency was set at 15 MHz instead of using a standard frequency of 12 MHz.

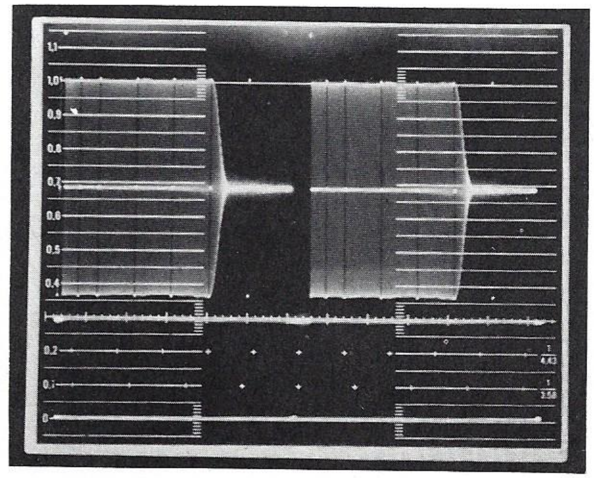
demodulating with or without a sound trap. Fig. 1-11A demonstrates flatness in wide-band mode (low-range sweep) and Fig. 1-11B shows flatness with sound-trap in. To determine the 3-dB cutoff frequency of the mainframe with sound trap, manual sweep in Last Burst Variable mode is used. Grounding the Last Burst Variable remote input to the TSG6 reduces the range of the front-panel FREQUENCY control to: 3.8 MHz to 4.5 MHz. Fig. 1-11C is a line-rate display of the signal with the front-panel knob set to achieve the desired amplitude. Note the ability to set the amplitude relative to the marker. The frequency can be measured by grounding the Calibrate remote input and connecting the TSG6 output to a frequency counter.

Television Studio Maintenance

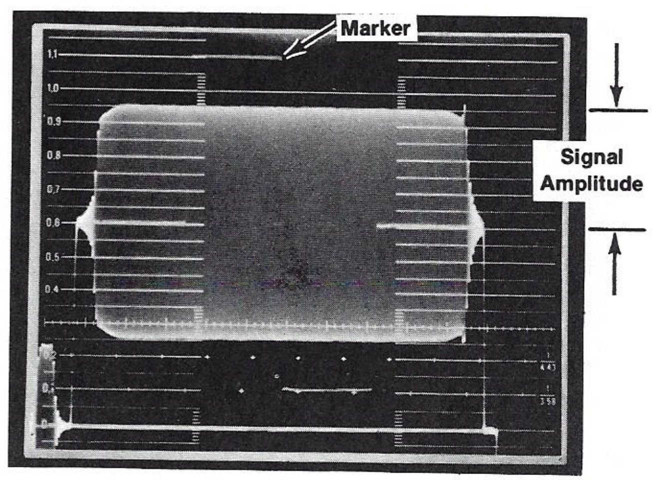
There are many points within the television studio at which frequency-response measurements are valuable. Several applications could be: 1) sweeping of routing switchers, 2) sweeping of production switchers, 3) testing of video tape recorders: electronic versus record/playback, 4) testing of time-base correctors, etc. Fig. 1-12A is a high-range sweep of a routing switcher. Figs. 1-12B and 1-12C are high-range, full- and reduced-amplitude sweeps (respectively) of a production switcher. These photographs illustrate the ability to examine performance of systems beyond specifications to check for deteriorating elements (i.e., slew-rate limiting amplifiers, reflections, oscillations, etc.). The low-range sweep is shown sweeping the electronic processing circuits in a helical scan video tape recorder in Fig. 1-13A. Fig. 1-13B is a playback on the same recorder. Fig. 1-13C illustrates the effect of recording with color processing, note the dip between 2 and 3 MHz.



(A) Without soundtrap. Sweep rate: 2 Field.

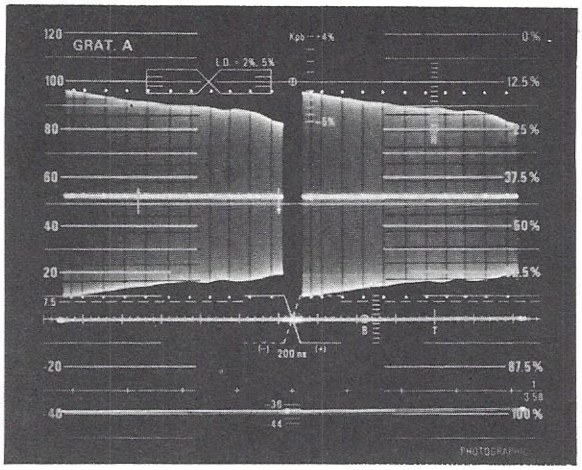


(B) With soundtrap. Sweep rate: 2 Field.

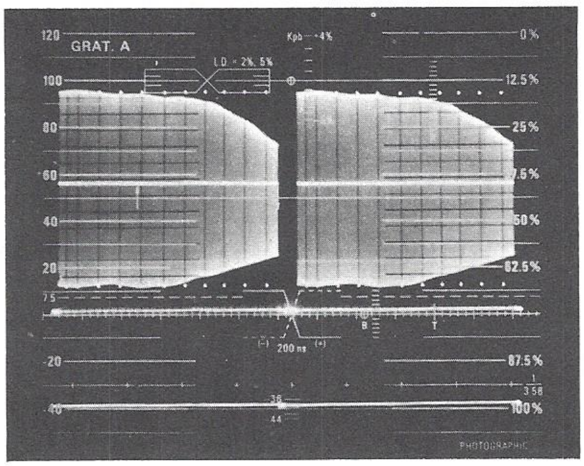


(C) With soundtrap. Sweep rate: 5 μs/div. 2528-10

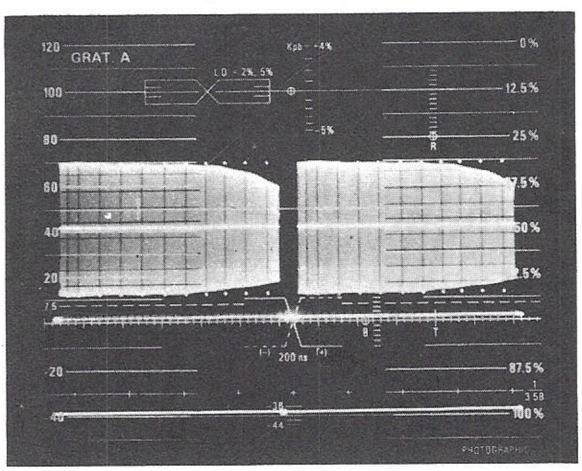
Fig. 1-11. Evaluating performance of a precision television demodulator.



(A) Routing switcher output.



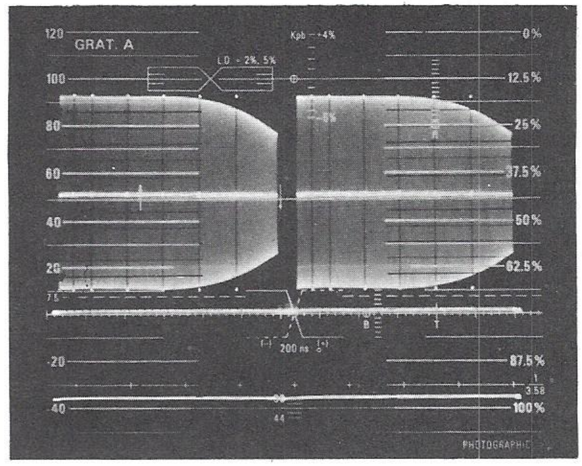
(B) Production switcher output.



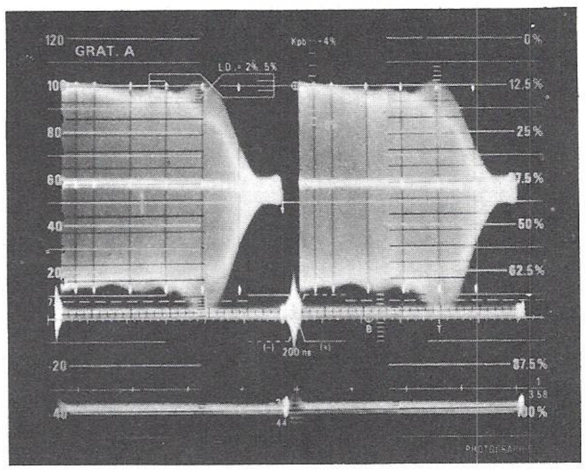
(C) Production switcher output.

2528-11

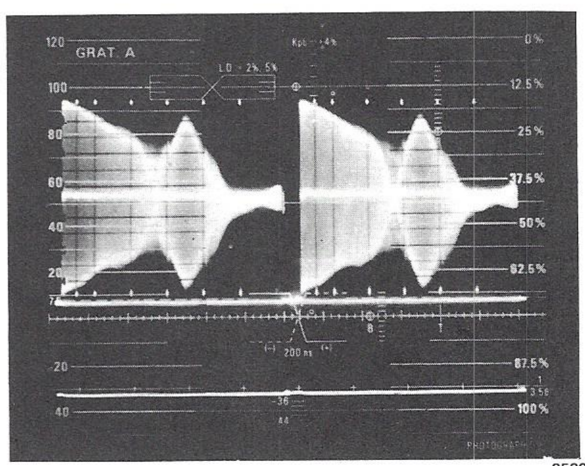
Fig. 1-12. Using the TSG6 high-frequency range sweep mode to check television switcher frequency response. Sweep rate of waveform monitor: 2 Field.



(A) Electronic processing circuit output.



(B) Direct color playback.



2528-12

(C) Heterodyne color processor playback.

Fig. 1-13. Using the TSG6 low-frequency range sweep mode to check helical scan VTR performance.

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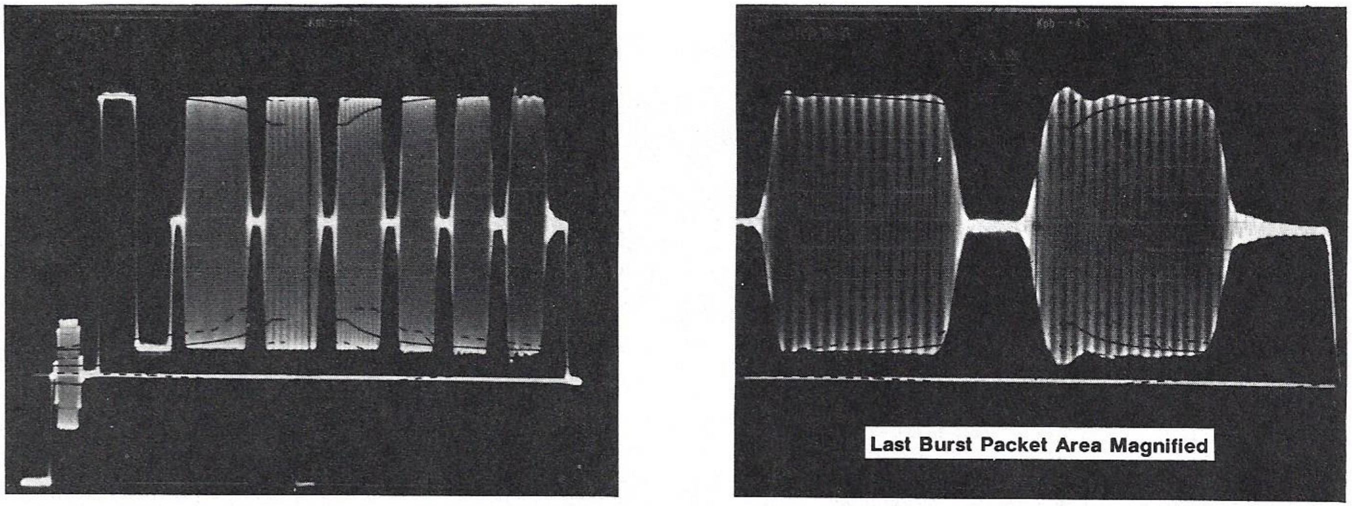
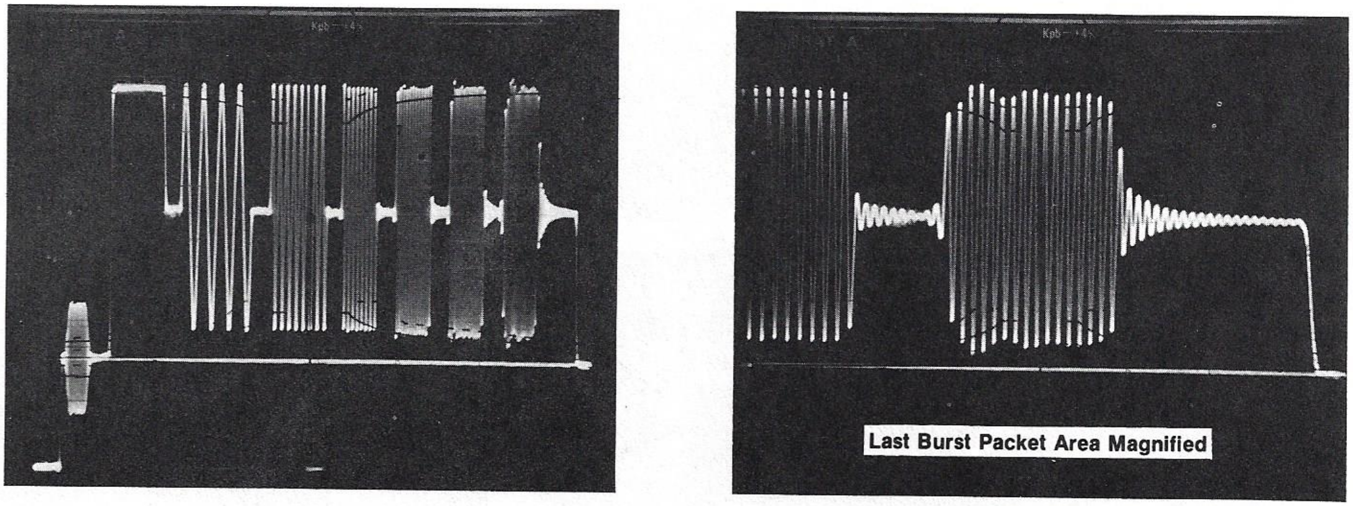


(A) TSG6 low-frequency range, full amplitude, multiburst signal.



(B) Conventional multiburst signal.

2528-13

Fig. 1-14. Comparing the TSG6 and conventional multiburst signals as observed at the output of a delay equalized low-pass filter (−40 dB at 5.5 MHz).

Common Carrier Transmission Testing

The low-range multiburst signal is commonly used to evaluate transmission over common-carrier microwave radio-relay links. The TSG6 can be VITS keyed to produce a multiburst in the vertical interval for insertion into a program. This allows in-service testing of the transmission path. The TSG6 multiburst, having less out-of-band energy because of controlled risetime, will produce less intermodulation distortion than previously available multiburst signals. Figs. 1-14A and 1-14B are full-field tests of a band-limited system, illustrating the difference between the TSG6 and conventional multiburst.

Picture Monitor Resolution

The low-range field and manual sweep can be used for comparative evaluation of horizontal resolution of picture monitors. By starting each line of the sweep at a fixed phase, the pattern displayed on a picture monitor is as shown in Fig. 1-4B. The frequency markers indicate positions in the field sweep corresponding to the appropriate frequencies. Figs. 1-15A and 1-15B represent the performance of two different high-resolution color picture monitors when tested using the low-frequency range sweep mode of the TSG6. Another use of the field sweep is detecting aliasing in pictures processed using digital techniques.

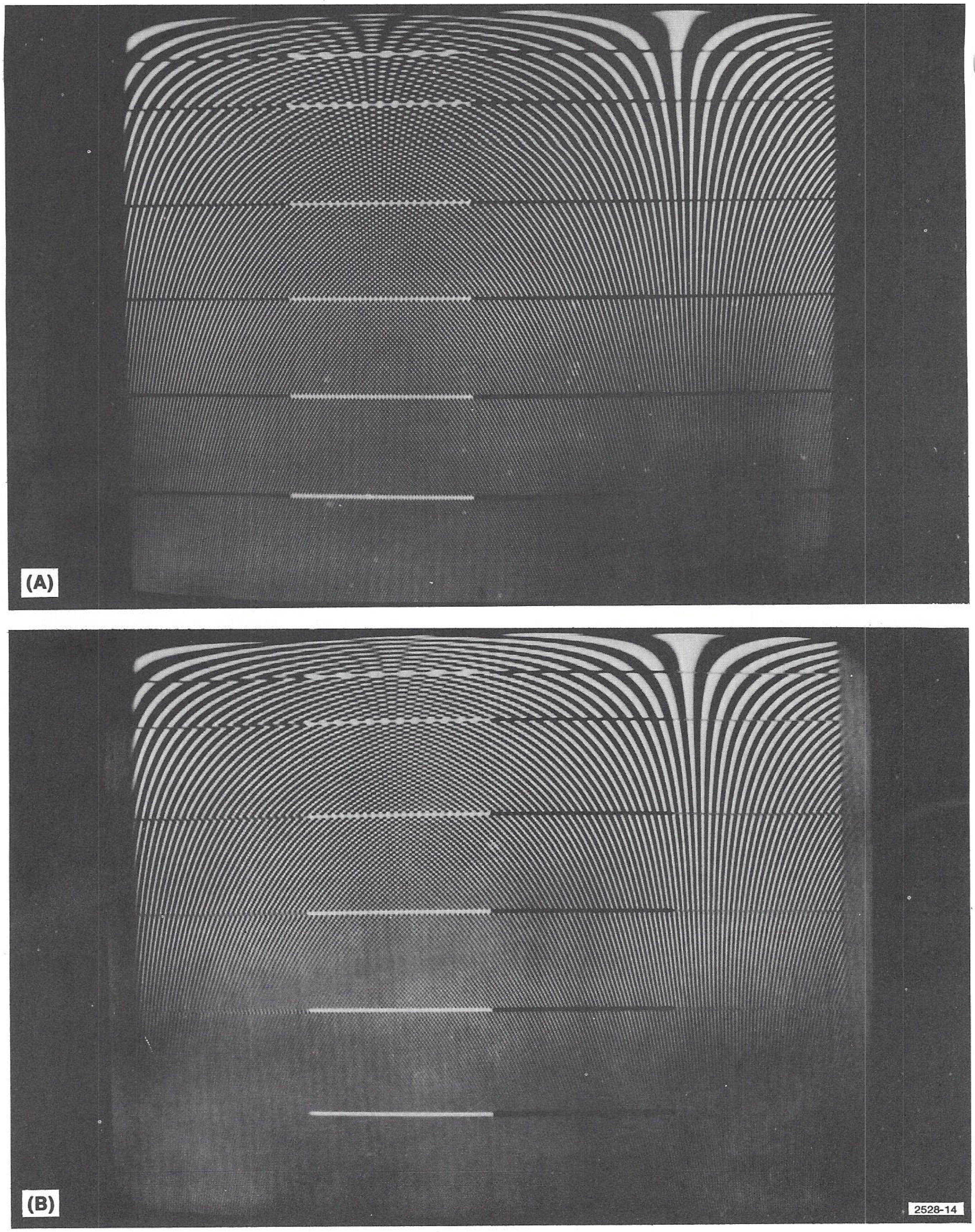


Fig. 1-15. Comparing performance of two different color picture monitors. Signal source: TSG6 low-frequency range sweep signal with markers on and burst off.

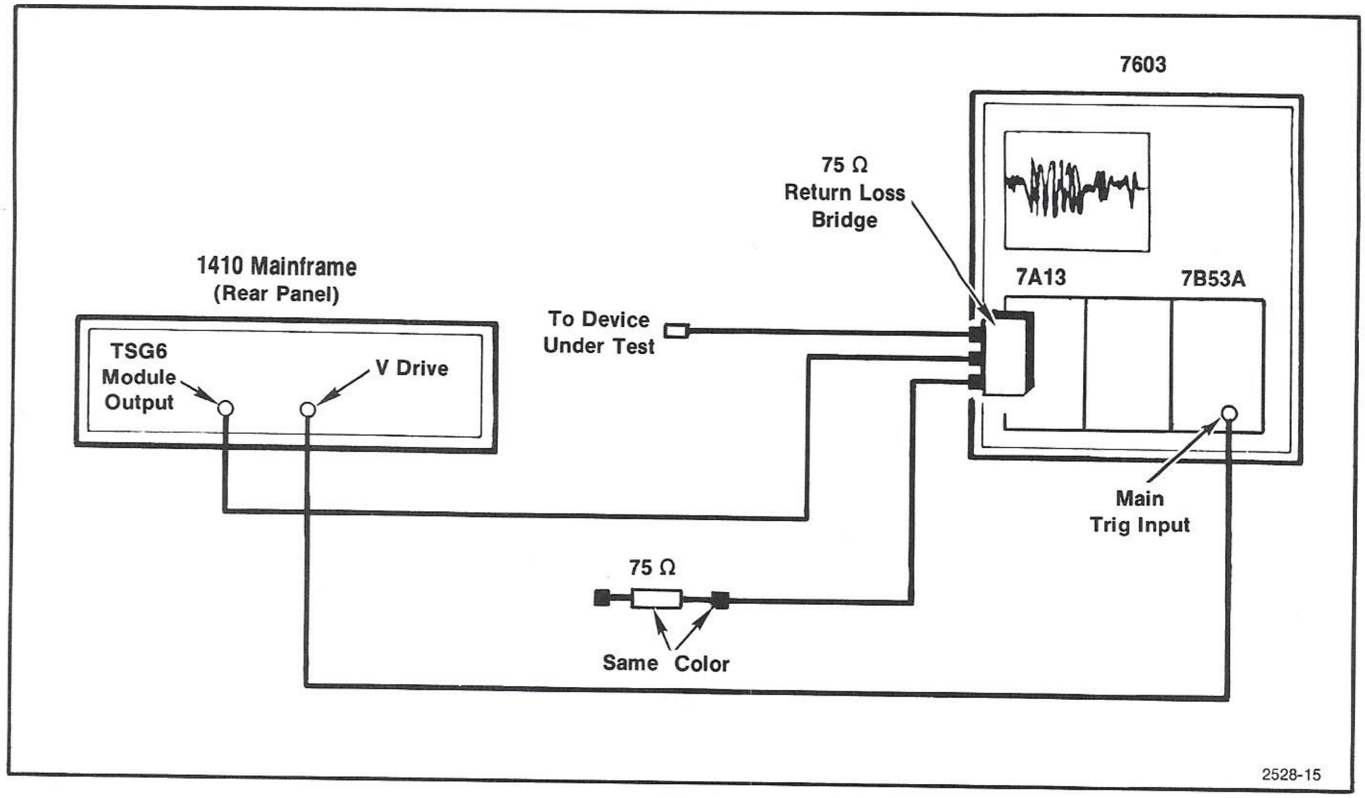
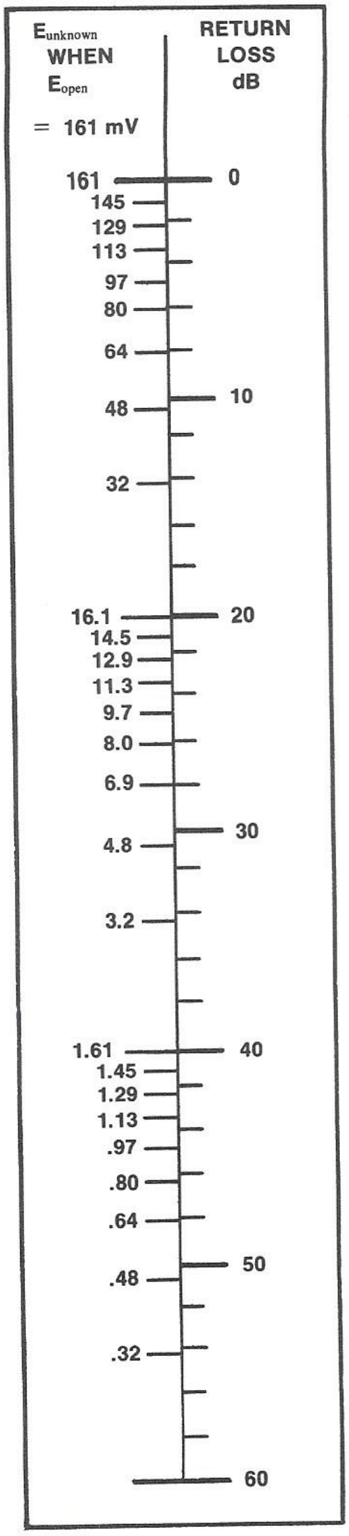


Fig. 1-16. Equipment connections for measuring return loss.

Return Loss Evaluation

The TSG6 provides convenient signals for evaluating return loss of video equipment when used in conjunction with: (1) TEKTRONIX Return Loss Bridge Part No. 015-0149-00, (2) TEKTRONIX 7603 Oscilloscope with a 7A13 Differential Comparator plug-in and a 7B53 Dual Time Base plug-in. This oscilloscope system provides an amplifier unit with the necessary common-mode rejection ratio to make return-loss measurements of better than 54 dB to 6 MHz and 46 dB to 20 MHz. The instruction manual for the Return Loss Bridge contains both theory of operation of the bridge and a detailed procedure for usage. The following changes are required to adapt the procedure for usage with the TSG6. The equipment setup is as shown in Fig. 1-16. The TSG6 can be operated in different modes, depending upon the desired measurement. Field SWEEP, MARKERS on, and CONTINUOUS provide a convenient display evaluation over either HIGH or LOW frequency range. MANUAL can be used for measurements at selected frequencies. The MULTI-BURST mode can also be used for line-rate displays on either frequency range. FULL amplitude should be used for best accuracy. This amplitude provides a 161 mV signal level for the E_{open} voltage. Fig. 1-17 is a nomograph to be used with the TSG6.



2528-16

Fig. 1-17. Nomograph for computing the return loss of a device under test.

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SPECIFICATION AND PERFORMANCE CHECK

SPECIFICATION

ELECTRICAL CHARACTERISTICS

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

Characteristic Instants

Signals shown in Fig. 2-1 are defined in characteristic instants. A characteristic instant equals approximately 2 μs (or 63.6 μs/32). T_0 is at the leading edge of sync.

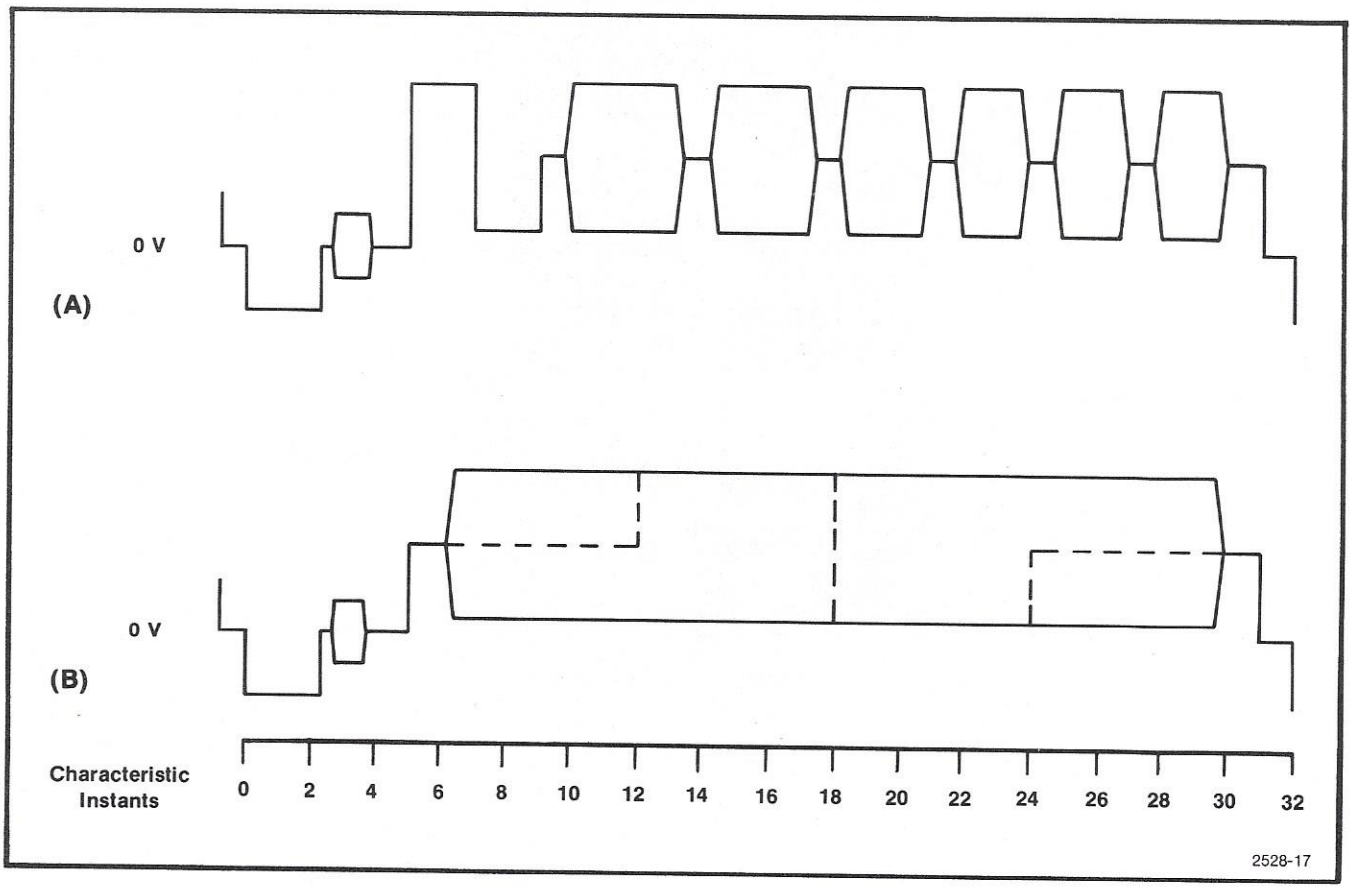

Fig. 2-1. Characteristic instants plotted against the TSG6 multiburst (A) and composite manual/sweep (B) signals.

Characteristics

Characteristics are the properties of the TSG6.

Performance Requirement

Items listed in the Performance Requirement column of the Electrical Characteristics are quantitative terms of performance, usually stated in terms of tolerance limits, and are guaranteed by Tektronix, Inc. Items in this column that are verified in the Performance Check Procedure, which follows this Specification, are indicated by a Performance Check Step number. Items not verified in the Performance Check Procedure may be one or more of the following:

a. Parameters that are dependent upon other 1410 system components (i.e., an SPG unit), where they are verified in the appropriate Instruction Manual.

b. Parameters that are fixed by the nature of their function, such as range settings of switches, etc.

c. Characteristics that are digitally derived from a timing reference that is checked (for example, from a crystal-controlled oscillator whose frequency is checked).

d. Characteristics of a very stable nature that would necessitate an exhaustive procedure and require test equipment that is not commonly available in order to perform a check.

Supplemental Information

Items listed in the Supplemental Information column are not verified in this manual; they are either explanatory notes or performance characteristics for which no performance check procedure is provided.

Table 2-1

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement		Supplemental Information	Perf. Ck. Step No.
	Low Range	High Range		
Multiburst				
Frequencies	500 kHz ±3% 1.25 MHz ±3% 2.00 MHz ±3% 3.00 MHz ±3% 3.58 MHz ±3% 4.10 MHz ±3%	1.25 MHz ±3% 3.50 MHz ±3% 5.50 MHz ±3% 8.00 MHz ±3% 10.0 MHz ±3% 12.0 MHz ±3%		1
Amplitude (First Multiburst Packet)				
Full (see Fig. 1-3)	643 mV (90 IRE) ±20 mV	643 mV ±25 mV		5
Reduced (see Fig. 1-5E)	428 mV (60 IRE) ±12 mV	428 mV ±16 mV		
Flatness				
Full	10 mV or less	16 mV or less		9
Reduced	10 mV or less	16 mV or less		
Packet Envelope Risetime	400 ns ±60 ns	400 ns ±60 ns		6
Burst Phasing			Phase shifted at field rate to provide filled-in burst packets.	

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Table 2-1 (cont)

Characteristics	Performance Requirement Low Range	High Range	Supplemental Information	Perf. Ck. Step No.
Sweep/Manual				
Sine Wave				
Frequencies				
Start	100 kHz minimum	330 kHz minimum		4
Stop	6 MHz ±10%	20 MHz ±10%		
Amplitude at First Marker				
Full (see Figs. 1-4 & 1-5C)	643 mV ±20 mV	643 mV ±25 mV		5
Reduced (see Fig. 1-5D)	428 mV ±12 mV	428 mV ±16 mV		
Flatness (Max-Min Diode Detected Peak-to-Peak Voltage)				
Full	10 mV	15 mV to 12 MHz 20 mV to 20 MHz		9
Reduced	10 mV	15 mV to 12 MHz 20 mV to 20 MHz		
Markers				
Frequencies (see Figs. 1-4, 1-5C & 1-5D)	500 kHz ±3%[a] 1.0 MHz ±3%[a] 2.0 MHz ±3%[a] 3.0 MHz ±3%[a] 4.0 MHz ±3%[a] 5.0 MHz ±3%[a]	1.0 MHz ±3%[a] 2.0 MHz ±3%[a] 4.0 MHz ±3%[a] 6.0 MHz ±3%[a] 8.0 MHz ±3%[a] 10.0 MHz ±4%[a] 12.0 MHz ±4%[b] 14.0 MHz ±6%[b] 16.0 MHz ±7%[b] 18.0 MHz ±7%[b] 20.0 MHz ±7%[b]		2
Multiburst/Manual (Last Burst Variable Mode)				
Frequency Range				
Start	<3.8 MHz	<14 MHz		3
Stop	>4.5 MHz	20 MHz ±10%		
Accuracy	±0.2% short term	±1% short term		

[a]Within one television line either side of the marker.

[b]Above 10 MHz, difference frequency between markers is 2 MHz ±400 kHz.

Table 2-1 (cont)

Characteristics	Performance Requirement Low Range	High Range	Supplemental Information	Perf. Ck Step No.
Markers & Pedestal (all modes)				
Amplitude				
Markers Relative to Pedestal Level				
Full (see Fig. 1-5A)	±321 mV ±1%	±321 mV ±1%		5
Reduced	±214 mV ±1%	±214 mV ±1%		
Pedestal Level				
Full	393 mV ±1%	393 mV ±1%		
Reduced	286 mV ±1%	286 mV ±1%		
Risetime	250 ns ±50 ns	250 ns ±50 ns		6
Harmonic Distortion (Full Amplitude Mode; Single Frequency Relative to Fundamental)	−44 dB, 300 kHz to 4.2 MHz −40 dB, 100 kHz to 300 kHz −40 dB, 4.2 MHz to 6.0 MHz	−38 dB, 330 kHz to 6.0 MHz −36 dB, 6.0 MHz to 20 MHz	Harmonic distortion in reduced amplitude mode may be degraded by up to 2 dB from full amplitude specification.	8
Sync				
Amplitude	−285.7 mV ±5.7 mV. −40 IRE from blanking.			5
Timing			From 1410 Composite Sync	
Risetime	130 ns +20 ns, −10 ns			6
Half Amplitude Duration (HAD)			4.70 μs ±100 ns	
Burst (Color)				
Amplitude	285.7 mV (40 IRE) ±8.6 mV peak-to-peak			5
Phase	Adjustable ±10°. From 1410 Subcarrier Reference.			7
Timing			From 1410 TSG Burst Flag	
Risetime	400 ns ±60 ns			6
Half Amplitude Duration			2.51 μs ±70 ns (9 cycles of subcarrier)	
Delay from Line Sync			5.309 μs ±35 ns (19 cycles of subcarrier)	
Breezeway			475 ns typical	
Output Impedance			75 Ω nominal	
Return Loss	30 dB or more to 20 MHz			10

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Table 2-1 (cont)

Characteristics	Performance Requirement	Supplemental Information	Perf. Ck. Step No.
Isolation			
Passive	Amplitude of all signal components, less than 5 MHz, at one output change less than 1% (40 dB) as the other output is switched to open or short circuit.	See Section 4, step 22, in the Calibration Procedure.	
Active (Non-coherent Crosstalk)	A signal introduced at one output connector shall be attenuated by at least 20 dB at the other connector.		

ENVIRONMENTAL CHARACTERISTICS

Table 2-2

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement
Temperature	
Operating	0°C to 50°C.
Storage	−40°C to +65°C.

Characteristic	Performance Requirement
Altitude	
Operating	To 15,000 feet.
Storage	To 50,000 feet.

PERFORMANCE CHECK

Introduction

This procedure is to be used to verify that the TSG6 is performing to specification. None of the checks in this procedure involve any internal adjustments or operating changes. **Do not remove any protective covers from the 1410 mainframe.**

NOTE

The procedure assumes that the internal jumpers are set to their factory-set positions.

Complete the entire procedure. If the TSG6 does not meet some of the performance requirements, a qualified service technician can refer to the Calibration Procedure in Section 4 of this manual to determine the adjustment step(s) that may need to be performed.

In the procedure, the TSG6 front-panel control names are all capitalized; for example, FREQ RANGE. Controls and connector names for the 1410 mainframe with its SPG2 Sync Generator and the names for the associated test equipment have only their first letter capitalized; for example, Module Output connector. No capitals are used if a generic term is used when referring to associated test equipment; for example, set the test oscilloscope time base triggering controls for internal triggering mode of operation.

TEST EQUIPMENT

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

1. TEKTRONIX 1410 Generator mainframe with an SPG2 NTSC Sync Generator Module.

With the TSG6 to be verified installed in the 1410 mainframe, and a remote control unit connected to the 1410 mainframe Remote connector.

2. Sine Wave Generator.

Frequency range, 250 kHz to 20 MHz. Frequency accuracy is not critical, since the frequency counter (item 3) is used for the readout. Output amplitude, approximately 200 mV to 300 mV and 6 V to 7 V. (Approximately 6.6 V is needed to drive the 015-0149-00 Return Loss Bridge). For example, a TEKTRONIX SG 503 Leveled Sine Wave Generator in a TM 503 mainframe.

3. Digital Counter.

Frequency range, 100 kHz to 20 MHz. Display, at least 4 digits. Minimum accuracy, 1%. Sensitivity, 200 mV peak-to-peak. For example, a TEKTRONIX DC 501 Digital Counter in a TM 503 mainframe.

4. Test Oscilloscope.

Dual Time Base. Range from 100 ns/div to 2 ms/div with provisions for delaying sweep.

Differential Comparator. Bandwidth, dc to 75 MHz (including mainframe). Minimum deflection factor, 5 mV/div.

For example, a TEKTRONIX 7603 Oscilloscope mainframe with a 7B53A Dual Time Base and a 7A13 Differential Comparator plug-in units.

5. Spectrum Analyzer.

Capable of measuring harmonic distortion of signals from 100 kHz to 20 MHz. Single frequency relative to fundamental harmonic distortion measurement capability: −46 dB. For example, a TEKTRONIX 7L12 Spectrum Analyzer in a 7000-Series Oscilloscope mainframe. Can be used with item 4.

6. Waveform Monitor.

Capable of viewing line-rate and field-rate signals. Contains a magnifier to measure risetime and check wave shape. For example, a TEKTRONIX 1480 NTSC Waveform Monitor with Graticule A.

7. Vectorscope.

Capable of measuring phase differences of less than 0.5° between two signals. For example, a TEKTRONIX 520A NTSC Vectorscope.

8. Video Detector.

Rectifies and detects the peak amplitude of the applied signal. For example, a Marconi TM9703 Video Detector.

9. Return Loss Bridge.

Return loss for the specification was verified using the following Marconi test equipment: TM9692 Video Sweep Unit, TF2361 Sweep Generator, TF2907 Differential Probe Unit, and TM9827 Return Loss Probe.

An alternate method was used in this Performance Check procedure. This method uses the TEKTRONIX 015-0149-00 Return Loss Bridge driven by the TEKTRONIX SG 503 Leveled Sine Wave Generator (item 2). The Return Loss Bridge is used with the TEKTRONIX 7603 Oscilloscope and 7B53A/7A13 plug-in units (item 4).

10. 50-Ohm to 75-Ohm Minimum Loss Attenuator.

Tektronix Part No. 011-0057-00.

11. BNC T Adapter.

Tektronix Part No. 103-0030-00.

12. 50-Ohm Coaxial Cable.

Two required. 42 inches long. Tektronix Part No. 012-0057-01.

13. 75-Ohm 10X Attenuator.

Tektronix Part No. 011-0061-00.

14. 75-Ohm End-Line Termination.

Two required. Tektronix Part No. 011-0102-00.

15. 75-Ohm Feed-Through Termination.

Tektronix Part No. 011-0103-00.

16. 75-Ohm Coaxial Cable.

Three required. 42 inches long. Tektronix Part No. 012-0074-00.

17. Calibration Fixture.

For use with 1480 Waveform Monitor (item 7). Refer to Fig. 2-2 and the topics, "Calibration Fixture" and "Measurements Using the Calibration Fixture", that follow for details.

Calibration Fixture

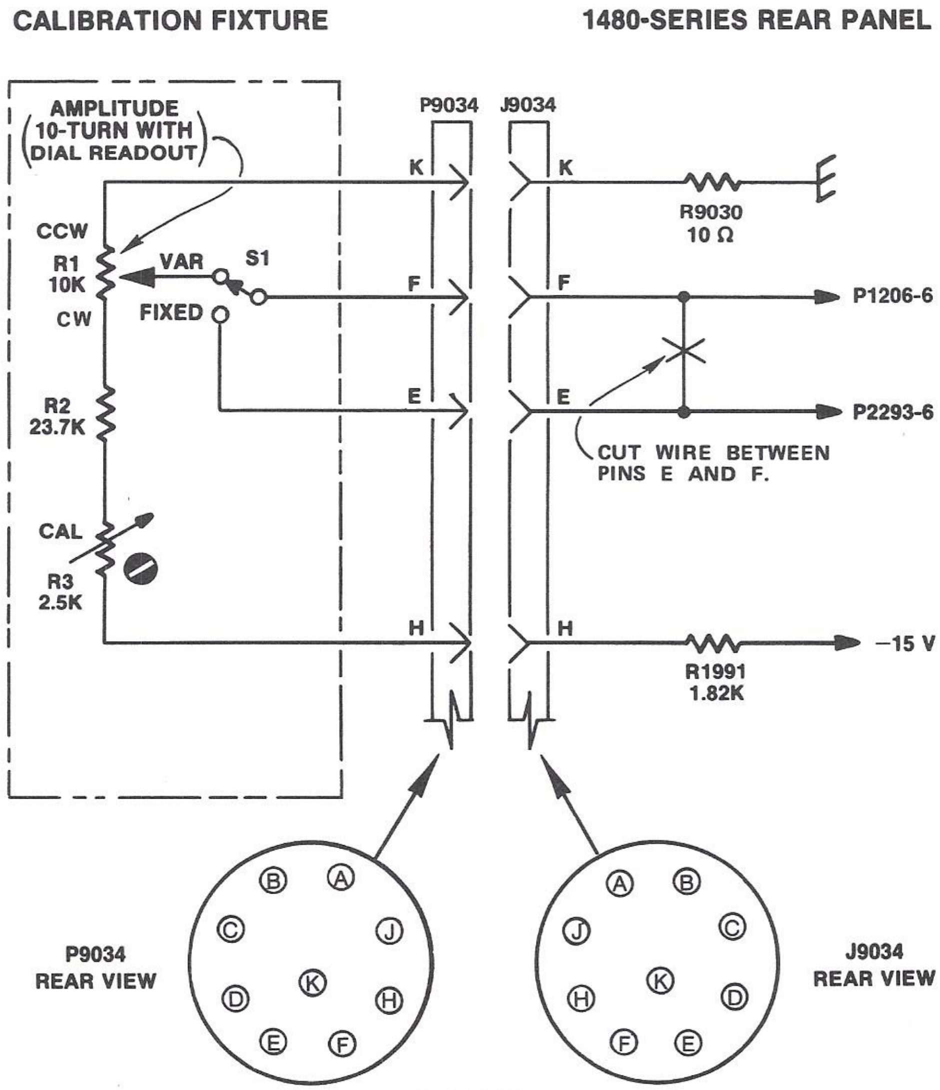
This fixture and the 1480 Waveform Monitor provide a variable calibration voltage level which can be read directly from a 10-turn dial. The schematic diagram and parts list for the fixture appear in Fig. 2-2. When S1 is in the Variable position, the 1480 calibrator voltage is determined by the circuit in the fixture.

With P9034 connected to J9034 on the 1480, set the fixture S1 to the Fixed position. Push in the 1480 Sync Tip and Cal buttons to display the internal calibrator 1 V square wave. Calibrate the graticule for 1 V. Set the Amplitude dial to 1000 and S1 to Variable. Adjust R3 (CAL), to exactly match the internal 1 V calibrator level. The dial is now calibrated so that each turn of the dial represents 100 mV.

Measurements Using the Calibration Fixture

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

Peak-to-peak chrominance amplitude can be checked for tolerance by adjusting the fixture Amplitude dial until the peaks of the chrominance packet being measured just meet.



Parts List

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

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

2528-18 (2329-04)

Fig. 2-2. Waveform Monitor Calibration Fixture.

PROCEDURE

Preliminary Instructions

Before starting this procedure, the TSG6 should be installed in the 1410 Generator mainframe along with an SPG2 module.

Allow a 20 minute warmup period for the 1410 system and all test equipment before starting the procedure.

The SPG2 installed in the 1410 mainframe should be set for internal mode of operation.

1. Check Multiburst Frequencies

a. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor CH A Video Input connector. Terminate the remaining CH A Video Input connector into 75 ohms. See Fig. 2-3.

b. Connect the output signal from the sine-wave generator via a 50-ohm coaxial cable to the 1480 Waveform Monitor CH B Video Input connector. Leave the Ch B loop-through connector unterminated. See Fig. 2-3.

c. Connect the 1410 mainframe or SPG2 Comp Sync signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A External Sync input connector. Terminate this loop-through connector into 75 ohms.

d. Set the TSG6 and test equipment controls as follows:

TSG6

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	Off

Sine-Wave Generator

Output Frequency	500 kHz
Output Amplitude	Approximately 286 mV (40 IRE)

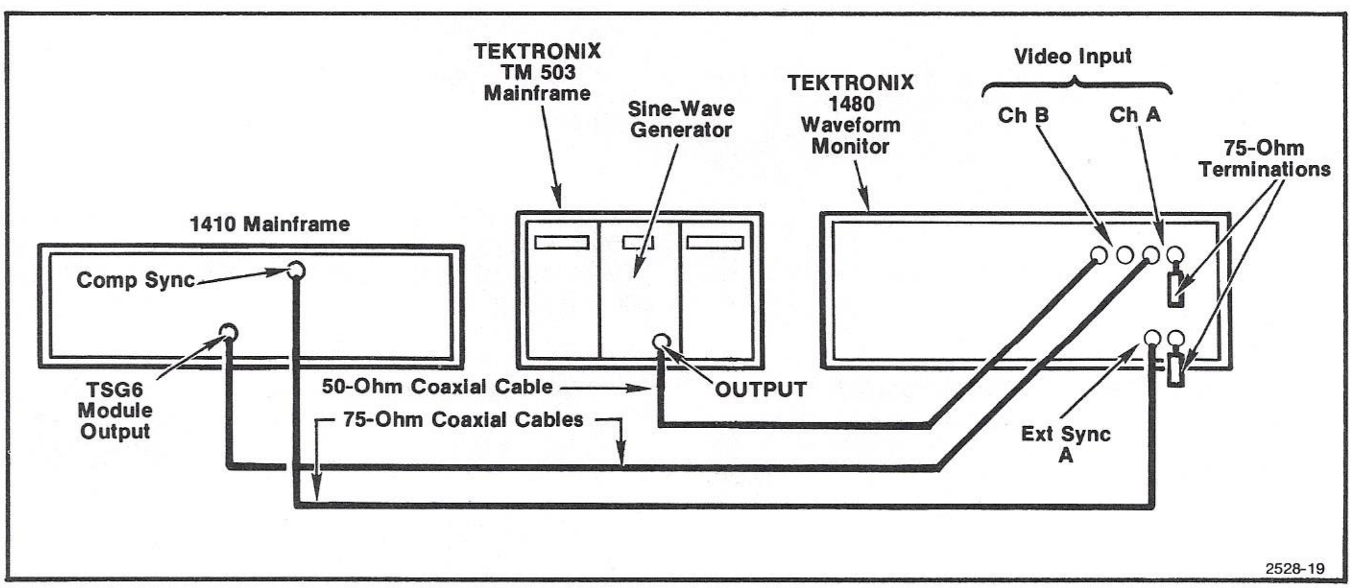


Fig. 2-3. Equipment connections for checking TSG6 multiburst and marker frequencies.

Table 2-3

CHECKING MULTIBURST FREQUENCIES

TSG6 FREQ RANGE Switch Setting	Multiburst-Packet Frequency	PROCEDURE: Set sine-wave generator to obtain a zero beat within the following range.
HIGH	1.25 MHz ±3%	1.29 MHz to 1.21 MHz
	3.50 MHz ±3%	3.61 MHz to 3.40 MHz
	5.50 MHz ±3%	5.67 MHz to 5.34 MHz
	8.00 MHz ±3%	8.24 MHz to 7.76 MHz
	10.0 MHz ±3%	10.30 MHz to 9.70 MHz
	12.0 MHz ±3%	12.36 MHz to 11.64 MHz
LOW	2.00 MHz ±3%	2.06 MHz to 1.94 MHz
	3.00 MHz ±3%	3.09 MHz to 2.91 MHz
	3.58 MHz ±3%	3.69 MHz to 3.47 MHz
	4.10 MHz ±3%	4.22 MHz to 3.98 MHz

1480 Waveform Monitor

Input	A-B, DC Coupled
Response	Flat
Volts Full Scale	1.0
DC Restorer	Slow, Backporch
Oper/Cal	Oper
Display	10 μs/Div
Magnifier	X1
Field	1
Line Selector	Variable
Sync	Ext. AFC

e. CHECK—500-kHz multiburst-packet frequency by slowly rotating the sine-wave generator Variable Frequency control until a zero beat is obtained (see Fig. 2-4A). The readout frequency should be 500 kHz ±3% or equivalent to 515 kHz to 485 kHz.

f. Set the sine-wave generator for an output frequency of 1.25 MHz.

g. CHECK—1.25-MHz multiburst-packet frequency by rotating the sine-wave generator Variable Frequency control until a zero beat is obtained. The readout frequency should be 1.25 MHz +3% or equivalent to 1.29 MHz to 1.21 MHz. See Fig. 2-4B.

h. CHECK—the remaining multiburst frequencies listed in Table 2-3 using the technique described in parts d through g of this step as a guide.

2. Check Marker Frequencies

a. Use the same equipment connections and control settings as described in parts a through d of step 1 except as follows:

TSG6

MARKERS	On
MULTIBURST/SWEEP/ MANUAL	SWEEP

Sine Wave Generator

Output Amplitude	200 mV (28 IRE)

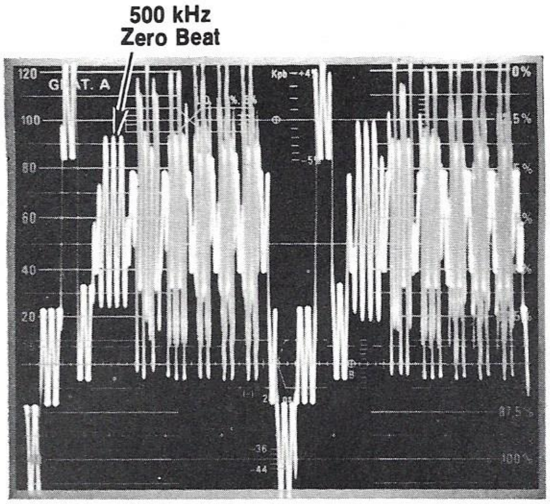
1480 Waveform Monitor

Display	2 Field

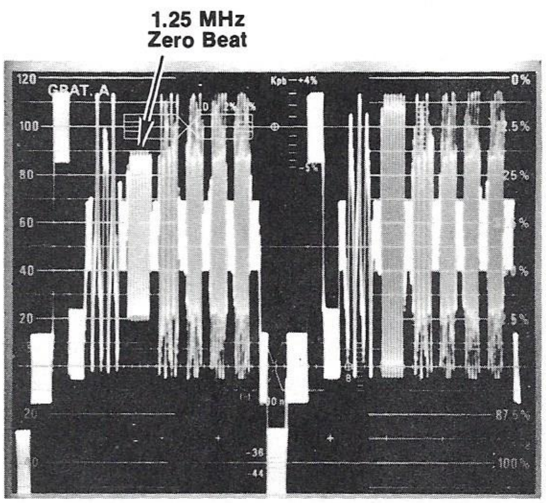
b. Check that the sine-wave generator is set for an output frequency of 500 kHz. Rotate the waveform monitor Variable Line Selector control to intensify the 500 kHz marker as shown in Fig. 2-5A.

c. Set the waveform monitor Display switch to 10 μs/Div. Check that the marker is displayed as shown in Fig. 2-5B. Set the TSG6 MARKERS pushbutton to Off.

d. CHECK—500-kHz marker frequency by rotating the sine-wave generator Variable Frequency control until a zero beat is obtained as shown in Fig. 2-5C. The frequency should be 500 kHz ±3% or 515 kHz to 485 kHz within one television line either side of the marker. For example, if the



(A) 500 kHz.

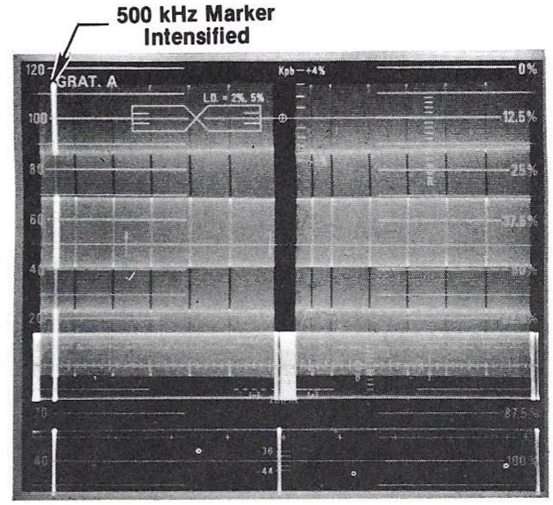


(B) 1.25 MHz.

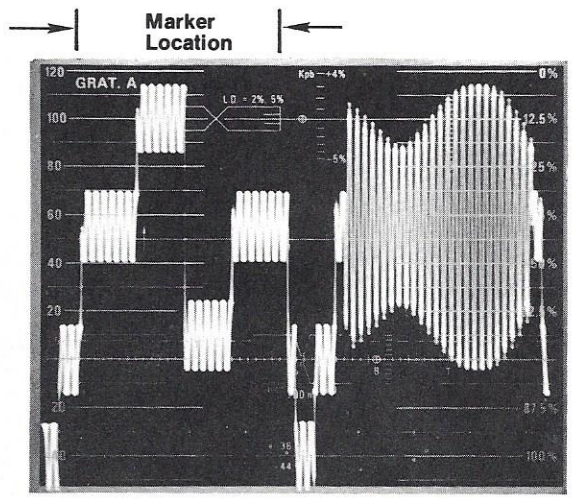
2528-20

Fig. 2-4. Typical waveforms obtained when checking the multiburst packet frequency using zero beat method. Waveform monitor Input switch set to A-B, DC Coupled.

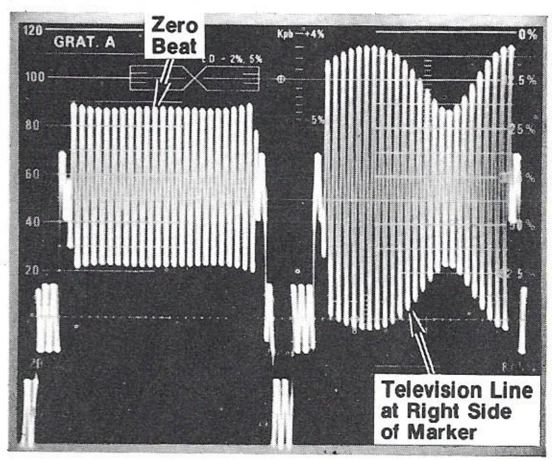
readout is 516 kHz at the marker location, obtain a zero beat on the television line located to the left of the marker. Then, obtain a zero beat on the television line to the right of the marker. (The TSG6 MARKERS button can be set to On while making the checks described in this example.) If the readout is 515 kHz or lower at one of these television line locations, the marker meets the performance requirement.



(A) 500 kHz marker intensified. Waveform monitor Display switch set to 2 Field.



(B) Location of 500 kHz marker. Waveform monitor Display switch set to 10 μs/Div.



(C) Zero beat at 500 kHz marker location. TSG6 MARKERS button set to Off. 2528-21

Fig. 2-5. Typical displays obtained when checking marker frequency.

Table 2-4

CHECKING MARKER FREQUENCIES

TSG6 FREQ RANGE Switch Setting	Marker Frequency	PROCEDURE: Locate appropriate marker and obtain a zero beat within the following range.	
LOW	2.0 MHz ±3%	2.06 MHz to 1.94 MHz	Within one television line either side of marker.
	3.0 MHz ±3%	3.09 MHz to 2.91 MHz	
	4.0 MHz ±3%	4.12 MHz to 3.88 MHz	
	5.0 MHz ±3%	5.15 MHz to 4.85 MHz	
HIGH	1.0 MHz ±3%	1.03 MHz to 0.97 MHz	
	2.0 MHz ±3%	2.06 MHz to 1.94 MHz	
	4.0 MHz ±3%	4.12 MHz to 3.88 MHz	
	6.0 MHz ±3%	6.18 MHz to 5.82 MHz	
	8.0 MHz ±3%	8.24 MHz to 7.76 MHz	
	10.0 MHz ±4%	10.40 MHz to 9.60 MHz	
	12.0 MHz ±4%	12.48 MHz to 11.52 MHz	Difference frequency between markers should be 2 MHz ±400 kHz.
	14.0 MHz ±6%	14.84 MHz to 13.16 MHz	
	16.0 MHz ±7%	17.12 MHz to 14.88 MHz	
	18.0 MHz ±7%	19.26 MHz to 16.74 MHz	
	20.0 MHz ±7%	21.40 MHz to 18.60 MHz	

e. Set the TSG6 MARKERS button to On. Set the waveform monitor Display switch to 2 Field and rotate the Variable Line Selector control to intensify the 1.0 MHz marker. Set the Display switch to 10 μs/Div and note the location of the marker on the waveform monitor display. Set the TSG6 MARKERS pushbutton to Off.

f. CHECK—1.0 MHz marker frequency by rotating the sine-wave generator Variable Frequency control until a zero beat is obtained. The readout frequency should be 1.0 MHz ±3% or 1.03 MHz to 0.97 MHz within one television line either side of the marker.

g. Set the waveform monitor Display switch to 2 Field and the TSG6 MARKERS button to On.

h. CHECK—the remaining marker frequencies listed in Table 2-4 using the technique described in parts b through g of this step as a guide.

i. Set the TSG6 FREQ RANGE switch to LOW and the MARKERS pushbutton to Off.

3. Check Multiburst/Manual Frequency Range and Accuracy

NOTE

The Multiburst/Manual (last burst variable mode) frequency range accuracy check given in the specification was verified using a Hewlett-Packard Gated Counter. The following procedure is an alternate method that utilizes less expensive test equipment. When using the alternate method, perform the high-frequency accuracy checks (parts t and v) within 10 seconds after setting the remote control unit to the Calibrate position. If it is necessary to repeat the check, wait at least 1-1/2 minutes for the TSG6 to stabilize. Checking the accuracy as quickly as possible is particularly important when checking the high-range stop-frequency accuracy in part t of this step.

a. Use the equipment connections as shown in Fig. 2-6A. Leave the Aux Video Out cable from the waveform monitor disconnected at the end as shown in the illustration. Use the same control settings as described in part d of step 1 except as follows:

TSG6

COMPOSITE/ CONTINUOUS	CONTINUOUS
FREQUENCY Control	Fully counterclockwise

Sine Wave Generator

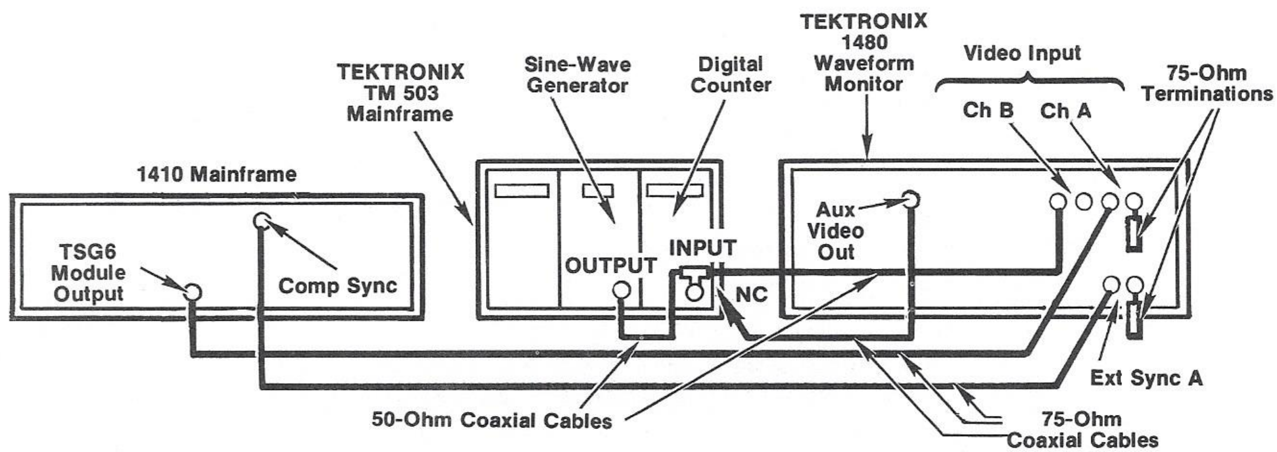
Output Frequency	Approximately 3.8 MHz

Waveform Monitor

Display	5 μs/Div

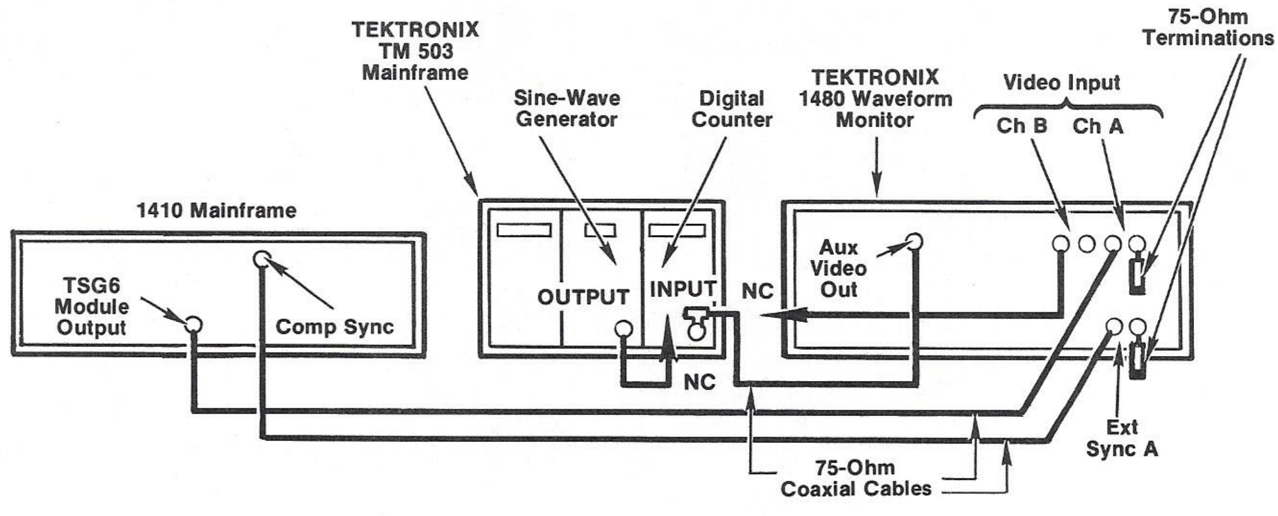
b. Check that the TSG6 FREQUENCY control is set fully counterclockwise and the waveform monitor Line Selector pushbutton switch is set to Variable. Check that the Variable Line Selector control is set to an active line displaying the multiburst signal.

c. Use the remote control unit to enable the last burst variable mode. (1410 mainframe Interface line 56 goes low.)



(A) Initial equipment connections for obtaining last burst variable zero beat.

NC = No Connection.



(B) Equipment connection changes required to obtain the last burst variable readout on the digital counter.

2528-22

Fig. 2-6. Checking last burst variable frequency and accuracy.

d. Rotate the sine-wave generator Variable Frequency control until a zero beat is obtained at the location of the last multiburst packet.

e. CHECK—the last multiburst packet for zero beat at 3.8 MHz or less. Note the frequency readout obtained at zero beat for use in part h of this step.

f. Disconnect the sine-wave generator output and waveform monitor Ch B video input cables from the bnc T connector adapter as shown in Fig. 2-6B. Connect the 75-ohm coaxial cable from the waveform monitor Aux Video Out connector to the bnc T adapter that is attached to the digital counter input.

g. Check that the remote control unit is set to the Last Burst Variable position. Set the remote control unit to the Calibrate position also. (1410 mainframe Interface lines 56 and 57 should be low.)

h. CHECK—that the digital counter readout frequency is within ±0.2% of the frequency noted in part e of this step.

i. Set the remote control unit Calibrate switch to Off while leaving the Last Burst Variable switch On.

j. Return the equipment cable connections to the original connections shown in Fig. 2-6A.

k. Rotate the TSG6 FREQUENCY control fully clockwise. Set the sine-wave generator Variable Frequency control to 4.5 MHz.

l. CHECK—the last multiburst packet for a zero beat at 4.5 MHz or higher. Note the frequency readout obtained at zero beat for use in part n of this step.

m. Repeat parts f and g of this step.

n. CHECK—that the digital counter readout frequency is within ±0.2% of the frequency noted in part l of this step.

o. Set the remote control unit Calibrate switch to Off while leaving the Last Burst Variable switch On.

p. Return the equipment cable connections to the original connections shown in Fig. 2-6A.

q. Set the TSG6 FREQ RANGE pushbutton to HIGH. Set the sine-wave generator Variable Frequency control to 20 MHz.

r. CHECK—the last multiburst packet for a zero beat at 20 MHz ±10%. Note the frequency readout obtained at zero beat for use in part t of this step.

s. Repeat parts f and g of this step.

t. CHECK—that the digital counter readout frequency is within ±1% of the frequency noted in part r of this step.

IMPORTANT

This check must be made within 10 seconds after setting the remote control unit to the Calibrate mode.

u. Set the remote control unit Calibrate switch to Off while leaving the Last Burst Variable switch On.

v. Return the equipment cable connections to the original connections shown in Fig. 2-6A.

w. Set the TSG6 FREQUENCY control fully counterclockwise. Set the sine-wave generator Variable Frequency control to 14 MHz. Check that the TSG6 FREQ RANGE switch is set to HIGH.

x. CHECK—the last multiburst packet for a zero beat at 14 MHz or lower. Note the frequency readout obtained at zero beat for use in part z of this step.

y. Repeat parts f and g of this step.

z. CHECK—that the digital counter readout frequency is within ±1% of the frequency noted in part x of this step.

aa. Set the remote control unit Calibrate and Last Burst Variable switches to Off.

ab. Disconnect all the signals.

4. Check Manual Sweep Frequency Range

a. Apply the TSG6 Module Output signal via a 75-ohm coaxial cable and a 75-ohm feed-through termination to the frequency counter input connector.

NOTE

If the TSG6 is VITS keyed (either by the TSP1 or an external signal applied to the 1410 rear-panel Remote connector), set the remote control unit Calibrate switch to On.

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MANUAL
FREQUENCY Control	Fully counterclockwise
BURST	Off

c. CHECK—for a 100 kHz, or less, frequency readout on the counter.

d. Rotate the TSG6 FREQUENCY control fully clockwise.

e. CHECK—for a 6 MHz ±10% or 6.6 MHz to 5.4 MHz readout on the counter.

f. Set the TSG6 FREQ RANGE switch to HIGH.

g. CHECK—for a 20 MHz ±10% or 22 MHz to 18 MHz readout on the counter.

h. Set the TSG6 FREQUENCY control to its fully counterclockwise position.

i. CHECK—for a 330 kHz, or less, frequency readout on the counter.

j. Disconnect the signal from the frequency counter. If the remote control unit Calibrate switch was set to On, set the switch to Off so that Interface line 57 is ungrounded.

5. Check Multiburst and Sweep Signal Amplitudes (Includes Marker, Pedestal Level, Sync, and Burst Amplitudes)

a. Apply the TSG6 Module Output signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor CH A Video Input connector. Terminate the remaining CH A Video Input connector into 75 ohms.

b. Set the TSG6 and waveform monitor controls as follows:

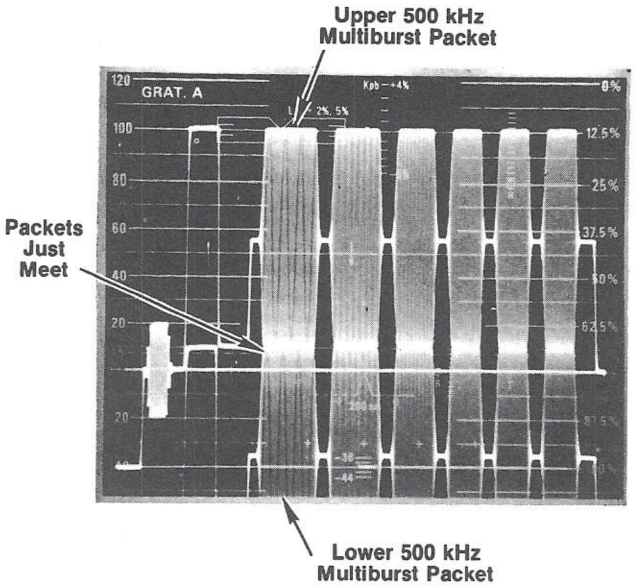
TSG6

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	On

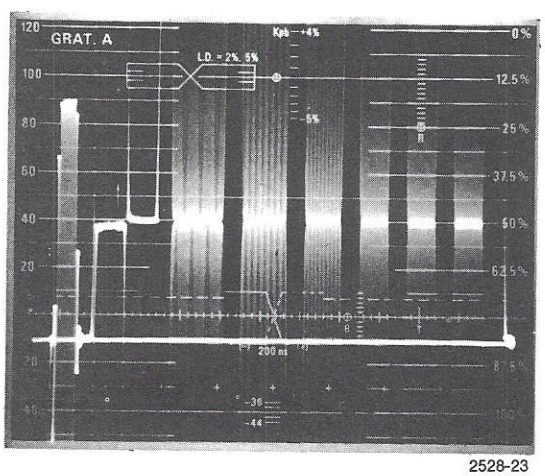
1480 Waveform Monitor

Input	A, DC Coupled
Response	Flat
Volts Full Scale	1.0
DC Restorer	Off
Oper/Cal	Oper
Display	5 μs/Div
Magnifier	X1
Field	1
Line Selector	Off
Sync	Int, AFC

c. Press in the waveform monitor Cal pushbutton while holding the Oper button depressed.



(A) Volts Full Scale switch set to 1.0.



(B) Volts Full Scale switch set to 0.2.

Fig. 2-7. Waveform monitor displays obtained when using the Calibration Fixture to check multiburst amplitude.

d. Use the Amplitude dial of the Calibration Fixture to match the top of the lower 500 kHz multiburst packet with the bottom of the upper 500 kHz multiburst packet as shown in Fig. 2-7A. Set the waveform monitor Volts Full Scale switch to 0.2 for better resolution (see Fig. 2-7B).

e. CHECK—Calibration Fixture dial for a 500 kHz multiburst packet amplitude reading of 643 mV peak-to-peak (90 IRE) ±20 mV.

f. CHECK—the TSG6 output waveform for the amplitudes given in Table 2-5. Use the technique described in parts d and e of this step. Figs. 2-8A through 2-8D show some typical displays that are obtained when checking the signal amplitudes. The waveform monitor Volts Full Scale switch was set to 1.0 to illustrate the measurement points on these waveforms. After locating the measurement points, the Volts Full Scale switch should be set to 0.2 for optimum resolution when performing the measurement.

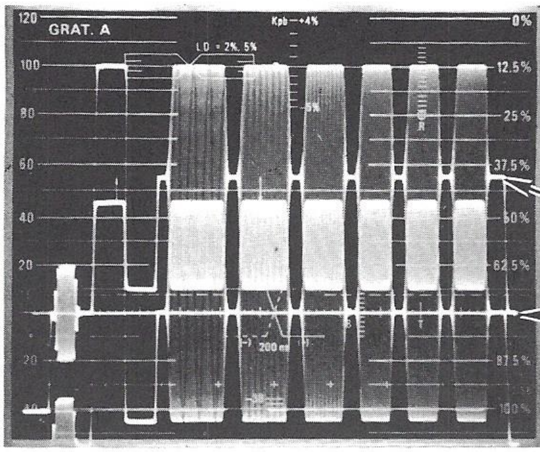
g. Press in the waveform monitor Oper button to release the Cal button.

Table 2-5

CHECK SIGNAL AMPLITUDES

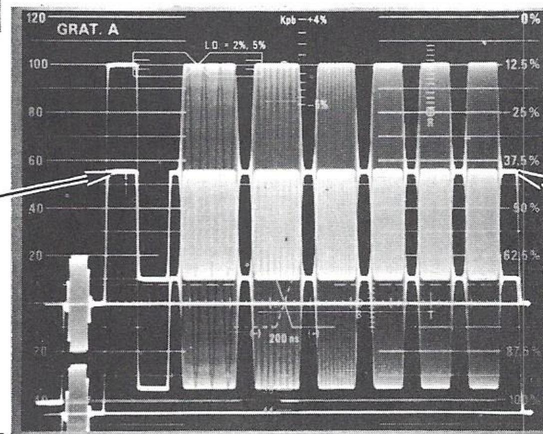
Check	Calibration Fixture Dial Reading:	TSG6 Control Settings	
		AMPL	FREQ RANGE
Multiburst Amplitude (First Packet Only)			
Full, High Range	643 mV ±25 mV or 668 mV to 618 mV	FULL	HIGH
Reduced, High Range	428 mV ±16 mV or 444 mV to 412 mV	REDUCED	HIGH
Reduced, Low Range	428 mV ±12 mV or 440 mV to 416 mV	REDUCED	LOW
Pedestal Level (Relative to Blanking)			
Full (see Fig. 2-8A)	393 mV ±1% or 396.9 mV to 390.1 mV	FULL	LOW or HIGH
Reduced	286 mV ±1% or 288.9 mV to 283.1 mV	REDUCED	LOW or HIGH
Marker Amplitude (Relative to Pedestal Level)			
Full (see Fig. 2-8B)	±321 mV ±1% or ±324.2 mV to ±317.8 mV	FULL	LOW or HIGH
Reduced	±214 mV ±1% or ±216.1 mV to ±211.9 mV	REDUCED	LOW or HIGH
Sync Amplitude (Relative to Blanking; see Fig. 2-8C)	−285.7 mV ±5.7 mV or −291.4 mV to −280 mV	FULL or REDUCED	LOW or HIGH
Color Burst Amplitude (Peak-to-Peak; see Fig. 2-8C)	285.7 mV ±8.6 mV or 294.3 mV to 277.1 mV	FULL or REDUCED	LOW or HIGH
Sweep Sine-Wave Amplitude[a] (Measured at First Marker)			
Full, Low Range (see Fig. 2-8D)	643 mV ±20 mV or 663 mV to 623 mV	FULL	LOW
Full, High Range	643 mV ±25 mV or 668 mV to 618 mV	FULL	HIGH
Reduced, High Range	428 mV ±16 mV or 444 mV to 412 mV	REDUCED	HIGH
Reduced, Low Range	428 mV ±12 mV or 440 mV to 416 mV	REDUCED	LOW

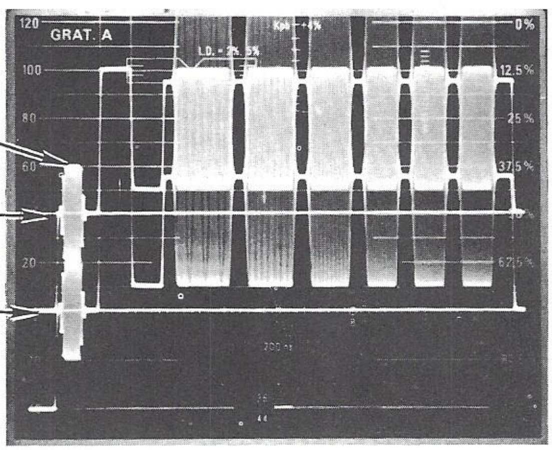
[a]Set the TSG6 MULTIBURST/SWEEP/MANUAL switch to SWEEP. Set the waveform monitor Display switch to 2 Field.



(A) Checking pedestal level relative to blanking.

(B) Checking marker amplitude relative to the pedestal level.





(C) Checking sync amplitude relative to blanking. Checking color burst peak-to-peak amplitude.

(D) Checking sweep sine-wave amplitude at first marker.

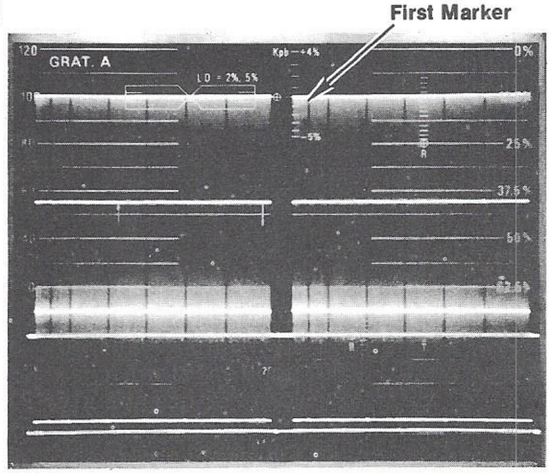


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Fig. 2-8. Typical displays obtained when locating the measurement points and using the Calibration Fixture to check amplitude.

6. Check Signal Risetimes

a. Use the same equipment connections and control settings as described in parts a and b of step 5 except as follows: Set the waveform monitor DC Restorer switch to Slow, Backporch.

b. To measure risetime, set the waveform monitor Volts Full Scale switch and Variable Volts Full Scale control so that the upper half of the 500 kHz multiburst packet is equivalent to 100 IRE in amplitude.

c. Set the waveform monitor Magnifier switch to .2. The sweep rate is now 200 ns/div. Use the Vertical and Horizontal Position controls to position the display so that the rising portion of the upper half of the 500 kHz multiburst packet is positioned to the location shown in Fig. 2-9. Note that the rising portion of the multiburst packet is positioned with the pedestal level at −10 IRE and the 90% amplitude point coincides with point R on the short 2 IRE division scale.

d. Measure the distance from point T on the 0 IRE graticule reference line to where the transition crosses the reference line. This is equivalent to the horizontal distance between the 10% and 90% amplitude points as shown in Fig. 2-9.

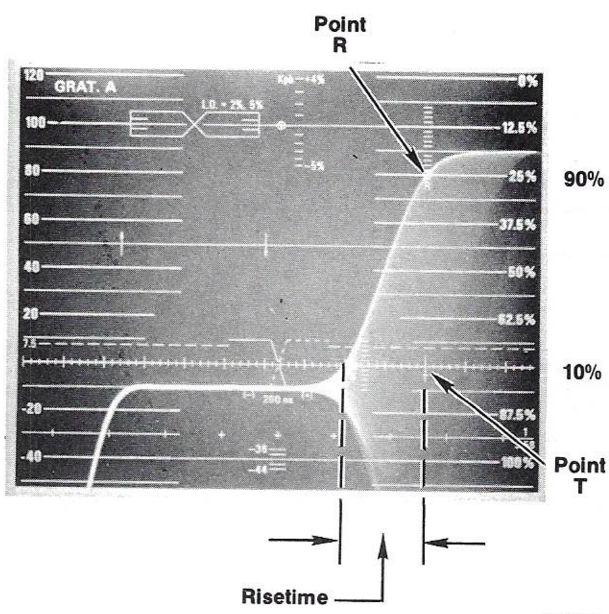


Fig. 2-9. Checking the 500 kHz multiburst packet risetime. Time base: 200 ns/div.

e. CHECK—the first multiburst packet envelope for a risetime of 400 ns ±60 ns or 460 ns to 340 ns as measured between the 10% and 90% amplitude points.

NOTE

Risetime measurements for the low-frequency range will be the same for the high-frequency range. Therefore, only the low-frequency range is checked in this procedure.

f. Use the waveform monitor controls to position the marker into view. Set the Variable Volts Full Scale control so that the marker is equivalent to 100 IRE in amplitude as measured from the backporch level to the top of the marker. Set the Magnifier switch to .1 (100 ns/div). Using the technique described in parts c and d of this step, measure the risetime.

g. CHECK—marker for a risetime of 250 ns ±50 ns or 300 ns to 200 ns as measured between the 10% and 90% amplitude points.

h. Set the waveform monitor controls to measure the risetime of the sync pulse.

i. CHECK—sync for a risetime of 130 ns +20 ns, −10 ns, or 150 ns to 120 ns.

j. Set the waveform monitor controls to measure the risetime of color burst. Use a 200 ns/div sweep rate.

k. CHECK—color-burst envelope for a risetime of 400 ns ±60 ns or 460 ns to 340 ns as measured between the 10% and 90% amplitude points on the upper half of the envelope. Depress the SPG2 Horiz Unlock button while performing this measurement.

l. Disconnect the signal from the waveform monitor.

7. Check Color Burst Phase

a. Connect the 1410 rear-panel Subcarrier output J20 signal via a 75-ohm coaxial cable to the 520A Vectorscope Ext CW ϕ Ref connector. Terminate the Ext CW ϕ Ref loop-through connector into 75 ohms. Connect the 1410 rear-panel Subcarrier output J21 signal through a 10X attenuator and a 75-ohm coaxial cable (in that order) to the vectorscope Ch A input connector. Terminate the Ch A loop-through connector into 75 ohms. See Fig. 2-10A.

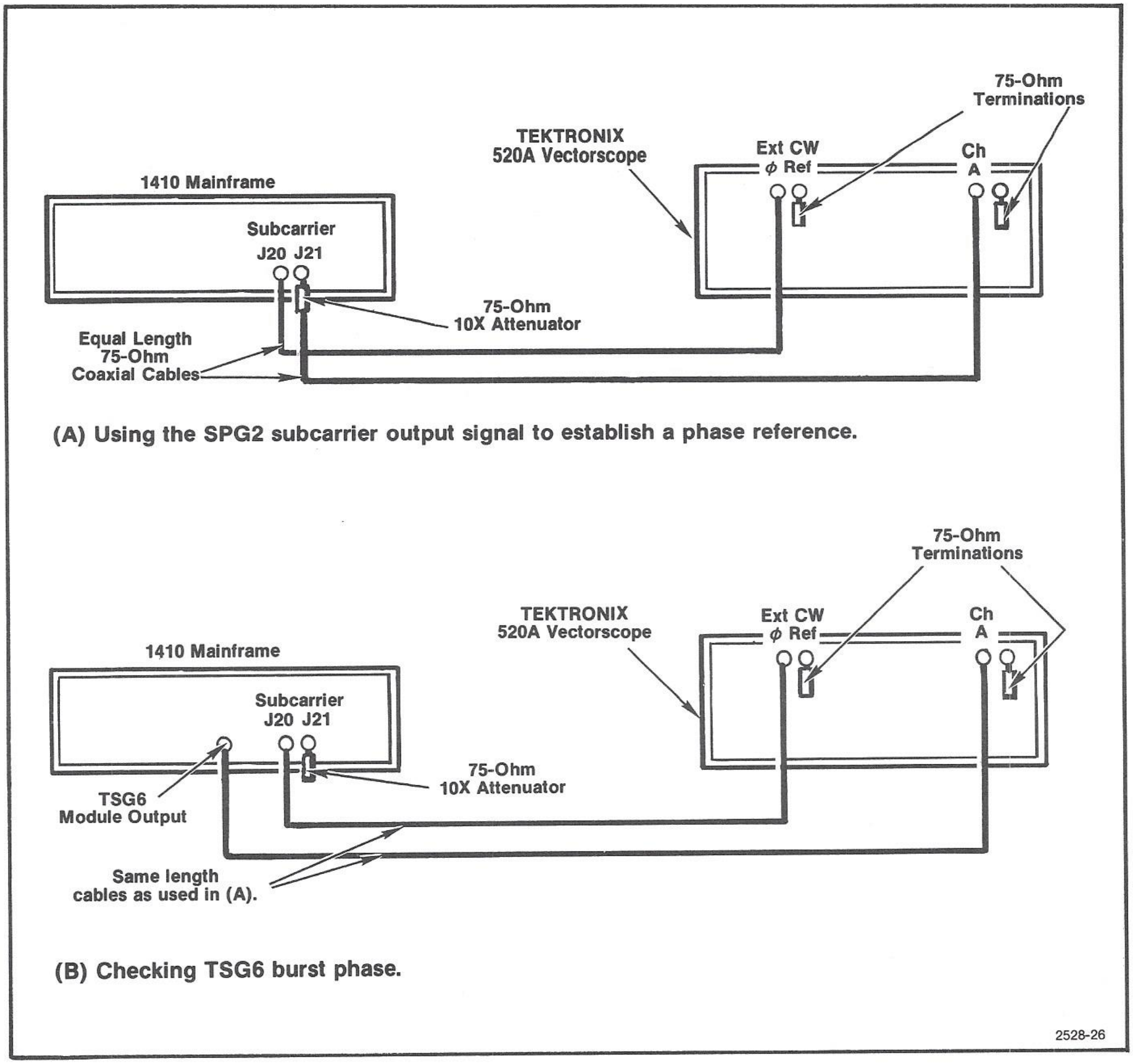


Fig. 2-10. Equipment connections for step 7.

b. Check that the TSG6 front-panel controls are set as follows:

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	On

c. Set the 520A Vectorscope controls as follows: Depress the Ch A, Full Field, Aφ, and Vector pushbuttons. Set the φ Ref switch to Ext. Check that the Ch A Gain control is set to Cal.

d. Rotate the vectorscope Ch A Phase control to position the subcarrier vector at 180° for use as a reference.

NOTE

Do not move the Vectorscope Ch A Phase control until completing parts e and f of this step.

e. Disconnect the 75-ohm coaxial cable at the 10X attenuator connection. Connect this same cable, without changing its length, to the TSG6 Module Output connector. See Fig. 2-10B.

f. CHECK—that the TSG6 color-burst vector is at 180° within a tolerance of ±10°. See Fig. 2-11.

g. Disconnect the signals applied to the vectorscope.

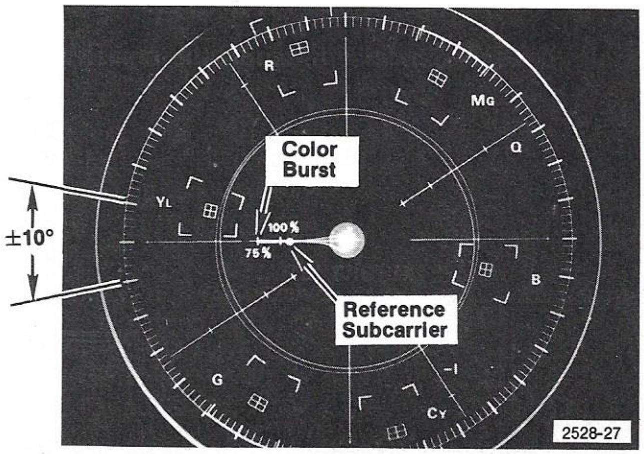


Fig. 2-11. Double-exposure photograph showing color burst in phase with the reference subcarrier.

8. Check Harmonic Distortion

a. Connect the TSG6 Module Output signal via the 75-ohm to 50-ohm minimum loss attenuator and a 50-ohm coaxial cable to the spectrum analyzer RF Input connector.

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MANUAL
FREQUENCY Control	100 kHz minimum
BURST	Off

c. Set the spectrum analyzer controls to display the signal at a resolution of 30 kHz. The 7L12 Spectrum Analyzer control settings that follow are given as a guide.

Time/Div switch	2 ms
Freq Span/Div selector	100 kHz (0.1 MHz)
Resolution selector	30 kHz
Center Frequency control	Tune to center the display
Display Mode	10 dB/Div
RF Attenuator selector	20 dB
Gain Selector (Reference Level)	−10 dBm
P-P Auto & Free Run buttons	Pressed in
Video Filters	30 kHz

d. CHECK—that harmonic distortion relative to the fundamental is at least −40 dB. See Fig. 2-12. Using this check as a guide, check harmonic distortion relative to the fundamental for the other continuous sine-wave frequencies as follows:

With the TSG6 FREQ RANGE pushbutton set to LOW, harmonic distortion for frequencies from 100 kHz minimum to 300 kHz should be at least −40 dB; above 300 kHz to 4.2 MHz harmonic distortion should be 44 dB; above 4.2 MHz to 6.0 MHz (±10%) harmonic distortion should be at least −40 dB.

e. Set the TSG6 FREQ RANGE pushbuttons to HIGH.

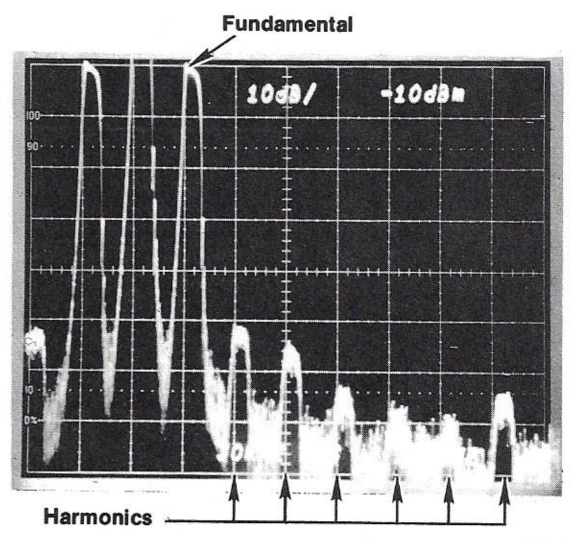


Fig. 2-12. Checking harmonic distortion.

f. CHECK—that harmonic distortion for frequencies from 330 kHz minimum to 6 MHz is at least −38 dB; above 6 MHz to 20 MHz (±10%) harmonic distortion should be at least −36 dB.

g. Disconnect the signal from the spectrum analyzer.

9. Check Sweep Sine-Wave Flatness

NOTE

If the TSG6 meets the performance requirements given in this step, the TSG6 will also meet the multiburst flatness performance requirements.

a. Connect the input of the video detector (item 8) directly to the TSG6 Module Output connector. Connect the output cable from the video detector to the +Input connector on the differential comparator plug-in unit of the test oscilloscope (see Fig. 2-13). Externally trigger the time base using the 1410 mainframe rear-panel V Drive signal.

b. Set the video detector slide switch to the Normal position. Set the TSG6 front-panel controls as follows:

FREQ RANGE	HIGH
MARKERS	Off
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	SWEEP
FREQUENCY Control	As is
BURST	Off

c. Set the test oscilloscope controls to establish a ground reference at graticule center. Set the differential comparator +Input Mode switch to DC and the −Input Mode switch to Vc. Set the Volts/Div switch to 5 mV and the Time/Div switch to 2 ms. Set the Comparison Voltage (Vc) control to approximately 0.39 V to position the top of the waveform to graticule center as shown in Fig. 2-14A.

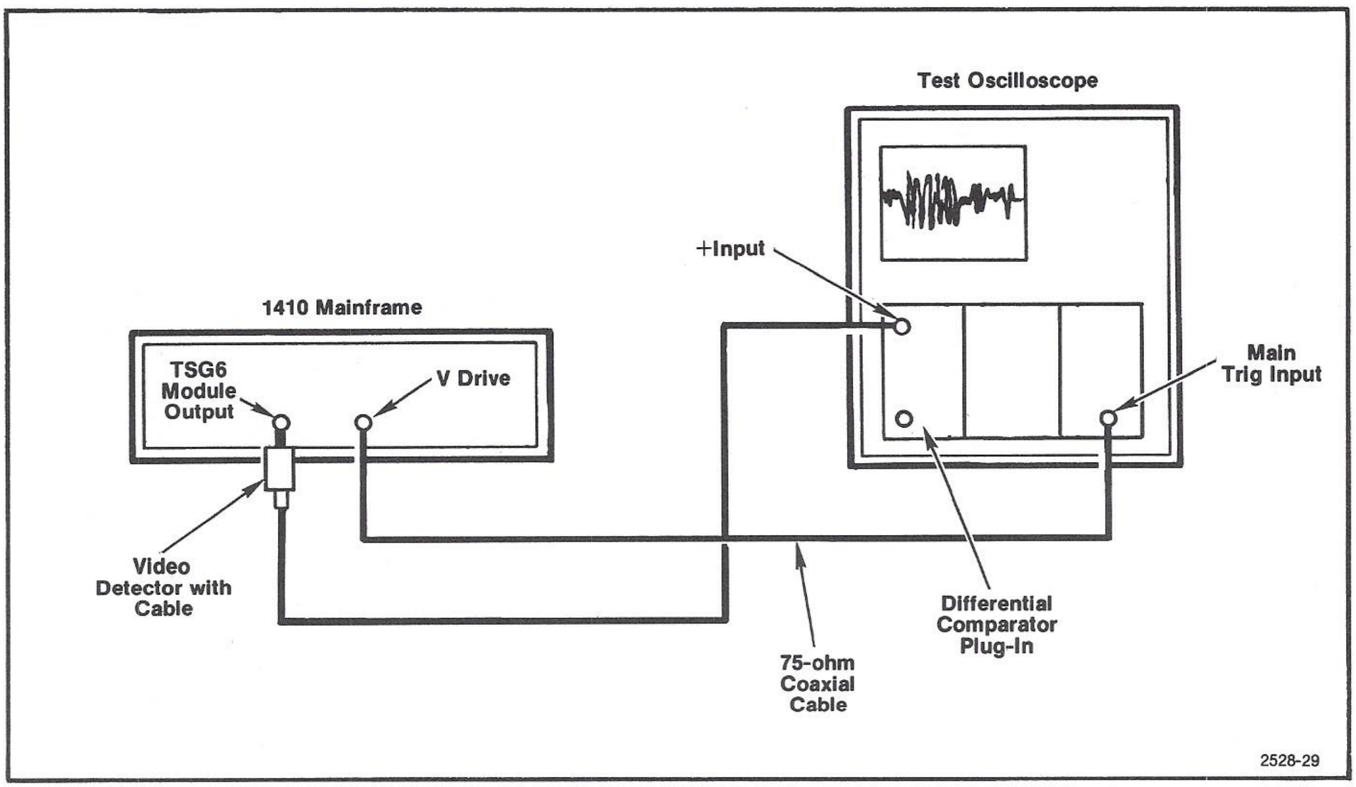
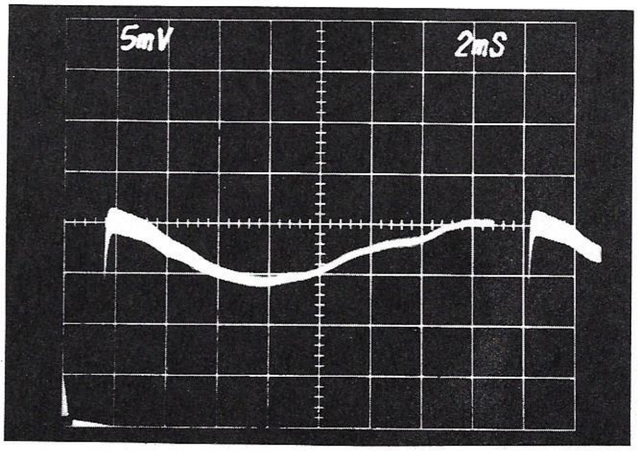


Fig. 2-13. Equipment connections for step 9.

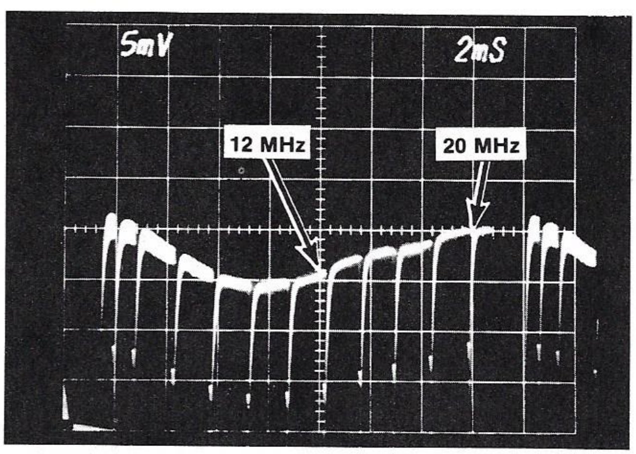
d. CHECK—for flatness of the brightened top portion of the waveform as follows: Within 15 mV up to a frequency of 12 MHz; within 20 mV above 12 MHz to 20 MHz. To locate the 12 MHz and 20 MHz frequency points, set the TSG6 MARKERS button to On as shown in Fig. 2-14B.

e. Set the TSG6 FREQ RANGE switch to LOW and the MARKERS button to Off.

f. CHECK—that flatness is within 10 mV.



(A) MARKERS button set to Off.



(B) MARKERS button set to On.

2528-30A

Fig. 2-14. Checking sweep sine-wave flatness using a Marconi Video Detector.

g. Set the TSG6 AMPL button to REDUCED. Set the test oscilloscope differential comparator Voltage (Vc) control to approximately 0.21 V to position the top of the reduced-amplitude waveform to graticule center.

h. CHECK—that flatness is within 10 mV.

i. Set the TSG6 FREQ RANGE switch to HIGH.

j. CHECK—that flatness is within 15 mV up to a frequency of 12 MHz; within 20 mV above 12 MHz to 20 MHz. If desired, set the MARKERS button to On to locate the 12 MHz and 20 MHz frequency points.

k. Disconnect all the signals applied to the test oscilloscope. Disconnect the video detector from the TSG6 Module Output connector.

10. Check Return Loss

Preferred Method

(Using Marconi Test Equipment)

The Preferred Method that was used to verify return loss to 20 MHz utilized the following Marconi test equipment: TM9692 Video Sweep Unit, TF2361 Sweep Generator, TF2907 Differential Probe Unit, and TM9827 Return Loss Probe. The instruction manuals for this equipment describes how to check return loss. If this equipment is not available, use the Alternate Method that follows.

Alternate Method

(Using Tektronix Test Equipment)

Refer to 015-0149-00 Return Loss Bridge instruction manual if detailed information is needed. The following procedure should provide sufficient information for those familiar with return loss measurements.

a. Connect the 015-0149-00 Return Loss Bridge to the test oscilloscope differential comparator input connectors.

b. Connect the leveled sine-wave generator output signal via a 50-ohm coaxial cable and a 50-ohm to 75-ohm minimum loss attenuator to the Return Loss Bridge input connector.

c. Set the leveled sine-wave generator frequency controls for 5 MHz output.

d. Remove the 75-ohm termination from the Return Loss Bridge Unknown arm. Leave the other arm of the bridge terminated into 75 ohms.

e. Set the test oscilloscope for dc-coupled differential amplifier mode of operation, Volts/Div switch set to .1 V, and the time base triggering controls for free-running mode of operation.

f. Adjust the leveled sine-wave generator output amplitude control for 500 mV displayed amplitude.

g. Reconnect the 75-ohm termination to the Return Loss Bridge Unknown arm.

h. Set the test oscilloscope Volts/Div switch to 10 mV.

i. Adjust the Return Loss Bridge Balance control for minimum display amplitude. Note the amplitude.

j. Remove the 75-ohm termination from the Return Loss Bridge Unknown arm. Connect the Unknown arm directly to the TSG6 Module Output connector on the 1410 mainframe rear panel.

k. Set the TSG6 controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	Off

l. Check that the 1410 mainframe Power switch is set to On.

m. CHECK—that the amplitude of the sine-wave generator signal component, superimposed on the TSG6 composite video signal, is 16 mV or less in amplitude after subtracting the null amplitude noted in part i of this step. Repeat this check, if desired, at frequencies between 250 kHz to 20 MHz.

n. Remove the Return Loss Bridge. This completes the Performance Check procedure.

WARNING

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

PART II
SERVICE INFORMATION

INSTALLATION

INSTALLING TSG6 IN THE MAINFRAME

Use the following steps to install the TSG6 module in the 1410 mainframe.

CAUTION

Set the 1410 mainframe Power switch to Off before starting the installation.

1. Remove the top cover from the mainframe. Remove the plastic spacer bars that hold down the installed modules.

2. Select one of the available 1410 module locations for installation. Use Locations 2 through 6 when a dual-width SPG is installed, or Locations 1 through 6 if a single-width SPG is installed. (The factory installs the TSG6 in Location 6 for use with the TSP1. This is the preferred location for the TSG6.) See Fig. 3-1. Remove the blank front panel from this location.

3. Check that the jumper connectors on the A60 Multiburst Logic board are positioned to the desired operating mode. Refer to the topic, "Operating Mode Selection" that follows this installation procedure.

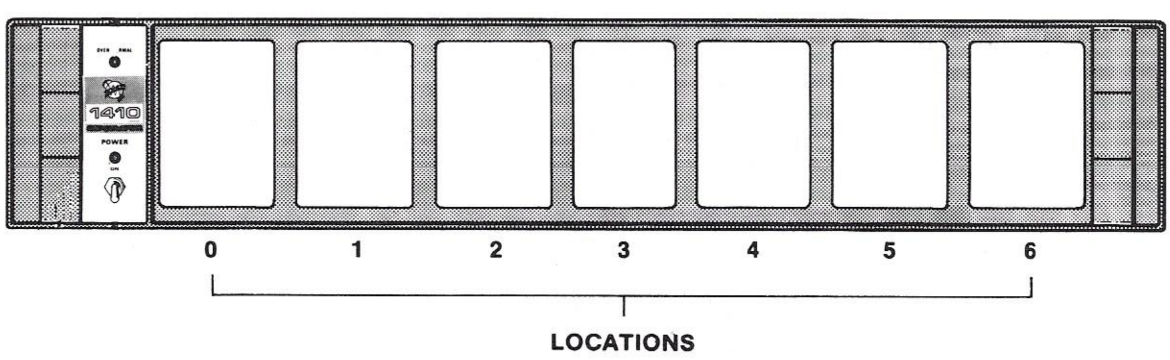


Fig. 3-1. 1410 Generator Module Locations.

4. If not already installed, install the plastic pushbutton extenders on the pushbutton shafts of both boards.

5. Position the A60 Multiburst Logic board over the right row of the mainframe interface pins at the selected location; for example, P72 at Location 6 as shown in Figs. 3-2 and 3-3. Use the plastic guides for proper pin alignment. Seat the board firmly on the Interface board.

CAUTION

Be sure that all of the pins on the Interface etched circuit board are properly aligned with the connectors on the TSG6. Improper alignment of the pins and connectors can permanently damage the TSG6 connectors.

6. Position the A61 Multiburst Output board over the middle row of interface pins; for example, P71 at Location 6 as shown in Figs. 3-2 and 3-3. Use the plastic guides for proper alignment. Seat the board firmly on the Interface board.

7. If you have installed the TSG6 to the immediate right of a Tektronix Part No. 670-4451-00 VIRS/Black Burst board (A25), install a shield board on the shield mounting pins located between the VIRS/Black Burst board and the A61 Multiburst Output board. Seat the board firmly on the Interface board.

If the Tektronix Part No. for the A25 VIRS/Black Burst board is 670-4451-01 or higher, do **not** install a shield board.

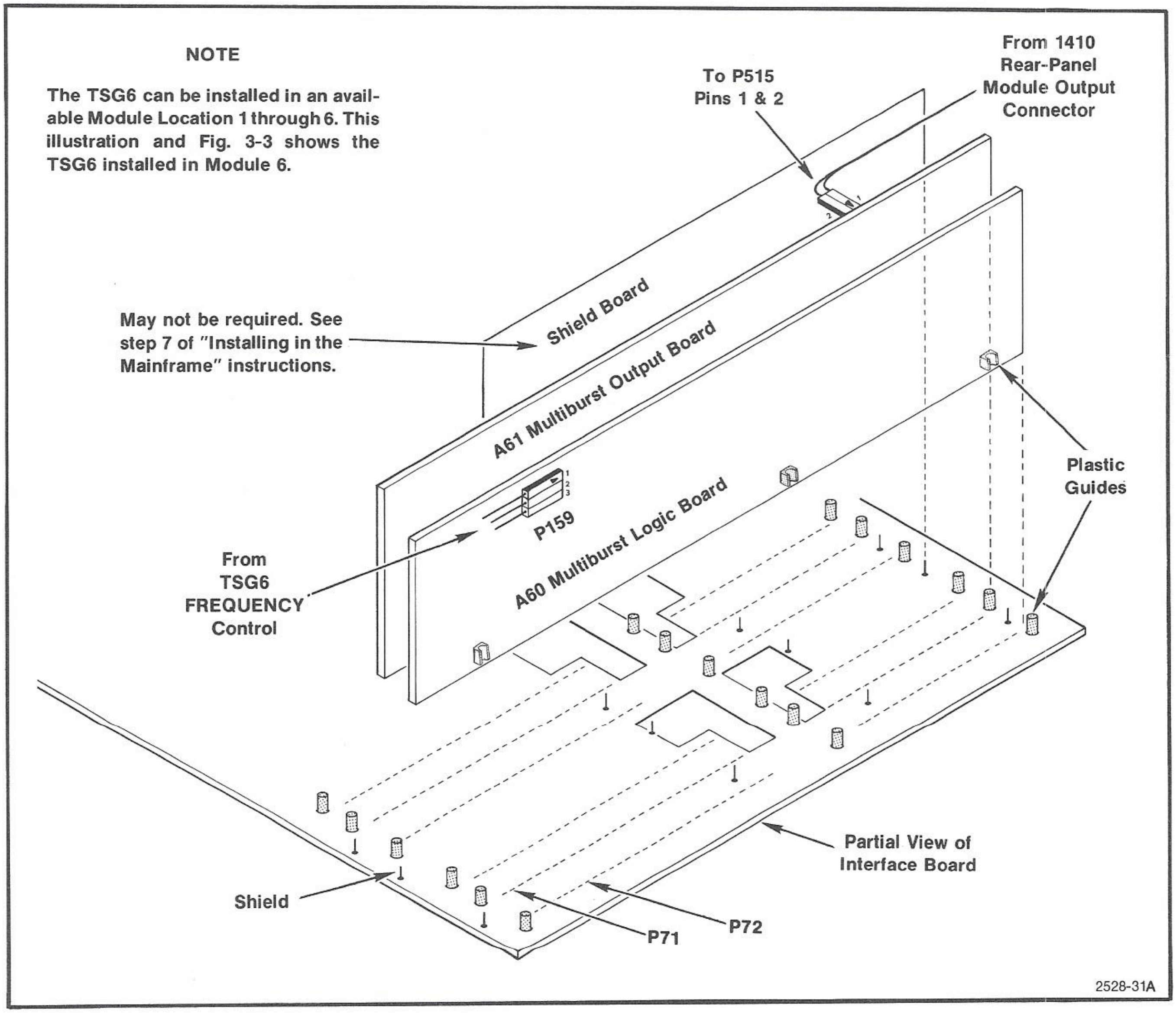


Fig. 3-2. Installing the TSG6 module in the 1410 Generator mainframe.

8. Position the TSG6 front panel over the pushbutton extenders and secure the front panel to the 1410 mainframe front casting, using the self-tapping screws provided.

9. Connect the TSG6 FREQUENCY control cable multi-pin connector to P159 on the A60 Multiburst Logic board. See Fig. 3-2. Also, refer to Fig. 8-1 in Section 8.

10. Connect the appropriate 75-ohm coaxial cable from the 1410 rear-panel Module Output connector to P515, pins 1 and 2, on the A61 Multiburst Output board. See Fig. 3-2. Also, refer to Fig. 8-2 in Section 8.

1410 MAINFRAME POWER SUPPLY MODIFICATION

The power supply in TEKTRONIX 1410 Generator mainframes below SN B010743 may not be capable of handling the requirements of a full complement of modules including the TSG6 NTSC Multiburst & Video Sweep Test Signal Generator. To modify the 1410 mainframe so that the power supply has increased capacity, order the following kit:

1410 Power Supply Field Modification Kit, Tektronix Part No. 040-0898-00.

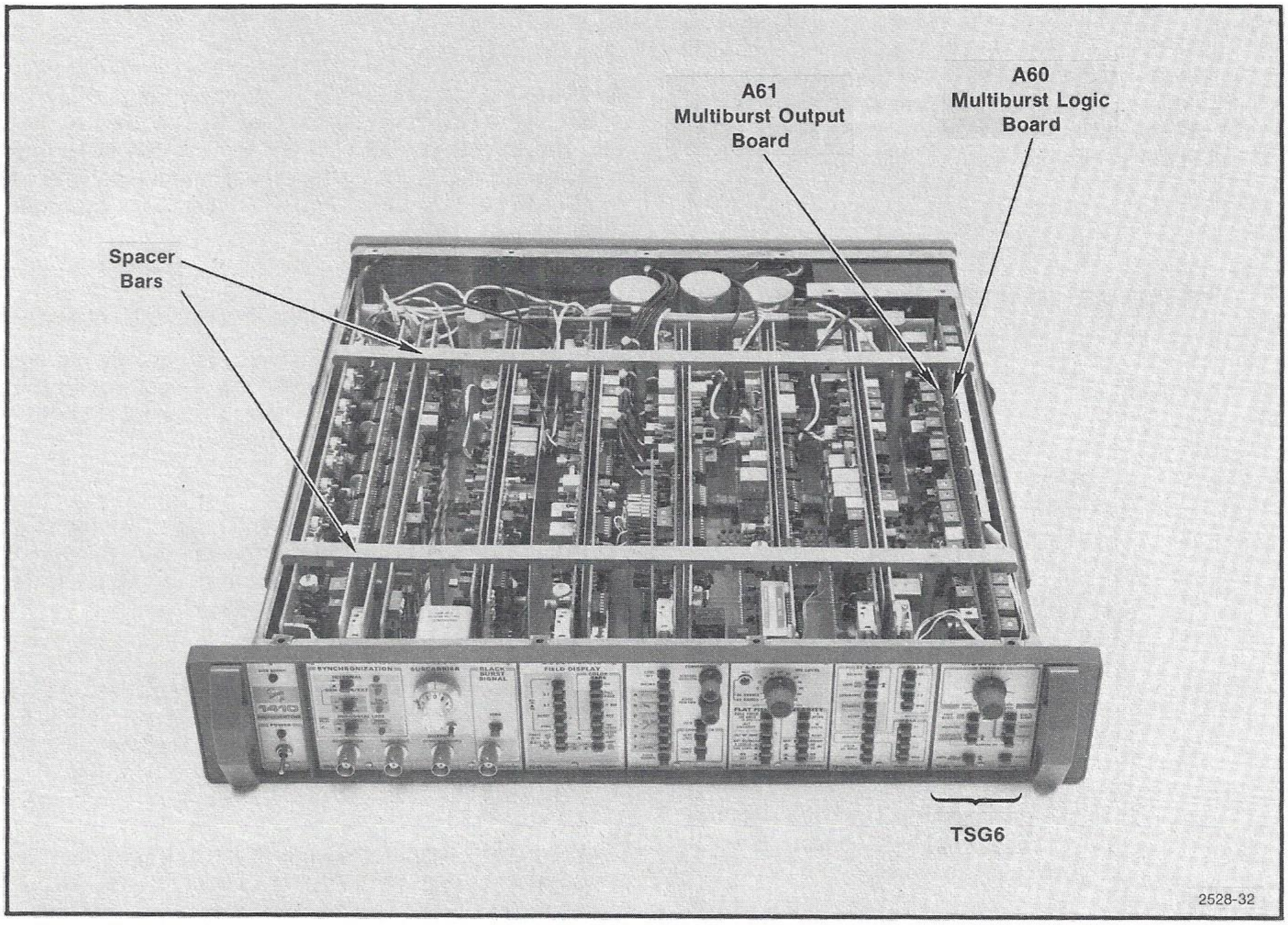


Fig. 3-3. TSG6 module installed.

INSTALLATION ADJUSTMENTS

After the TSG6 is installed in the 1410 mainframe, the Calibration Procedure is Section 4 provides a detailed, logically-sequenced procedure that may have to be performed to check that the TSG6 meets all the published performance requirements.

NOTE

The TSG6 contains many interrelated adjustments. Some of the most important ones are as follows: C336, C383, R138, R139, R309, R319, R349, R359, R369, R379, R389, and R399. If any of these adjustments are inadvertently misadjusted, the TSG6 may have to be recalibrated.

If you prefer to quickly check the TSG6 performance, Table 3-1 lists the minimum checks and readjustments that should be performed after the TSG6 is installed. The step numbers are the same as those used in the Calibration Procedure of Section 4. These steps can be performed without using an Extender board. Refer to the Calibration Procedure for detailed instructions.

Table 3-1

ADJUSTMENTS AFTER INSTALLATION

Step No. (See Calibration Procedure in Section 4)	Instructions
11	Perform parts a through e in Step 11 of the Calibration Procedure. If the 500 kHz multiburst packet is not within the 643 mV peak-to-peak (±20 mV) amplitude requirement, adjust R489 (Master Gain).
14	If R489 in Step 11 is adjusted, adjust R479 (Continuous DC Level) and R278 (Composite Backporch Level).
19	Adjust R439 and R429. These are Reduced and Full Amplitude Pedestal Balance adjustments, respectively.

The following test equipment is needed for performing steps 11, 14, and 19 in the Calibration Procedure of Section 4. Refer to Section 4 for more information about the listed items.

Item No.	Description
1	TEKTRONIX 1410 Generator Mainframe with SPG2 installed. (The TSG6 to be checked is installed in this mainframe.)
5	Test Oscilloscope with Vertical Amplifier and Time Base Plug-in Units.
7	Waveform Monitor.
16	75-Ohm Feed-Through Termination.
17	75-Ohm End-Line Termination.
18	Two 75-Ohm Coaxial Cables.

OPERATING MODE SELECTION

The TSG6 contains internal jumpers to permit selection of operating modes. Altering an operating mode is accomplished by moving the appropriate jumper connector. The following information describes the operating mode selections. To locate the jumper connectors, refer to the Servicing Illustration, Fig. 8-1, located on a foldout page in Section 8.

Internal Jumpers on A60 Multiburst Logic Board

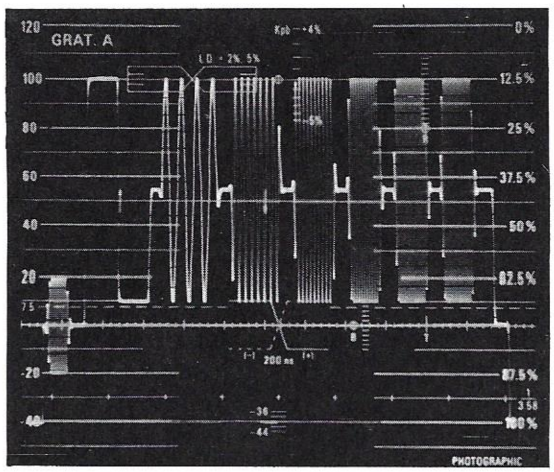
P104, P105, P114, and P115: These jumpers are factory installed to obtain normal operation. Do not move these jumpers until instructed to do so in the Calibration Procedure, Section 4, of this manual.

P132: No jumper is installed. Not needed for normal operation. The Calibration Procedure in Section 4 describes when to move the jumper connector from P104 to P132 for calibration purposes.

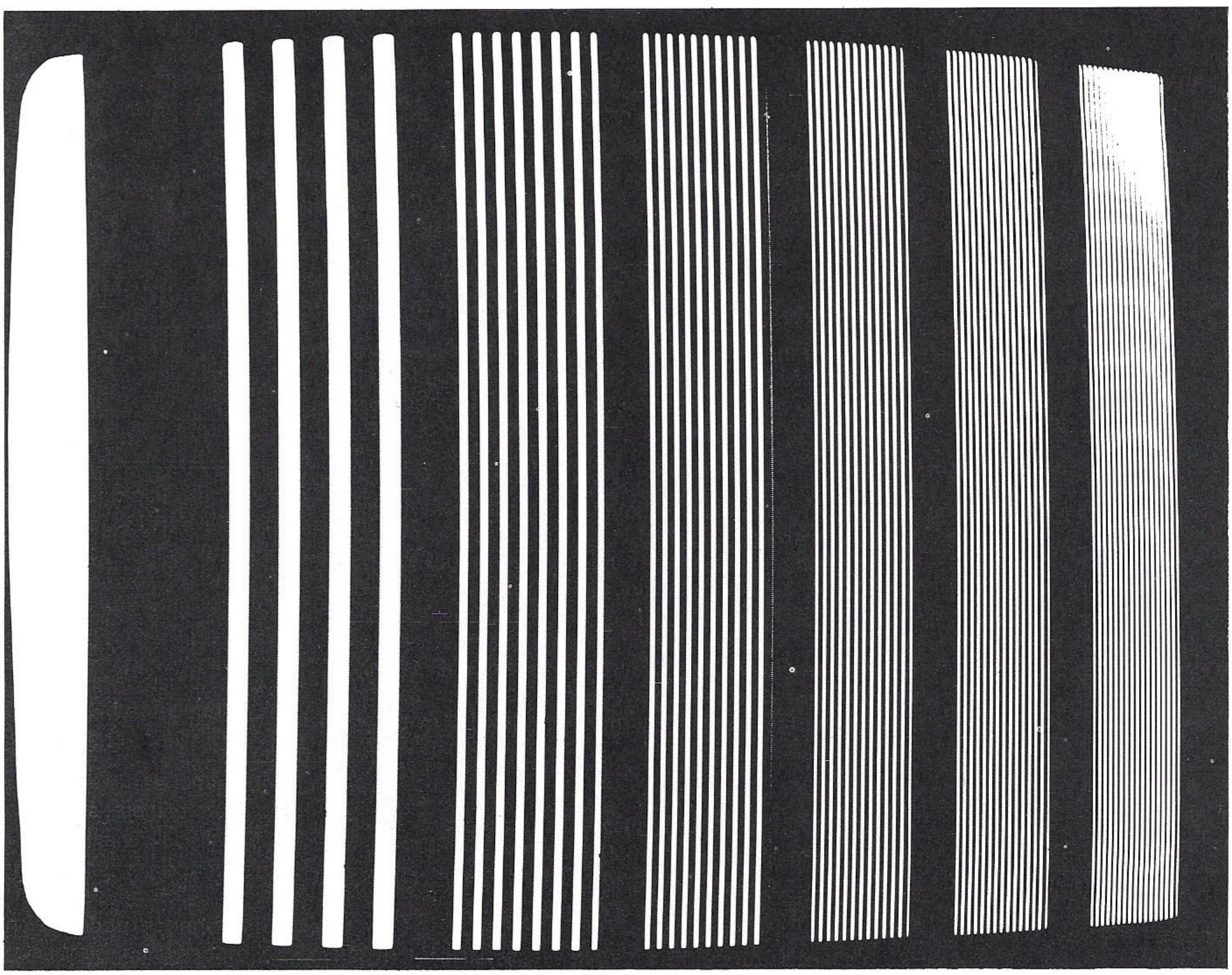
P239: Phase-Slewed Multiburst. Fixed Phase if set to 1 and 2; see Fig. 3-4. Phase Slewed if set to 2 and 3. P239 is normally factory-set to the Phase Slewed position (2 and 3 connected).

P280: Luminance Drive. Risetime is 250 ns if set to 1 and 2; 130 ns if set to 2 and 3. P280 is normally factory-set for 250 ns risetime (1 and 2 connected).

P281: Sync Drive. Risetime is 250 ns if set to 1 and 2; 130 ns if set to 2 and 3. P281 is normally factory-set for 130 ns risetime (2 and 3 connected).



(A) TEKTRONIX 1480 Waveform Monitor display. Sweep rate: 5 μs/div.



(B) Monochrome picture monitor display.

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Fig. 3-4. TSG6 low range, full amplitude, composite multiburst, burst on, output signal. P239 set to the Fixed Phase position.

Wire Strap Connections for A60 Multiburst Logic Board

W260: This wire strap is connected from 1 to 2 for NTSC operation and should not be moved. (The wire strap is connected between 2 and 3 when the board is used in a TSG16 PAL module.)

Wire Strap Connections for A61 Multiburst Output Board

W400: A wire strap that connects pin 13 of U390 to pin 14 for NTSC operation and should not be moved.

W420: No wire strap is needed for NTSC operation.

Terminating Connector on A61 Multiburst Output Board

P515 (Pins 3 and 4): These pins are the Spare Output connector for the TSG6 module output signal. A multi-pin connector with a 75-ohm resistor is installed on P515, pins 3 and 4, to terminate the signal when it is not used. If a TSP1 is installed in the 1410 mainframe, the TSP1 input signal cable is connected to the TSG6 Spare Output connector and the multi-pin connector with its terminating resistor is stored on an unused shield pin.

Altering the High-Range Multiburst-Packet Frequencies

The high-range multiburst-packet frequencies are controlled by R107, R115, R117, R125, R127, and R112. These frequency-control resistors are located on the A60 Multiburst Logic board. If it is necessary to alter the multiburst frequencies, refer to the topic, "Frequency Decode Logic", in Section 5, Multiburst Logic (Diagram 1) circuit description for further information.

Altering the Multiburst Packet Widths

A PROM set is available to generate multiburst with six equal 4 μs duration burst packets. The PROMs in this set replace U121 and U141 on A60 Multiburst Logic board. The PROM set can be obtained by ordering as follows: PROM Set consisting of U121, Tektronix Part No. 160-0220-00, and U141, Tektronix Part No. 160-0222-00.

TSG6 REMOTE FUNCTIONS

Table 3-2 provides the Remote connector J41 information required to perform the TSG6 remote functions. An example is given in the Multiburst description that follows.

Multiburst (Interface Line 55)

The TSG6 front-panel MULTIBURST pushbutton is enabled and the MANUAL and SWEEP pushbuttons are disabled by grounding the appropriate pin at the 1410 rear-panel Remote connector J41. For example, if the TSG6 is installed in Location 6 of the 1410, pin 1 of the Remote connector must be grounded to enable MULTIBURST and disable the MANUAL and SWEEP functions. Grounding pin 1 of J41 grounds 1410 Interface line 55. This Interface line connects to the TSG6 Multiburst Remote enabling circuit on A60 Multiburst Logic board.

Table 3-2

1410 REMOTE CONNECTOR INPUTS

TSG6 Module Location	1410 Remote Connector J41 Pins to 1410 Interface Line			
	Interface Line 55 Multiburst	Interface Line 56 Last Burst	Interface Line 57 Calibrate	Interface Line 19 VITS Key
1	16	17	18	24
2	13	14	15	23
3	10	11	12	22
4	7	8	9	21
5	4	5	6	20
6	1	2	3	19

NOTE

Pin 36 of 1410 Remote Connector is ground.

VITS Key (Interface Line 19)

Normally, the TSG6 uses the vertical blanking signal from the 1410 mainframe to ensure that no test signal is generated during the vertical interval. If a multiburst VITS is desired, the TSG6 can be enabled by grounding the TSG6 Interface line 19 during the active portion of the appropriate television line. See Table 3-1 and the 1410/TSP1 Instruction Manuals for more details.

CALIBRATION

Introduction

This procedure is arranged in a logical sequence to either verify the accuracy of the TSG6 adjustments or to recalibrate the TSG6 after repairs or long periods of operation.

NOTE

This procedure assumes that the internal jumpers are set to their factory-set positions as shown in Figs. 8-1 and 8-2 in Section 8. The SPG2 should be set for internal mode of operation.

Calibration at 20° C to 30° C, with a 20-minute warm-up period, is required to attain stated accuracies. Limits and tolerances appearing in this procedure are calibration guides. They are not performance requirements unless listed in Section 2, Specification.

In the procedure, the TSG6 front-panel names are all capitalized; for example, FREQ RANGE. Controls and connector names for the 1410 mainframe with its SPG2 module and the names for the associated test equipment have only their first letter capitalized; for example, Module Output connector. No capitals are used if a generic term is used when referring to the associated test equipment; for example, set the test oscilloscope time base triggering controls for internal triggering mode of operation.

A short form procedure precedes the Calibration Procedure for use by an experienced calibrator. This procedure can also be used as a calibration record or as an index to the complete procedure.

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 specification. If alternative equipment is used, it must meet or exceed these requirements.

1. TEKTRONIX 1410 Generator mainframe with a SPG2 NTSC Sync Generator Module. With the TSG6 (to be checked and/or recalibrated) installed in the 1410 mainframe.

2. Digital Voltmeter (DVM). 20-volt dc range. 0.1% dc voltage accuracy. For example, a TEKTRONIX DM 501 Digital Multimeter in a TM 503 mainframe.

3. Sine Wave Generator. Frequency range, 500 kHz to 20 MHz. Frequency accuracy is not critical since the frequency counter (item 4) is used for the readout. Output amplitude, approximately 200 mV to 300 mV. For example, a TEKTRONIX SG 503 Leveled Sine Wave Generator in a TM 503 mainframe.

4. Digital Counter. Frequency range, 500 kHz to 20 MHz. Display, at least 4 digits. Minimum accuracy, 1%. Sensitivity, 200 mV peak-to-peak. For example, a TEKTRONIX DC 501 Digital Counter in a TM 503 mainframe.

5. Test Oscilloscope.

Dual Time Base. Range from 100 ns/div to 2 ms/div with provisions for delaying sweep.

Differential Comparator. Bandwidth, dc to 75 MHz (including mainframe). Minimum deflection factor, 5 mV/div. Selectable bandwidth, full or 5 MHz.

Dual Trace Amplifier. OPTIONAL: Used if the Marconi Video Detector (item 9) is not available to perform step 21. Bandwidth, dc to 100 MHz, including mainframe. Minimum deflection factor, 200 mV/div. Used as a single-trace amplifier in this procedure.

For example, a TEKTRONIX 7603 Oscilloscope mainframe with 7B53A Dual Time Base, 7A13 Differential Comparator, and 7A26 Dual Trace Amplifier.

6. Spectrum Analyzer. Capable of measuring the 2nd through 5th harmonic of 500 kHz, 4 MHz, and 5 MHz signals to −46 dB of the fundamental. For example, a TEKTRONIX 7L12 Spectrum Analyzer in a 7000-Series Oscilloscope mainframe. Can be used with item 5.

7. Waveform Monitor. Capable of viewing line-rate and field-rate signals. Includes a magnifier to measure risetime and check wave shape. For example, a TEKTRONIX 1480 NTSC Waveform Monitor with Graticule A.

8. Vectorscope. Capable of measuring phase difference of less than 0.5° between two signals. For example, a TEKTRONIX 520A NTSC Vectorscope.

9. Video Detector. Rectifies and detects the peak amplitude of the applied signal. For example, a Marconi TM9703 Video Detector. If not available, use a 100 MHz bandwidth test oscilloscope.

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

11. 50-Ohm End-Line Termination. Tektronix Part No. 011-0049-01.

12. 50-Ohm Coaxial Cable. Two required. 42 inches long. Tektronix Part No. 012-0057-01.

13. 50-Ohm Connector-Adapter Cable. Equipped with a male Peltola connector on one end and a bnc female connector on the other end. Cable is 30 inches long. Tektronix Part No. 067-0709-00.

14. Bnc T Adapter. Tektronix Part No. 103-0030-00.

15. 75-Ohm 10X Attenuator. Tektronix Part No. 011-0061-00.

16. 75-Ohm Feed-Through Termination. Tektronix Part No. 011-0103-00.

17. 75-Ohm End-Line Termination. Two required. Tektronix Part No. 011-0102-00.

18. 75-Ohm Coaxial Cable. Three required. 42 inches long. Tektronix Part No. 012-0074-00.

19. Calibration Fixture. For use with the 1480 Waveform Monitor (item 7). Refer to the topics "Calibration Fixture" and "Measurements", that follow this Test Equipment list for a description. See Fig. 2-2 in Section 2 of this manual for a schematic diagram and a parts list.

Calibration Fixture

This fixture and the 1480 Waveform Monitor provide a variable calibration voltage level which can be read directly from a 10-turn dial. The schematic diagram and parts list for the fixture appear in Fig. 2-2 in Section 2. When S1 is in the Variable position, the 1480 calibrator voltage is determined by the circuit in the fixture.

With P9034 connected to J9034 on the 1480, set the fixture S1 to the Fixed position. Push in the 1480 Sync Tip and Cal buttons to display the internal calibrator 1 V square wave. Calibrate the graticule for 1 V. Set the Amplitude dial to 1000 and S1 to Variable. Adjust R3 (CAL), to exactly match the internal 1 V calibrator level. The dial is now calibrated so that each turn of the dial represents 100 mV.

Measurements Using The Calibration Fixture

The signal to be measured must be fed to the 1480 CH A input, and both the OPER and CAL buttons pushed in. Set the DC Restorer button to Off. To check luminance amplitude within a given tolerance, adjust the fixture Amplitude dial while watching the waveform monitor display. When the level being measured overlays the blanking level, read the amplitude directly from the dial.

Peak-to-peak chrominance amplitude can be checked for tolerance by adjusting the fixture Amplitude dial until the peaks of the chrominance packet being measured just meet.

To adjust a signal level, use the Calibration Fixture as a reference. First, set the Amplitude dial to the desired level. Then, for a luminance signal, adjust the proper control so that the signal level overlays the blanking level. For chrominance, adjust for the peaks to just meet.

Extender Board

Use the A2 Extender board, furnished with the 1410 mainframe, whenever it is necessary to obtain easy access to the adjustments and test points on the TSG6 circuit board under test. The boards can be removed without removing the front panel.

SHORT-FORM CALIBRATION PROCEDURE

Refer to Figs. 8-1 and 8-2 in Section 8, Servicing Illustrations, for adjustment and jumper locations.

Table 4-1

TSG6 SHORT FORM CALIBRATION PROCEDURE

Step	Adjustments	Parameter
1	R339	Equal deviation from 3 V measured at pins 3 and 22 of U390.
2	R319[a], R309	Even harmonics should be at least 50 dB down relative to the fundamental as measured at J370.

Table 4-1 (cont)

Step	Adjustments	Parameter
3	R389[a]	Top of triangle waveform at J370 should be +60 mV above ground.
	R379[a]	Bottom of triangle waveform at J370 should be −60 mV below ground.
4[b]	R493	Minimum residual subcarrier on backporch.
5	L535, L537	Best corner on leading edge of negative-going line sync pulse.
6	L531, L533	Best leading top corner on white reference bar.
	R439[c]	Reduced amplitude pedestal segments are all at the same level.
	R459	Minimum transients between reduced amplitude pedestal segments.
	R429[c]	Full amplitude pedestal segments are all at the same level.
7	L475, L485	Subcarrier harmonics should be at least 30 dB down as displayed on spectrum analyzer. Best phase transient response is displayed on vectorscope.
8	C224	Burst vector phase matches phase of reference subcarrier.
	L211	Adjust if C224 has insufficient range.
9	L471	Best burst shape.
10	R379, R389 R319	Optimum 2nd through 5th harmonic attenuation at 500 kHz manual mode.
	C383	Minimum 3rd harmonic at 4 MHz manual mode.
	R349[d]	Minimum 2nd harmonic at 4 MHz manual mode.
11	R489	643 mV (90 IRE) ±20 mV 500 kHz multiburst packet amplitude. Low-frequency range, full-amplitude, multiburst mode.
	R442	Burst: 285.7 mV (40 IRE) ±8.6 mV peak-to-peak.
12	R268	Sync: −285.7 mV (−40 IRE) ±5.7 mV from blanking. Low-frequency range, markers on, reduced-amplitude, multiburst mode.
	R279	Setup: 71.4 mV (10 IRE) ±7.1 mV from blanking. Same mode as for R268.

Table 4-1 (cont)

Step	Adjustments	Parameter
	R298	Reduced Pedestal: 214 mV (30 IRE) ±2.1 mV from setup. Same mode as for R268.
	R289	Reduced Marker: 214 mV (30 IRE) ±2.1 mV from pedestal. Same mode as for R268.
13	R299	Full Pedestal: 321.5 mV (45 IRE) ±3.22 mV from setup. Low-frequency range, markers on, full-amplitude, multiburst mode.
	R288	Full Marker: 321.5 mV (45 IRE) ±3.22 mV from pedestal. Same mode as for R299.
14	R479	0 V ±50 mV dc level between sinewave packets. Low-frequency range, markers on, continuous, full-amplitude sweep mode.
	R278	0 V ±50 mV backporch dc level. Same mode as for R479.
15	C336	Same mode as for R479 except use manual operation. Set FREQUENCY control to 3 MHz, set FREQ RANGE button to HIGH, and adjust C336 to obtain 10 MHz ±100 kHz output signal.
16	R138	Marker at 500 kHz ±3% within one television line either side of marker in low-frequency range, markers on, composite, full-amplitude sweep mode.
	R139	Marker at 3 MHz ±3% within one television line either side of marker using same mode as for R138.
17	R359	15 MHz ±6% zero beat centered between 14 MHz and 16 MHz markers. Same mode as for R138 except use high-frequency range.
	R369	Marker at 20 MHz ±7%. The difference frequency between the 20 MHz and 18 MHz markers must be within 2 MHz ±400 kHz.
18	R109	500 kHz ±3% in low-frequency range, markers off, continuous, full amplitude, multiburst mode. Jumper moved from P104 to P132.
	R112	1.25 MHz ±3% using high-frequency range mode. Jumpers same as for R109.

Table 4-1 (cont)

Step	Adjustments	Parameter
	R108	1.25 MHz ±3% using same mode as for R109. Jumper moved from P105 to P104.
	R119	2.00 MHz ±3% using same mode as for R109. Jumper moved from P114 to P105.
	R118	3.00 MHz ±3% using same mode as for R109. Jumper moved from P115 to P114.
	R129	3.58 MHz ±3% using same mode as for R109. Jumper moved from P125 to P115.
	R128	4.10 MHz ±3% using same mode as for R109. Jumper moved from P132 to P125.
	R146	6.00 MHz ±10% using same mode as for R109 except use manual operation with FREQUENCY control set fully clockwise.
19	R439	Flat pedestal. Low-frequency range, markers off, composite, reduced-amplitude, multiburst mode.
	R429	Flat pedestal. Same mode as for R439 except use full amplitude.
20	R349	Best high-frequency symmetry around pedestal axis. High-frequency range, markers off, composite, full-amplitude, sweep mode.
21	C505	Preferred method using Diode Detector: Equal deviation when observing brightened top portion of waveform. Same mode as for R349 except use continuous sweep. Flatness must be within 15 mV to 12 MHz; within 20 mV to 20 MHz.
		Alternate method response. Same mode as for R349 except use markers on, composite mode.
22	√ Only	Check Isolation: 1% or less.

[a]Readjusted in step 10.
[b]Steps 4 through 22 use the TSG6 Module Output signal.
[c]Readjusted in step 19.
[d]Readjusted in step 20.

CALIBRATION PROCEDURE
A61 Multiburst Output Board (see Fig. 8-2)

NOTE

The TSG6 contains many interrelated adjustments. Be aware of the interrelationships when performing only part of the Calibration Procedure. This procedure is logically sequenced to minimize interaction.

Preliminary Procedure

a. Mount the A61 Multiburst Output board on the 1410 Extender board (see Fig. 4-1). Turn on the 1410 mainframe and allow 20 minutes warmup time at +20° C to +30° C.

b. Set the 1410 mainframe Power switch to Off. Carefully remove U390 from its socket. Set the 1410 mainframe Power switch to On.

IMPORTANT

Steps 1 through 9 are performed with U390 removed from its socket.

1. Check/Adjust 3.000 V Hybrid Supply Adj (R399)

a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Connect a DVM between pins 1 and 3 of U390. Note the voltage deviation from +3 V.

c. Connect the DVM between pins 1 and 22 of U390. Note the voltage deviation from −3 V.

d. CHECK—for equal deviation from 3 V. For example, if the voltage at pin 3 is +3.003 V, the voltage at pin 22 should be −2.997 V.

e. ADJUST—R399 (3.000 V Hybrid Supply Adj) for equal voltage deviation from 3 V as described in parts b through d of this step.

f. Disconnect the DVM from the test points.

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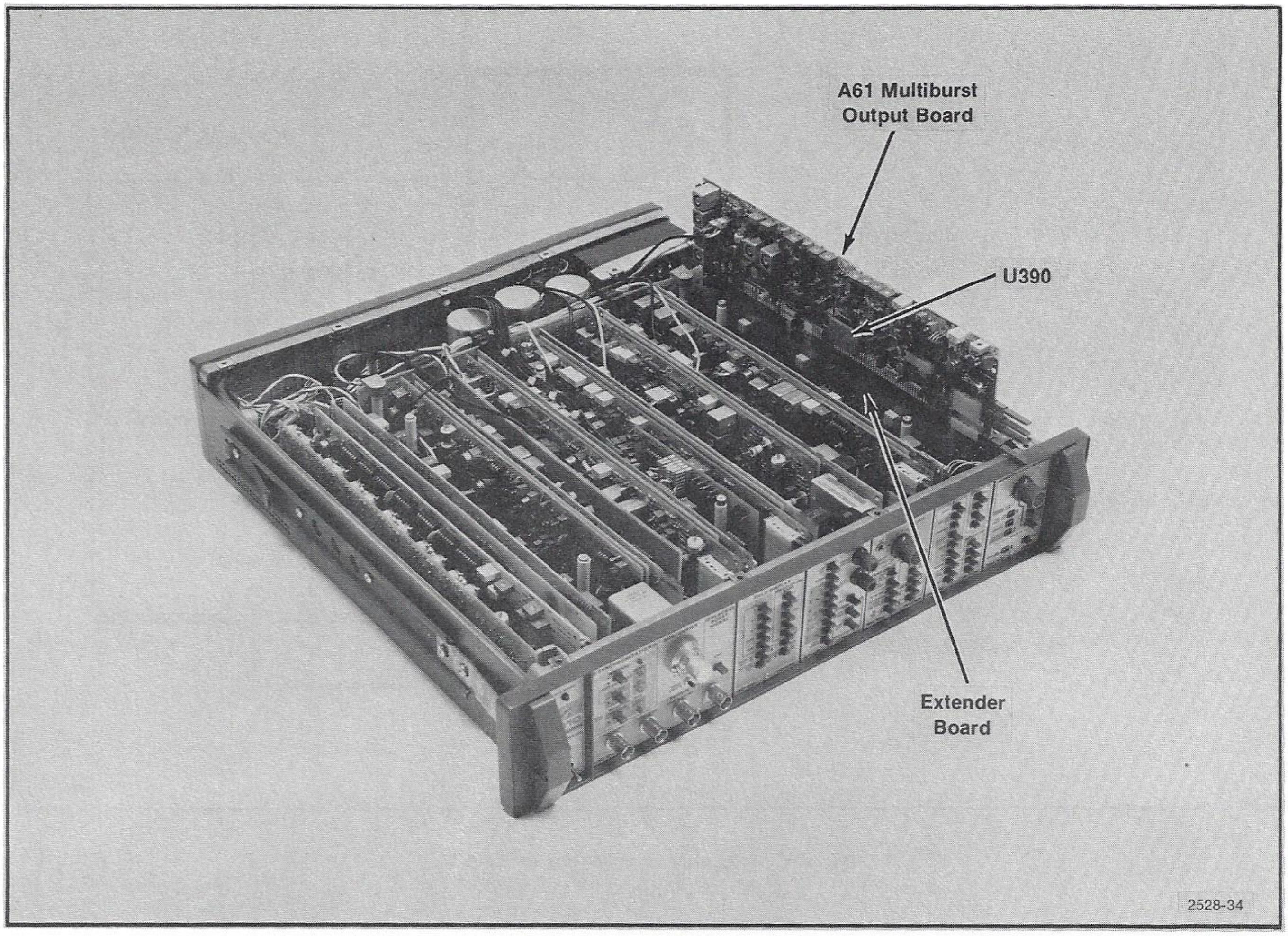


Fig. 4-1. A61 Multiburst Output board mounted on the Extender board.

2. Check/Adjust Symmetry (R319) and Low-Current Symmetry (R309)

a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Connect the signal from J370 on the Multiburst Output board via the 50-ohm connector-adapter cable to the spectrum analyzer RF Input connector (see Fig. 4-2).

c. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MANUAL
FREQUENCY Control	Approximately 4 MHz (control set to midrange)
BURST	Off

d. Set the spectrum analyzer controls to display the signal at a resolution of 300 kHz. The 7L12 Spectrum Analyzer control settings that follow are given as a guide.

Time/Div switch	2 ms
Freq Span/Div selector	5 MHz
Resolution selector	300 kHz
Center Frequency control	Tuned to center the display
Display Mode	10 dB/Div
RF Attenuator selector	10 dB
Gain selector (Reference Level)	−20 dBm
P-P Auto & Free Run buttons	Pressed in
Video Filters	30 kHz

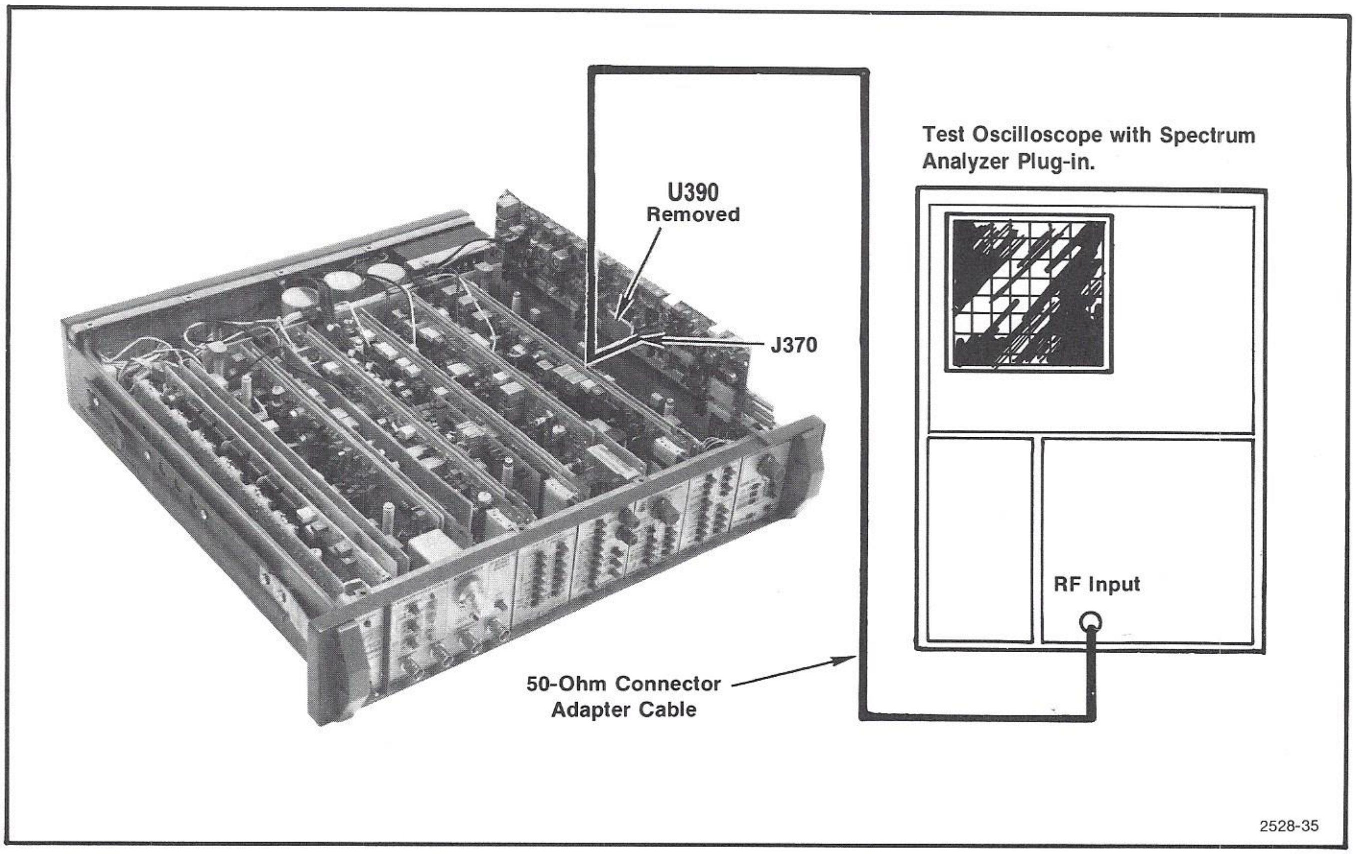


Fig. 4-2. Equipment connections for step 2.

e. CHECK—that the even harmonics are at least 50 dB down relative to the fundamental. See Fig. 4-3A.

f. ADJUST—R319 (Symmetry) for minimum even harmonics; −50 dB or less.

g. Set the TSG6 FREQUENCY control to approximately 100 kHz. Set the spectrum analyzer Frequency Span/Div selector to 100 kHz (0.1 MHz) and the Resolution selector to 30 kHz.

h. CHECK—that the even harmonics are at least 50 dB down. See Fig. 4-3B.

i. ADJUST—R309 (Low-Current Symmetry) for minimum even harmonics; −50 dB or less.

j. Disconnect the signal from the spectrum analyzer. Leave the adapter cable connected to J370.

NOTE

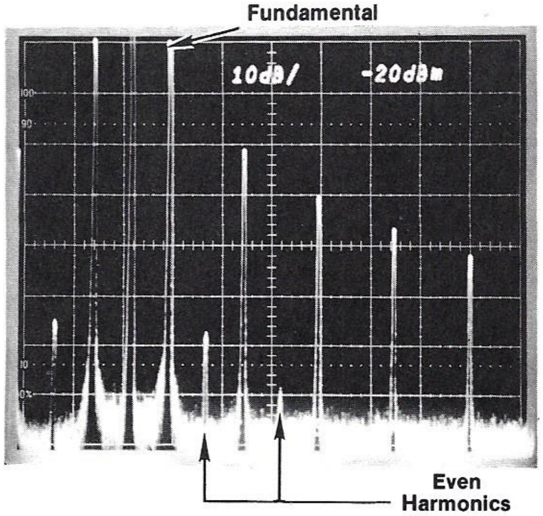
R319, R379, and R389 are readjusted in step 10 to minimize harmonics.

3. Check/Adjust Triangle Amplitude (R389) and Negative-Level Triangle (R379)

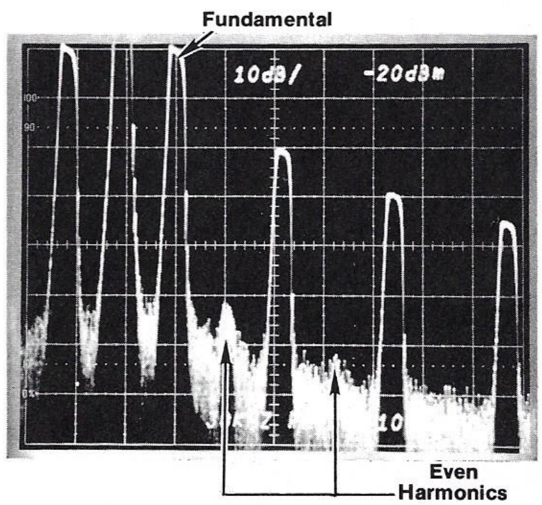
a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Connect the signal from J370 on the Multiburst Output board via the 50-ohm connector-adapter cable and a 50-ohm termination to the test oscilloscope vertical connector. Use internal triggering for the time base.

c. Set the TSG6 controls to the same settings as given in part c of step 2 except the FREQUENCY control should remain at approximately 100 kHz. This is the frequency used when completing step 2.



(A) FREQUENCY control set to approximately 4 MHz.



(B) FREQUENCY control set to approximately 100 kHz.

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Fig. 4-3. Spectrum analyzer displays obtained when checking even harmonic attenuation at J370. The TSG6 is operating in the manual mode.

d. CHECK—that the triangle waveform is symmetrical around ground and 80 mV to 120 mV peak-to-peak in amplitude. Figure 4-4 shows a 120 mV peak-to-peak amplitude waveform symmetrical around ground for use as a guide when performing part e of this step.

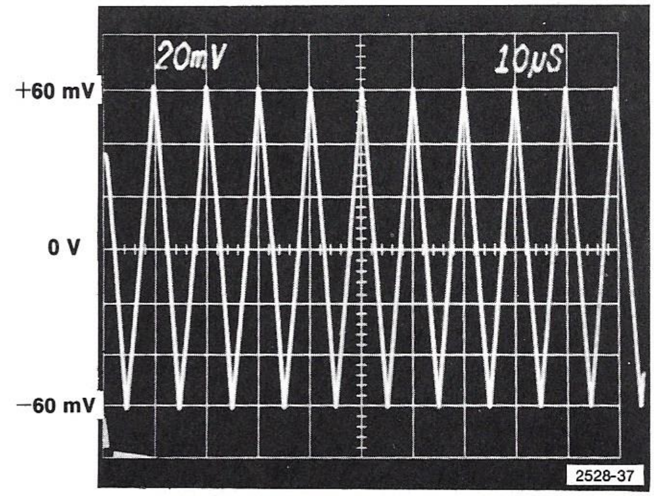


Fig. 4-4. Checking amplitude and dc level of J370 triangle waveform. FREQUENCY control is set to approximately 100 kHz in the manual mode.

CAUTION

Do not perform part e of this step if the signal amplitude is within the 80 mV to 120 mV amplitude range. If R389 and R379 are adjusted, never leave the signal amplitude in excess of +65 mV and −65 mV with respect to ground. This excessive amplitude may damage U390 when U390 is returned to its socket.

e. ADJUST—if necessary, R389 (Triangle Ampl) so that the top of the triangle waveform is +60 mV above ground. Adjust R379 (Neg Level Triangle) so that the bottom of the triangle waveform is −60 mV below ground as shown in Fig. 4-4.

f. Disconnect the signal applied to the test oscilloscope. Disconnect the adapter cable from J370.

4. Check/Adjust Residual Subcarrier (R493)

a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Apply the TSG6 (Module Output) signal from the 1410 mainframe rear-panel Module Output connector through a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A Video Input connector. Terminate the other 1480 Ch A Video Input loop-through connector into 75 ohms.

c. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	Off

d. Set the waveform monitor controls to display the backporch portion of the composite video signal. Set the Volts Full Scale switch to 0.2. Set the Display switch to 10 μs/Div and the Magnifier switch to 1 (1 μs/div).

e. CHECK—for minimum residual subcarrier. See Fig. 4-5.

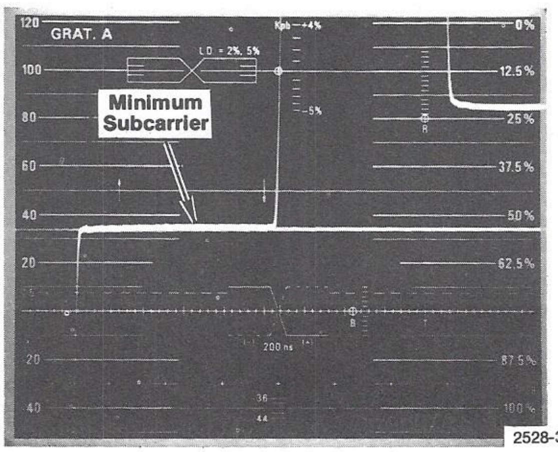


Fig. 4-5. Checking for minimum subcarrier on backporch of TSG6 Module Output signal. BURST pushbutton set to Off.

f. ADJUST—R493 (Residual Subcarrier) for minimum residual subcarrier on the backporch portion of the composite video signal.

5. Check/Adjust Sync Filter (L535, L537)

a. Use the same equipment setup and TSG6 control settings as described in parts a through c of step 4.

b. Check that the waveform monitor Volts Full Scale switch is set to 0.2. Check that the Display and Magnifier switches are set to obtain a 1 μs/div sweep rate. Set the remaining controls to display the horizontal sync pulse portion of the line-rate waveform.

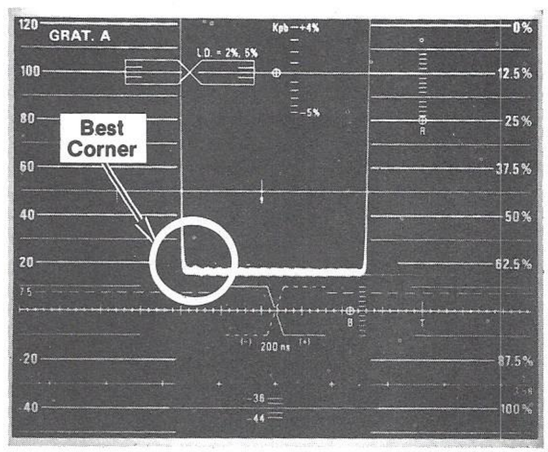
c. CHECK—for best corner on the leading edge of the sync pulse. See Fig. 4-6A.

d. ADJUST—L535 and L537 (Sync Filter) for best corner on the leading edge of the sync pulse.

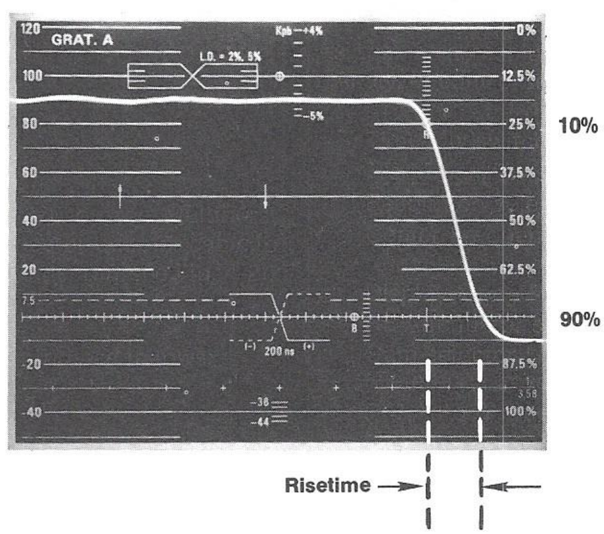
e. Set the waveform monitor Variable Volts Full Scale control so that the sync pulse displayed amplitude is equivalent to 10 divisions (100 IRE). Set the Magnifier switch to the .1 position (100 ns/div).

f. CHECK—sync pulse for a risetime of 130 ns, +20 ns −10 ns, as measured between the 10% and 90% amplitude points. See Fig. 4-6B.

g. Return the waveform monitor Variable Volts Full Scale control to Cal. Set the Volts Full Scale switch to 0.5 and the Magnifier switch to X1.



(A) Checking for best corner.



(B) Checking risetime. Time base: 100 ns/div.

2528-39

Fig. 4-6. Negative-going horizontal sync pulse.

6. Check/Adjust Luminance Filter (L531, L533), Reduced Amplitude Pedestal Balance (R439), Multiburst Modulator Balance (R459), and Full Amplitude Pedestal Balance (R429)

a. Use the same equipment setup and TSG6 control settings as described in parts a through c of step 4 except as follows: Set the TSG6 AMPL pushbutton to REDUCED.

b. Set the waveform monitor controls to display the leading top corner of the marker at a sweep rate of 1 μs/div.

c. CHECK—for best leading top corner on the marker.

d. ADJUST—L531 and L533 (Luminance Filter) for best leading top corner on the marker.

e. Using the technique described in part e of step 5, set the waveform monitor controls so the marker risetime can be checked.

f. CHECK—for a risetime of 250 ns ±50 ns as measured between the 10% and 90% amplitude points.

g. Set the waveform monitor controls to display the pedestal portion of the waveform. Set the Volts Full Scale switch to 0.2, Variable Volts Full Scale control to Cal, Display switch to 5 μs/Div, and the Magnifier switch to X1. Check that the Response switch is set to Flat.

h. CHECK—for a flat pedestal (see Fig. 4-7A).

i. ADJUST—R439 (Reduced Ampl Pedestal Bal) to obtain a flat pedestal level. Adjust R459 for minimum transients between pedestal segments. Figure 4-7B shows how the pedestal level becomes distorted when R439 and R459 are misadjusted.

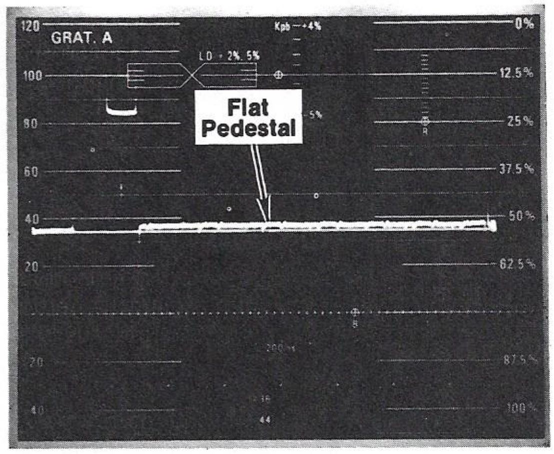
j. Set the TSG6 AMPL pushbutton to FULL.

k. CHECK—for a flat pedestal.

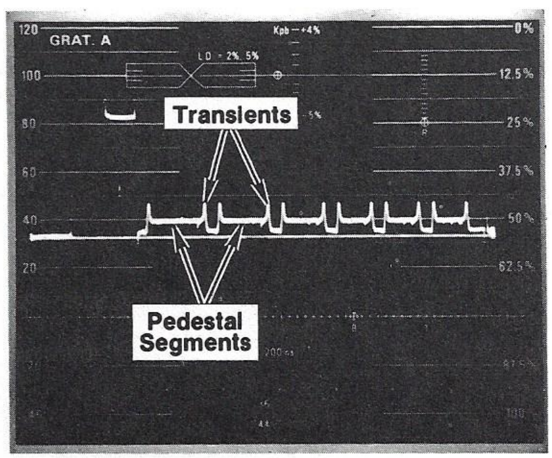
l. ADJUST—R429 (Full Ampl Pedestal Bal) to obtain a flat pedestal.

NOTE

To check accuracy of the adjustments, set the AMPL pushbutton to REDUCED and then to FULL. Check for no change in pedestal flatness.



(A) Properly adjusted pedestal.



(B) Improperly adjusted pedestal. R439 and R459 were misadjusted to obtain this waveform. 2528-40

Fig. 4-7. Checking pedestal flatness in reduced-amplitude composite multiburst mode.

m. Disconnect the signal from the waveform monitor.

7. Check/Adjust Chrominance Bandpass Filter (L475, L485)

a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable to the 520A Vectorscope Ch A input connector. Terminate the other Ch A loop-through connector into 75 ohms.

c. Disconnect a module output multi-pin connector from an adjacent TSG module and connect this same connector to pins 3 and 4 (Spare Output) of P515 on A61 Multiburst Output board. (In this application, the module output multi-pin connector with its cable is borrowed from the adjacent TSG module. The cable is used to apply the spare signal to one of the 1410 rear-panel Module Output connectors.) Connect this spare TSG6 Module Output signal via a 75-ohm to 50-ohm minimum loss attenuator and a 50-ohm coaxial cable to the spectrum analyzer RF Input connector. See Fig. 4-8.

d. Check that the TSG6 front-panel controls are set as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	On

e. Set the spectrum analyzer controls to display the chrominance (burst) signal using these settings as a guide: Time/Div switch set to 5 ms, Freq Span/Div selector set to 2 MHz, Resolution selector set to 30 kHz, RF Attenuator selector set to 0 dB, and the Gain selector set to −30 dBm reference level.

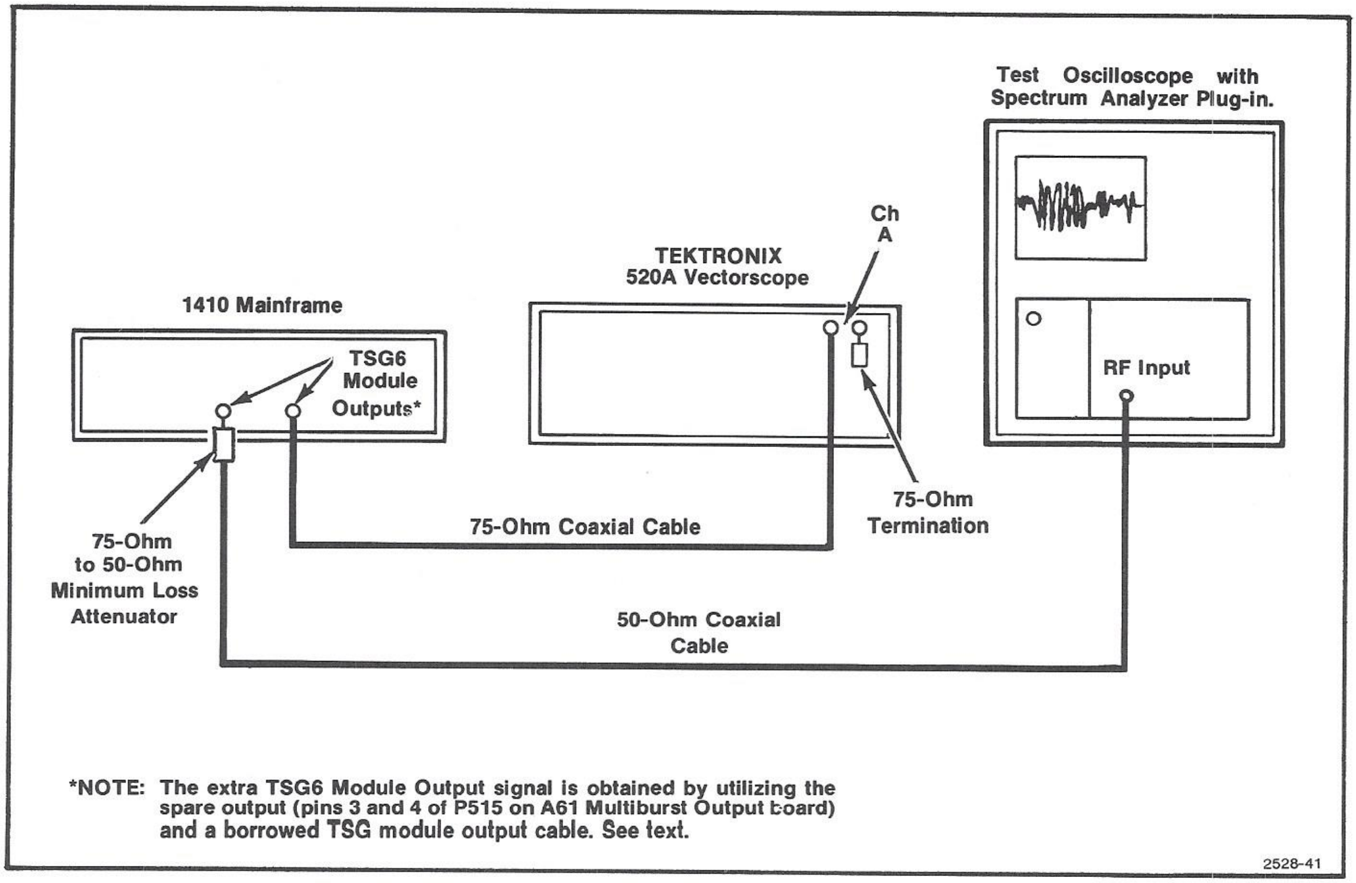
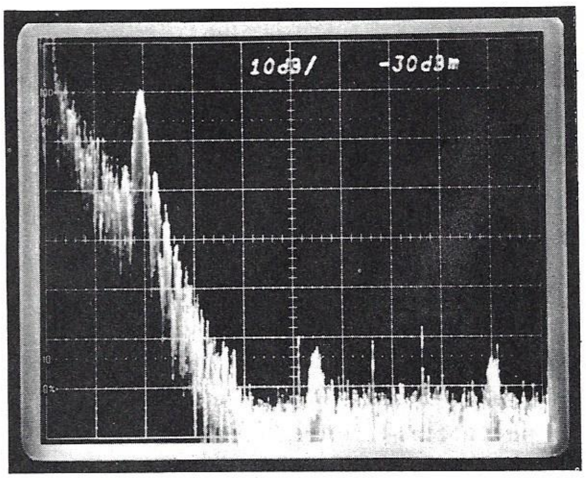


Fig. 4-8. Equipment connections for step 7.

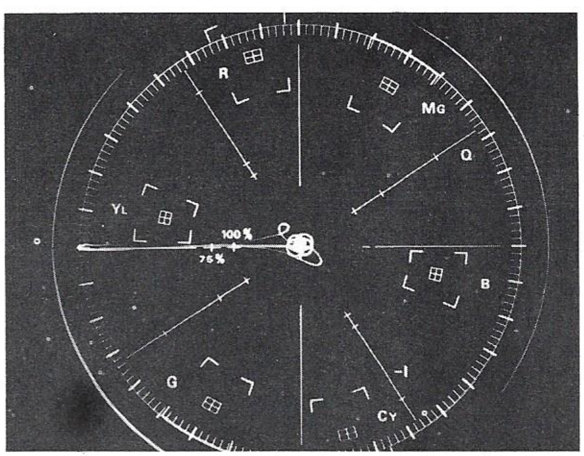
f. Set the 520A Vectorscope controls as follows: Depress the Ch A, Full Field, Aϕ, and Vector pushbuttons. Check that the ϕ Ref switch is set to Int. Set the Ch A Gain control so that the burst tip reaches the graticule circle. Rotate the Ch A Phase control so that the burst vector is at 180°.

g. CHECK—that the subcarrier harmonics are at least 30 dB down as displayed on the spectrum analyzer (see Fig. 4-9A). The burst vector, as displayed on the vectorscope, should have good phase transient response; that is, minimum loop opening. See Fig. 4-9B.

h. ADJUST—L475 and L485 (Chrominance Bandpass Filter) for best harmonic attenuation as displayed on the spectrum analyzer and phase transient response as viewed on the vectorscope.



(A) Checking subcarrier harmonic attenuation.



(B) Checking transient response. 2528-42

Fig. 4-9. Displays obtained when performing step 7.

NOTE

L475 mostly affects phase transient response; L485 mostly affects harmonics. Adjust L485 for equal amplitude 2nd and 3rd harmonics.

i. Disconnect the signals applied to the spectrum analyzer and vectorscope. Disconnect the borrowed multi-pin connector, with attached cable, from pins 3 and 4 of P515. Reconnect this cable to its original connector on the adjacent TSG module.

8. Check/Adjust Burst Phase (C224, L211)

a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Connect the 1410 rear-panel Subcarrier output J20 signal via a 75-ohm coaxial cable to the 520A Vectorscope Ext CW ϕ Ref connector. Terminate the other Ext CW ϕ Ref loop-through connector into 75 ohms. Connect the 1410 rear-panel Subcarrier output J21 signal through a 10X attenuator and a 75-ohm cable (in that order) to the vectorscope Ch A input connector. Terminate the other Ch A loop-through connector into 75 ohms. See Fig. 4-10A.

c. Check that the TSG6 front-panel controls are set to the same settings as given in part d of step 7.

d. Check that the vectorscope controls are set to the same positions as described in part f of step 7 except set the Ch A Gain control to Cal and the ϕ Ref switch to Ext.

e. Rotate the vectorscope Ch A Phase control to position the subcarrier vector at 180° for use as a reference.

NOTE

Do not move the vectorscope Ch A Phase control until completing parts f through h of this step.

f. Disconnect the 75-ohm coaxial cable at the 10X attenuator connection. Connect this same cable, without changing its length, to the TSG6 Module Output connector so that the TSG6 signal is applied to the vectorscope Ch A input connector. See Fig. 4-10B.

g. CHECK—that the TSG6 color burst vector is at 180° within a tolerance of ±10% (see Fig. 2-11 in Section 2). The TSG6 color burst phase should be the same as the subcarrier phase used as a reference in part e of this step.

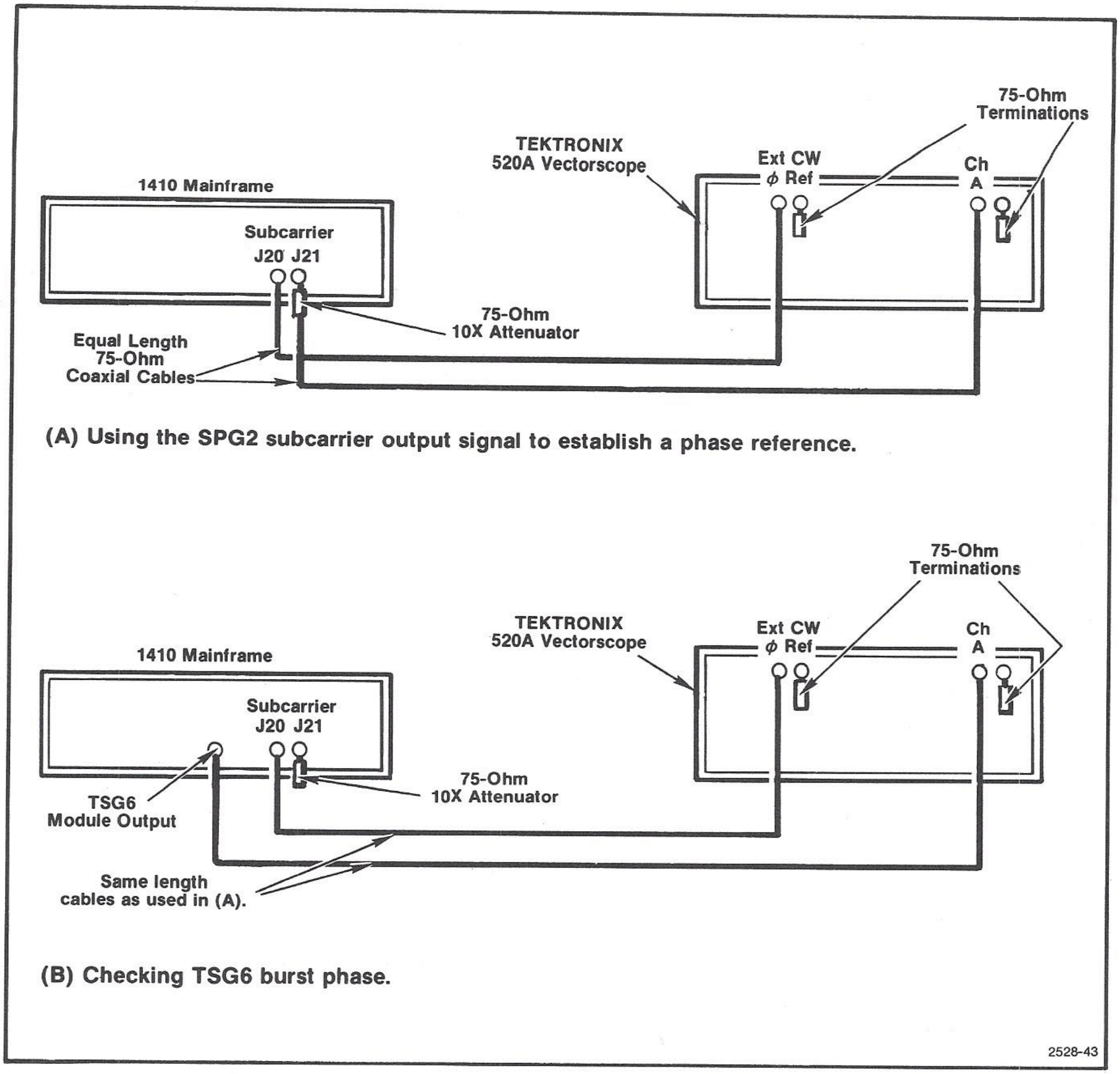


Fig. 4-10. Equipment connections for step 8.

h. ADJUST—C224 (Burst Phase) to obtain the same phase as the reference subcarrier. Location of C224 is on A60 Multiburst Logic board (see Fig. 8-1). This adjustment is accessible without using the Extender board.

NOTE

If C224 has insufficient range, set the 1410 mainframe Power switch to Off, place the A60 Multiburst Logic board on the 1410 Extender. Reinstall A61 Multiburst Output board in the 1410 mainframe. Set the 1410 mainframe Power switch to On, set C224 to the center of its range, and adjust L211 to obtain the same phase as the reference subcarrier. Set the 1410 Power switch to Off, mount the A60 board in the mainframe. Set the 1410 Power switch to On.

i. Disconnect the signals applied to the vectorscope.

9. Check/Adjust Burst Shape (L471)

a. Check that parts a and b of the Preliminary Procedure have been performed.

b. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A Video Input connector. Terminate the other Ch A loop-through connector into 75 ohms.

c. Check that the TSG6 front-panel controls are set to the same settings as described in part d of step 7.

d. Set the 1480 Waveform Monitor controls to display the back porch portion of the composite video signal. Use these settings: input switch set to A, Dc-Coupled; Response switch set to Flat; DC Restorer switch set to Slow, Backporch; Volts Full Scale switch set to 0.2; Display switch set to 10 μs/Div; Magnifier switch set to the 0.5 position.

e. CHECK—for best burst shape while depressing the SPG2 Horiz Unlock button. The shape of the burst envelope should appear similar to the waveform shown in Fig. 4-11.

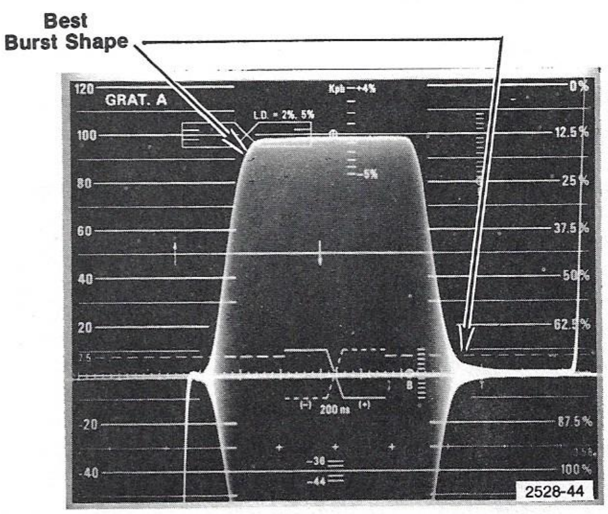


Fig. 4-11. Checking color burst shape. Waveform monitor Volts Full Scale switch set to 0.2.

f. Adjust—L471 (Burst Shape) for best leading corners while depressing the SPG2 Horiz Unlock button. Also, check that L471 is adjusted for best trailing edge as the burst packet approaches zero.

g. Set the waveform monitor Magnifier switch to 0.2 (200 ns/div). Set the remaining appropriate waveform monitor controls to perform a burst envelope risetime measurement.

h. CHECK—burst envelope for a risetime of 400 ns ±60 ns as measured between the 10% and 90% amplitude points on the upper half of the envelope. Depress the SPG2 Horiz Unlock button while performing the measurement.

i. Disconnect the signal from the waveform monitor.

j. Set the 1410 mainframe Power switch to Off and insert U390 into its socket. Remove the Extender board and install the A61 Multiburst Output board in the 1410 mainframe. Set the 1410 Power switch to On.

10. Check/Adjust Negative Level Triangle (R379), Triangle Amplitude (R389), Delay Compensation (C383), High-Frequency Even Harmonics (R349), and Symmetry (R319)

a. Check that part j of step 9 has been performed.

b. Connect the TSG6 Module Output signal via a 75-ohm to 50-ohm minimum loss attenuator and a 50-ohm coaxial cable to the spectrum analyzer RF Input connector.

c. Set the TSG6 front-panel controls as follows:

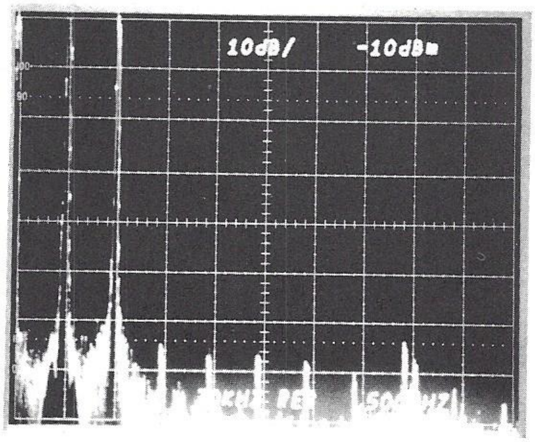
FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MANUAL
FREQUENCY Control	Approximately 500 kHz
BURST	Off

d. Set the spectrum analyzer controls to display the signal at 30 kHz resolution, 500 kHz/div, and −10 dBm. Set the RF Attenuator selector to 20 dB.

e. CHECK—for maximum 2nd through 5th harmonic attenuation. See Fig. 4-12.

f. READJUST—R379 and R389 for optimum harmonic attenuation. Repeat these adjustments, as necessary, to minimize the harmonics.

g. Set the TSG6 FREQUENCY control to approximately 4 MHz. Set the spectrum analyzer controls to display the signal at 300 kHz resolution and 2 MHz/div.



2528-45

Fig. 4-12. Checking harmonic attenuation in continuous manual mode. TSG6 FREQUENCY control set to approximately 500 kHz.

h. CHECK—for maximum 2nd and 3rd harmonic attenuation.

i. ADJUST—C383 (Delay Comp) to minimize the 3rd harmonic. Adjust R349 (HF Even Harmonics) to minimize the 2nd harmonic.

j. READJUST—if the 2nd harmonic is greater in absolute amplitude than the 3rd harmonic, readjust R319 so the 2nd harmonic attenuation is equal to the 3rd harmonic.

NOTE

If R319 is readjusted, set the TSG6 FREQUENCY control to 500 kHz and repeat part e of this step.

k. Disconnect the signal from the spectrum analyzer.

11. Check/Adjust Master Gain (R489)

a. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A Video Input connector. Terminate the other Ch A loop-through connector into 75 ohms.

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	Off

c. Set the 1480 Waveform Monitor controls as follows: Input switch set to A, Dc-Coupled, Response switch set to Flat, Volts Full Scale switch set to 0.2, DC Restorer button to Off, Display switch set to 10 μs/Div, and Magnifier switch set to X1. Press in the Cal button while holding the Oper button depressed.

d. Use the Amplitude dial of the Calibration Fixture to match the top of the lower 500-kHz multiburst packet with the bottom of the upper 500-kHz multiburst packet. (Fig. 2-7 in Section 2 illustrates this technique.)

e. CHECK—for a 500 kHz multiburst packet amplitude of 643 mV peak-to-peak (90 IRE) ±20 mV.

f. ADJUST—R489 (Master Gain) for 643 mV peak-to-peak 500-kHz multiburst packet amplitude.

A60 Multiburst Logic Board (see Fig. 8-1)

The following Calibration Procedure for the A60 board also includes instructions for adjusting C336, C505, R349, R359, R369, R429, R442, and R479 that are located on the A61 Multiburst Output board. The A61 board adjustments are accessible without using an extender.

12. Check/Adjust Burst Amplitude (R442), Sync Amplitude (R268), Setup Amplitude (R279), Reduced Pedestal Amplitude (R298), and Reduced Marker Amplitude (R289)

a. Use the same equipment connections as described in part a of step 11.

@

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	REDUCED
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	On

c. Check that the waveform monitor controls are set the same as described in part c of step 11.

d. Use the Amplitude dial of the Calibration Fixture to match the top of the lower burst envelope with the bottom of the upper burst envelope (see Fig. 4-13A).

e. CHECK—Calibration Fixture dial for a burst amplitude reading of 285.7 mV (40 IRE) ±8.6 mV peak-to-peak.

f. ADJUST—R442 (Burst Ampl) for a burst amplitude of 285.7 mV peak-to-peak.

g. Set the TSG6 BURST button to Off if desired.

h. CHECK—the TSG6 output waveform for the amplitudes that follow. Use the Calibration Fixture to perform the measurements. Use Fig. 4-13 to identify the points on the waveform to be measured. Be sure to set the waveform monitor Volts Full Scale switch to 0.2 for optimum measurement resolution.

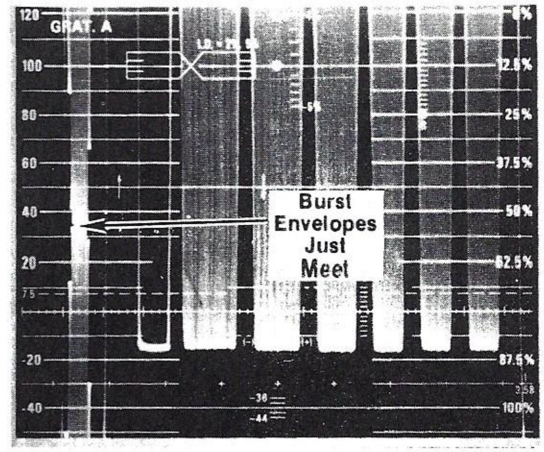
Sync: −285.7 mV (−40 IRE) ±5.7 mV from blanking.

Setup: 71.4 mV (10 IRE) ±7.1 mV from blanking.

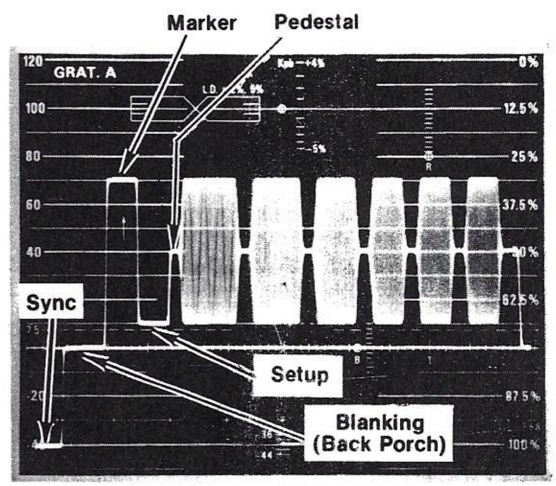
Reduced Pedestal: 214 mV (30 IRE) ±2.1 mV from setup.

Reduced Marker: 214 mV (30 IRE) ±2.1 mV from the pedestal.

i. ADJUST—R268 (Sync Ampl), R279 (Setup Ampl), R298 (Reduced Pedestal Ampl), and R289 (Reduced Marker Ampl) to obtain the respective amplitudes described in part h of this step.



(A) Checking burst amplitude. TSG6 BURST button set to On. Waveform monitor Volts Full Scale switch set to 0.2.



(B) Identifying the points on the waveform to be measured in parts h and i of step 12. TSG6 BURST button set to Off and waveform monitor Volts Full Scale switch set to 1.0 for this illustration. 2528-46

Fig. 4-13. Checking the TSG6 output waveform amplitudes.

13. Check/Adjust Full Pedestal Amplitude (R299) and Full Marker Amplitude (R288)

a. Use the same equipment connections as described in part a of step 11.

b. Check that the TSG6 front-panel controls are set to the same positions as given in part b of step 12 except set the AMPL pushbutton to FULL. The BURST pushbutton can be set to either On or Off.

c. CHECK—the TSG6 output waveform for the amplitudes that follow. Use the technique described in step 11 to make the measurement.

Full Pedestal: 321.5 mV (45 IRE) ±3.22 mV from setup.

Full Marker: 321.5 mV (45 IRE) ±3.22 mV from pedestal.

d. ADJUST—R299 (Full Pedestal Ampl) and R288 (Full Marker Ampl) to obtain the respective amplitudes given in part c of this step.

e. Press in the waveform monitor Oper button to release the Cal button. Set the DC Restorer switch to Slow. Disconnect the signal from the waveform monitor.

14. Check/Adjust Continuous DC Level (R479) and Composite Backporch Level (R278)

a. Apply the TSG6 Module Output signal via a 75-ohm coaxial cable and a 75-ohm feed-through termination to the test oscilloscope vertical input connector. Externally trigger the time base using the 1410 rear-panel V Drive signal.

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	SWEEP
FREQUENCY Control	As is
BURST	Off

c. Set the test oscilloscope Vertical Input switch to Gnd, Volts/Div switch to 50 mV, the Time/Div switch to 5 ms, and position the trace to graticule center.

d. Change the test oscilloscope Vertical Input switch to DC.

e. CHECK—that the dc level between the sine-wave packets is at 0 V ±50 mV.

f. ADJUST—R479 (Cont DC Level; see Fig. 8-2) so that the dc level between sine-wave packets is at 0 V dc.

g. Set the TSG6 MULTIBURST/SWEEP/MANUAL switch to MULTIBURST.

h. Use the 1410 rear-panel H Drive signal to externally trigger the test oscilloscope time base. Set the test oscilloscope controls to display the waveform at 10 μs/div.

i. CHECK—that the backporch or blanking level is at 0 V dc ±50 mV.

j. ADJUST—R278 (Comp Backporch Level) for 0 V dc backporch level.

k. Disconnect the signals applied to the test oscilloscope.

15. Check/Adjust Hi/Lo Range Ratio (C336)

a. Apply the TSG6 Module Output signal via a 75-ohm coaxial cable and a 75-ohm feed-through termination to the frequency counter input connector.

b. Set the TSG6 front-panel controls to the same settings as given in part b of step 14 except set the MULTIBURST/SWEEP/MANUAL switch to MANUAL.

NOTE

If the TSG6 is VITS keyed (either by the TSP1 or an external signal applied to the 1410 rear-panel Remote connector), it is necessary to ground Interface line 57. This is accomplished by using one of the following methods: (1) Set the remote control unit Calibrate switch to On; (2) If the remote control unit is not available or not connected to the 1410 rear-panel Remote connector, connect pin 57 on the Interface board to ground, or (3) connect test point 57 on the Extender board to ground.

c. Set the TSG6 FREQUENCY control to obtain a readout of 3.00 MHz on the counter and then set the FREQ RANGE pushbutton to HIGH.

d. CHECK—for a 9.90 MHz to 10.10 MHz readout on the counter.

e. ADJUST—C336 (Hi/Lo Range Ratio) to obtain 10.00 MHz readout on the counter.

f. INTERACTION—Set the FREQ RANGE pushbutton to LOW and repeat parts c and d of this step to obtain the proper ratio.

g. Disconnect the signal applied to the counter. Unground Interface line 57 if it was grounded.

16. Check/Adjust Sweep Start Frequency (R138) and Field Sweep Rate (R139)

a. Apply the TSG6 Module Output signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A Video Input connector. Terminate the remaining Ch A Video Input connector into 75 ohms.

b. Connect the output signal from the sine-wave generator via a 50-ohm coaxial cable to a bnc T adapter. Connect the bnc T adapter to the digital counter input connector. Connect another 50-ohm coaxial cable from the bnc T connector to the 1480 Waveform Monitor Ch B Video Input connector. Leave the other Ch B connector unterminated. See Fig. 4-14.

c. Connect the 1410 mainframe or SPG2 Comp Sync signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A External Sync input connector. Terminate the other loop-through connector into 75 ohms.

d. Set the TSG6 and test equipment controls as follows:

TSG6

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	SWEEP
FREQUENCY Control	As is
BURST	Off

Sine Wave Generator

Output Frequency	500 kHz
Output Amplitude	Approximately 200 mV (28 IRE)

1480 Waveform Monitor

Input	A-B, DC-Coupled
Response	Flat
Volts Full Scale	1.0
DC Restorer	Off, Backporch
Oper/Cal	Oper
Display	2 Field
Magnifier	X1
Field	1
Line Selector	Variable
Sync	Ext, AFC

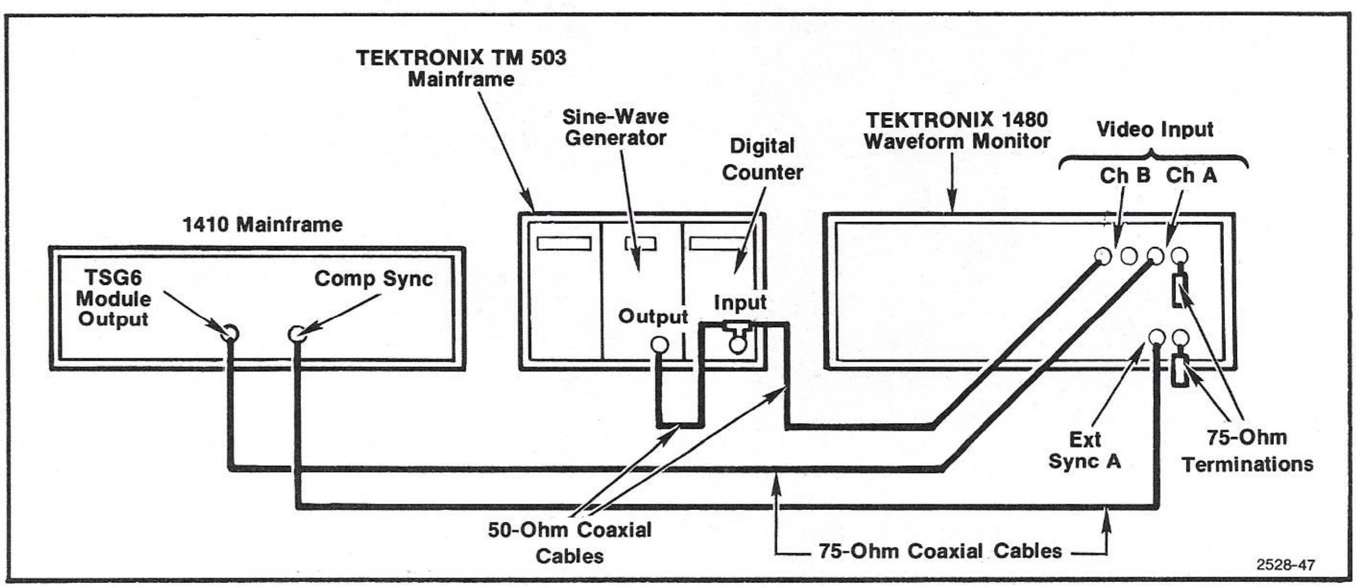
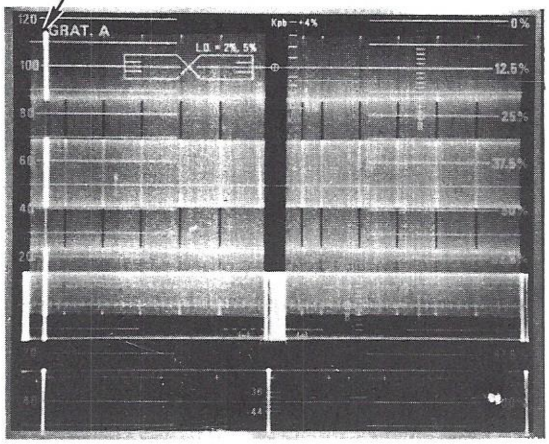


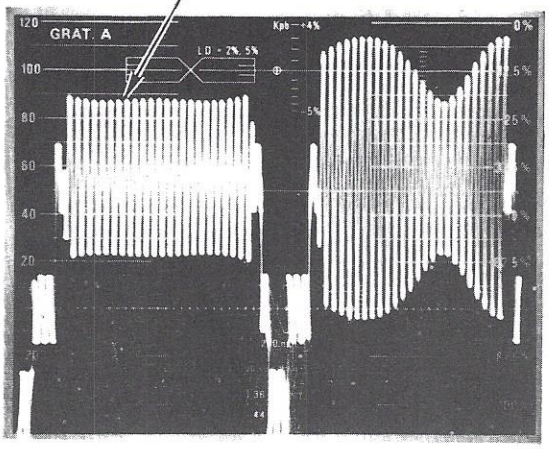
Fig. 4-14. Equipment connections for step 16.

e. Set the waveform monitor Variable Line Selector control to intensify the first marker (500 kHz) as shown in Fig. 4-15A. Set the Display switch to 10 μs/Div and note the marker location on the waveform monitor display.

f. Set the TSG6 MARKERS button to Off. Slowly rotate the sine-wave generator Variable Frequency control until a null or zero beat is obtained at the location of the 500-kHz marker (see Fig. 4-15B).



(A) Locating the 500 kHz marker. Waveform monitor Display switch set to 2 Field.



(B) Zero beat at 500 kHz marker location. Display switch set to 10 μs/Div and TSG6 MARKERS button set to Off. 2528-48

Fig. 4-15. Typical waveforms obtained when checking 500 kHz marker frequency. Waveform monitor Input switch set to A-B, DC Coupled.

g. CHECK—for a digital counter readout of 500 kHz, ±3% or 515 kHz to 485 kHz, within one television line either side of the marker. For example, if the readout is 516 kHz at the marker location, obtain a zero beat on the television line located to the left of the marker. Then, obtain a zero beat on the television line to the right of the marker. (The TSG6 MARKERS button can be set to On while making these checks.) If the readout is 515 kHz or lower at one of these television line locations, the marker meets the performance requirement.

h. Set the TSG6 MARKERS button to Off. Set the sine-wave generator for an output frequency of 500 kHz.

i. ADJUST—R138 (Sweep Start Freq) for a zero beat at the location of the 500 kHz marker.

j. Set the TSG6 MARKERS button to On. Set the waveform monitor Display switch to 2 Field.

k. Set the sine-wave generator to 3.0 MHz. Using the same technique as described in part e of this step, set the waveform monitor Variable Line Selector control to intensify the 4th marker (3.0 MHz). Set the Display switch to 10 μs/Div and note the location of the marker on the waveform monitor display.

l. Set the TSG6 MARKERS button to Off. Slowly rotate the sine-wave generator Variable Frequency control to obtain a zero beat at the 3.0 MHz marker location.

m. CHECK—for a digital counter readout of 3.0 MHz, ±3% or 3.09 MHz to 2.91 MHz, within one television line either side of the marker.

n. Set the sine-wave generator for an output frequency of 3 MHz. Check that the TSG6 MARKERS button is set to Off.

o. ADJUST—R139 (Field Sweep Rate) for a zero beat at the location of the 3 MHz marker.

q. INTERACTION—Set the sine-wave generator to 500 kHz and repeat parts e, h, i, j, k, n, and o, until R138 and R139 are properly adjusted.

17. Check/Adjust High-Range Linearity (R359, R369)

a. Use the same equipment connections as described in parts a through c of step 16 and as shown in Fig. 4-14.

b. Set the TSG6 and test equipment controls to the same settings given in part d of step 16 except as follows:

TSG6

FREQ RANGE	HIGH

Sine Wave Generator

Output Frequency	15 MHz

c. Set the waveform monitor Variable Line Selector control to intensify the portion of the display centered between the 14 MHz and 16 MHz markers as shown in Fig. 4-16.

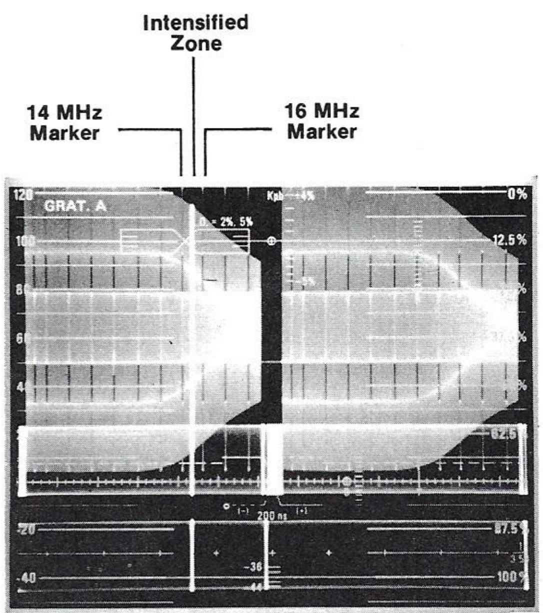


Fig. 4-16. Intensified zone centered between the 14 MHz and 15 MHz markers. Waveform monitor Input switch set to A-B, DC Coupled; Display switch set to 2 Field.

d. Set the waveform monitor Magnifier switch to X10 or X20 and recheck that the intensified zone is centered as closely as possible between the 14 MHz and 16 MHz markers.

e. CHECK—for a zero beat centered between the 14 MHz and 16 MHz markers. To observe the zero beat, you may prefer to depress the Line Selector Digital button so that the intensified zone is not present. Requirement is 15 MHz, ±6% or 15.9 MHz to 14.1 MHz.

f. Set the sine-wave generator so that the output frequency is exactly 15 MHz.

g. ADJUST—if necessary, R359 (High Range Linearity; see Fig. 8-2) to obtain a 15 MHz zero beat at a point centered between the 14 MHz and 16 MHz markers.

h. Set the sine-wave generator output frequency to 20 MHz.

i. Use the waveform monitor Horizontal Position control to position the last marker (20 MHz) into view. Check that the Line Selector Variable button is pressed in. Set the Variable Line Selector control to intensify the 20 MHz marker. Set the TSG6 MARKERS button to Off.

j. CHECK—for a zero beat at the 20 MHz marker location. Requirement is 20 MHz, ±7% or 21.4 MHz to 18.6 MHz. The difference frequency between the 20 MHz and 18 MHz markers must be within 2 MHz ±400 kHz.

k. Set the sine-wave generator for an output frequency of 20 MHz.

l. ADJUST—R369 (High Range Linearity; see Fig. 8-2) for zero beat at the 20 MHz marker location.

m. Disconnect all the signals applied to the test equipment.

18. Check/Adjust Low-Range Multiburst Frequencies (R109, R108, R119, R118, R129, R128), 1.25 MHz Range (R112), and Manual Stop Frequency (R146)

NOTE

It is possible to perform the following step without using the Extender board. That is, the jumpers can be moved without removing the A60 Multiburst Logic board. If the Extender is not used, omit parts a and j of the following step.

a. Set the 1410 mainframe Power switch to Off. Mount the A60 Multiburst Logic board on the Extender. Set the 1410 mainframe Power switch to On.

b. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable and a 75-ohm feed-through termination to the frequency counter.

c. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	CONTINUOUS
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	6 MHz (fully cw)
BURST	Off

d. Connect Interface line 57 to ground. To accomplish this, use one of the three methods described in the NOTE in part b of step 15. Grounding Interface line 57 changes the TSG6 Module Output multiburst signal to a continuous sine-wave signal for driving the digital counter.

e. Remove the jumper from P104; connect this jumper to P132. Leave jumpers intalled on P105, P114, P115, P125, and P132 until instructed to move them in part h, Table 4-2, of this procedure.

f. CHECK—for a 500-kHz, ±3%, or 515-kHz to 485-kHz readout on the digital counter.

g. ADJUST—R109 (500 kHz) for a readout of 500 kHz on the digital counter.

NOTE

Be sure that R138 in step 16 has been properly adjusted before adjusting R109.

h. CHECK/ADJUST—using the procedure given in Table 4-2.

Table 4-2

STEP 18h CHECKS & ADJUSTMENTS
(Interface line 57 grounded)

Procedure	Check Counter Readout for:	Adjust
Set TSG6 FREQ RANGE switch to HIGH	1.25 MHz, ±3%, or 1.0375 MHz to 0.9625 MHz	R112 (1.25 MHz)
Set TSG6 FREQ RANGE switch to LOW Move jumper from P105 to P104	1.25 MHz, ±3%, or 1.2875 MHz to 1.2125 MHz	R108 (1.25 MHz)
Move jumper from P114 to P105	2.00 MHz, ±3%, or 2.06 MHz to 1.94 MHz	R119 (2.00 MHz)
Move jumper from P115 to P114	3.00 MHz, ±3%, or 3.09 MHz to 2.91 MHz	R118 (3.00 MHz)
Move jumper from P125 to P115	3.58 MHz, ±3%, or 3.6874 MHz to 3.4726 MHz	R129 (3.58 MHz)
Move jumper from P132 to P125	4.10 MHz, ±3%, or 4.223 MHz to 3.977 MHz	R128 (4.10 MHz)
Set TSG6 MULTIBURST/SWEEP/MANUAL switch to MANUAL. Remaining control settings are same as given in part c of this step.	6.00 MHz, ±10%, or 6.60 MHz to 5.40 MHz	R146 (Manual Stop Freq; 6.00 MHz)

i. Unground Interface line 57.

j. Set the 1410 mainframe Power switch to Off. Remove the Extender board and install the A60 Multiburst Logic board in the 1410 mainframe. Set the 1410 Power switch to On.

k. Disconnect the TSG6 Module Output signal applied to the digital counter.

19. Readjust Reduced and Full Amplitude Pedestal Balance (R439, R429)

a. Apply the TSG6 Module Output signal via a 75-ohm coaxial cable to the 1480 Waveform Monitor Ch A Video Input connector. Terminate the other 1480 Ch A Video Input loop-through connector into 75 ohms.

b. Set the TSG6 and 1480 Waveform Monitor front-panel controls as follows:

TSG6

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	REDUCED
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	Off

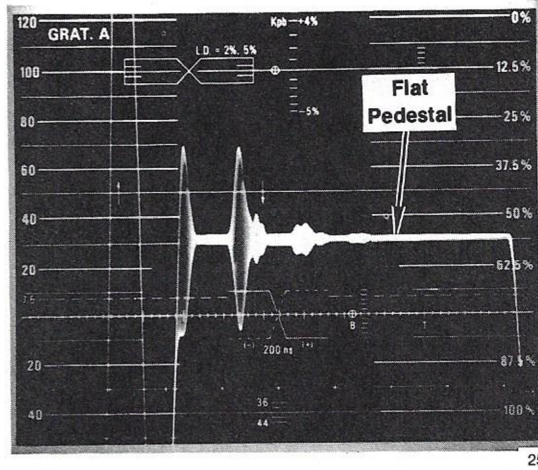
1480 Waveform Monitor

Input	A, DC-Coupled
Response	Low Pass
Volts Full Scale	0.2
DC Restorer	Slow, Backporch
Oper/Cal	Oper
Display	5 μs/Div
Magnifier	X1
Field	1
Line Selector	Off
Sync	Int, AFC

c. Use the waveform monitor Vertical Position control to position the pedestal portion of the waveform into view.

d. READJUST—R439 slightly to obtain a flat pedestal (see Fig. 4-17).

e. Set the TSG6 AMPL pushbutton to FULL.



2528-50

Fig. 4-17. Properly adjusted pedestal. Waveform monitor Response switch set to Low Pass.

f. READJUST—R429 slightly to obtain a flat pedestal.

g. Disconnect the signal from the waveform monitor.

20. Readjust HF Even Harmonics (R349)

a. Use the same test equipment and connections as described in part a of step 19.

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	HIGH
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	SWEEP
FREQUENCY Control	As is
BURST	Off

c. Set the waveform monitor controls to the same settings as given in part b of step 19 except as follows: Set the Response switch to IRE and the Display switch to 2 Field.

d. READJUST—R349 (see Fig. 8-2) slightly for best high-frequency symmetry around the pedestal axis. See Fig. 4-18.

e. ADJUST C328 for minimum disturbance around pedestal axis in range 14 mHz to 20 mHz.

f. Disconnect the signal from the waveform monitor.

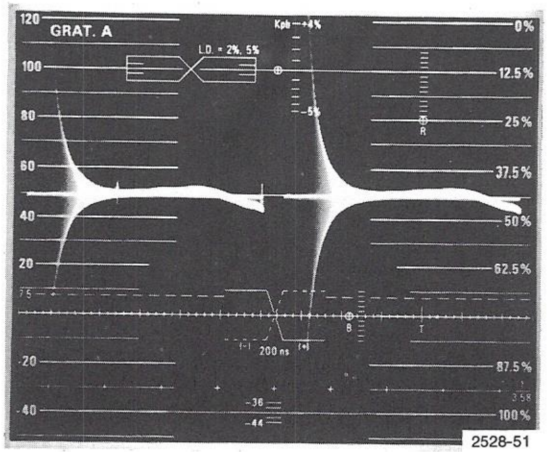


Fig. 4-18. Checking high-frequency symmetry around the pedestal axis. Waveform monitor Response switch set to IRE.

21. Check/Adjust High-Range Frequency Compensation (C505)

Preferred Method (Using Video Detector)

a. Connect the input of the video detector directly to the TSG6 Module Output connector. Connect the output cable from the video detector to the +Input connector on the differential comparator plug-in unit of the test oscilloscope (see Fig. 4-19). Externally trigger the time base using the 1410 mainframe rear-panel V Drive signal.

b. Set the video detector slide switch to the Normal position. Set the TSG6 front-panel controls to the same settings as given in part b of step 20 except set the COMPOSITE/CONTINUOUS switch to CONTINUOUS.

c. Set the test oscilloscope controls to establish a ground reference at graticule center. Set the differential comparator +Input Mode switch to DC and the −Input Mode switch to Vc. Set the Volts/Div switch to 5 mV and the Time/Div switch to 2 ms. Set the Comparison Voltage (Vc) control to approximately 0.39 V to position the top of the waveform to graticule center as shown in Fig. 4-20A.

d. CHECK—for flatness of the brightened top portion of the waveform as follows: Within 15 mV up to a frequency of 12 MHz; within 20 mV from 12 MHz to 20 MHz. To locate the 12 MHz and 20 MHz points, set the MARKERS button to On as shown in Fig. 4-20B.

e. Set the MARKERS button to Off.

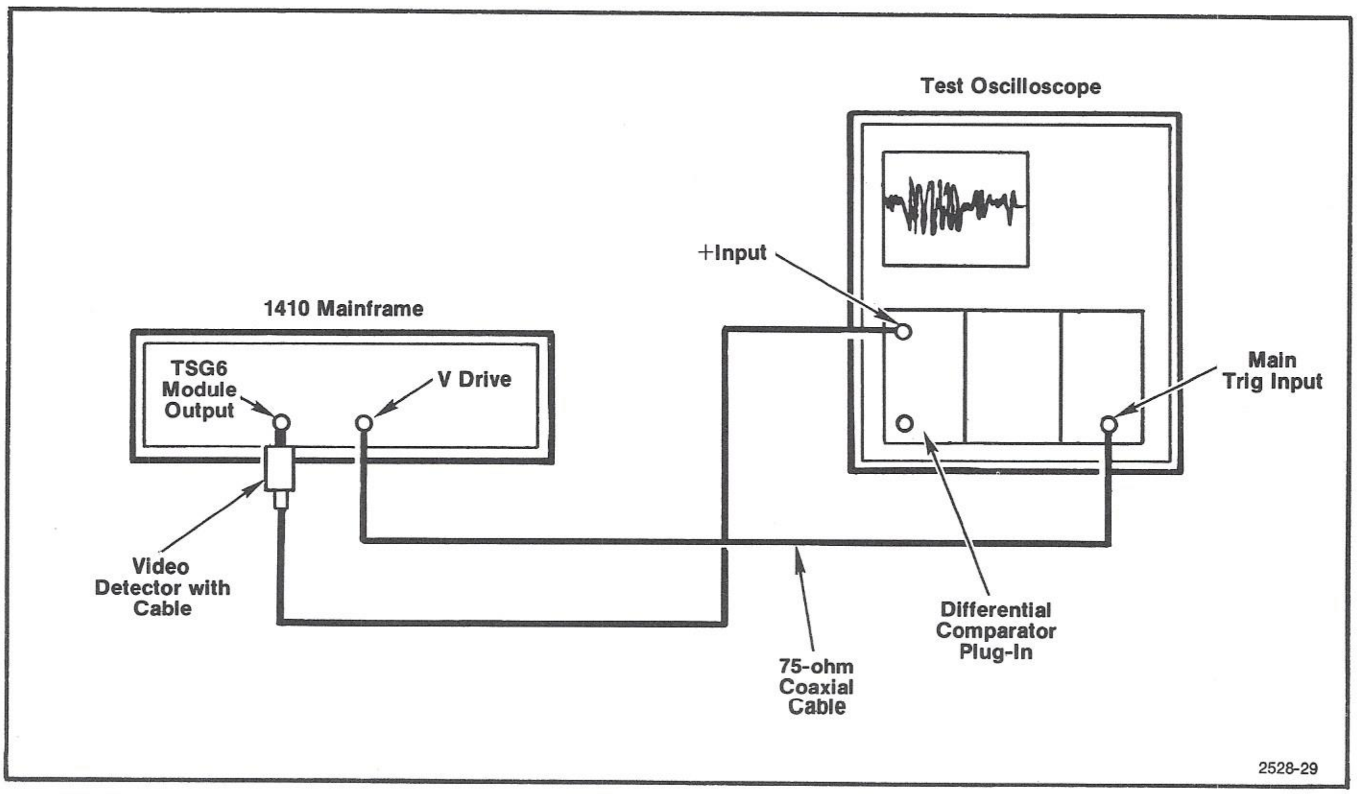
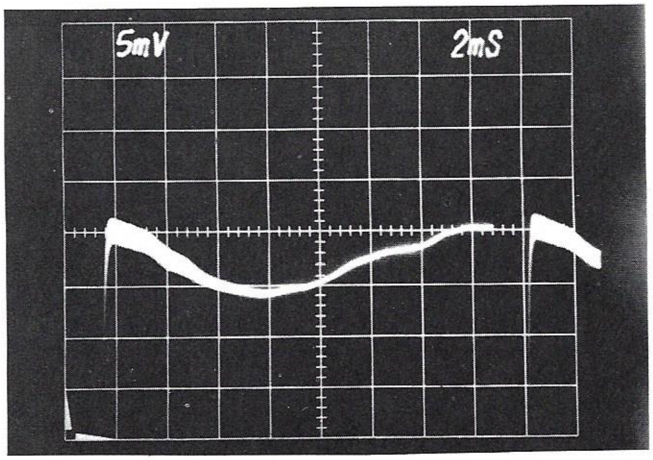
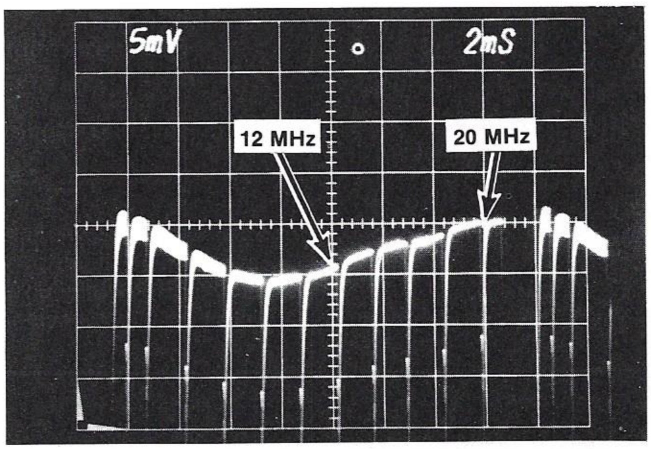


Fig. 4-19. Equipment connections for step 21 Preferred Method.



(A) TSG6 Spare Output connector terminated and MARKERS button set to OFF.



(B) TSG6 Spare Output connector terminated and MARKERS button set to ON. 2528-52A

Fig. 4-20. Typical waveforms obtained when checking high-range frequency compensation using a video detector.

f. ADJUST—C505 (Hi-Range Freq Comp) for minimum total deviation within the requirements given in part d of this step. Use Fig. 4-20A as a guide.

NOTES

Figures 4-20A and 4-20B show the waveforms obtained when the TSG6 Spare Output signal is working into a 75-ohm load such as the TSP1 module and C505 is properly adjusted.

Because of the high sensitivity in the area above C505, the installation of the cover changes the high-frequency compensation slightly. Readjust C505, as necessary, to compensate for the metal cover.

g. Disconnect all the signals applied to the test oscilloscope. Disconnect the video detector from the TSG6 Module Output connector.

Alternate Method (Using a 100 MHz Bandwidth Oscilloscope)

h. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable and 75-ohm feed-through termination to the 100 MHz bandwidth test oscilloscope vertical input connector. Externally trigger the time base using the 1410 mainframe rear-panel V Drive signal.

i. Set the TSG6 controls to the same settings as given in part b of step 20 except set the MARKERS button to On and the COMPOSITE/CONTINUOUS switch to COMPOSITE.

j. Set the test oscilloscope controls to display the waveform at a vertical deflection factor of 200 mV/div and a sweep rate of 2 ms/div.

k. CHECK—for optimum flat frequency response as shown in Fig. 4-21.

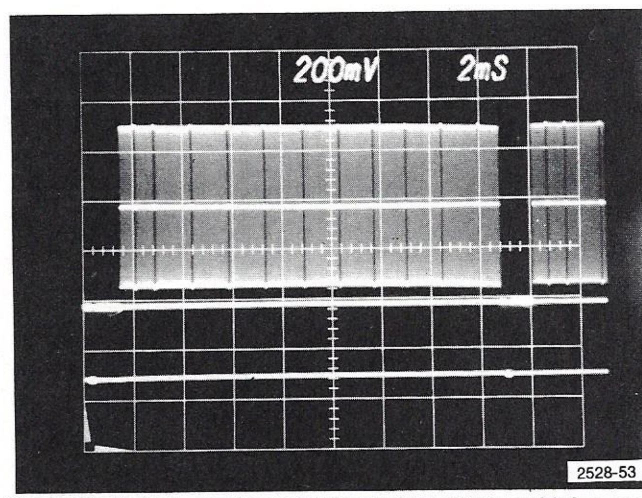


Fig. 4-21. Typical waveform obtained when checking high-range frequency compensation using a 100-MHz bandwidth test oscilloscope.

l. ADJUST—C505 (Hi-Range Freq Comp) for optimum high-frequency response.

NOTE

For consistency, always use the same test oscilloscope when performing this alternate method. The waveform obtained in parts j through l of this step may not appear the same if a different 100 MHz test oscilloscope is used.

m. Disconnect all the signals applied to the 100 MHz test oscilloscope.

Optional Check Procedure

22. Check Isolation

a. Connect the TSG6 Module Output signal via a 75-ohm coaxial cable and a 75-ohm feed-through termination to the test oscilloscope vertical input. Use the 1410 mainframe H Drive signal to externally trigger the time base.

b. Set the TSG6 front-panel controls as follows:

FREQ RANGE	LOW
MARKERS	Off
COMPOSITE/ CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/ MANUAL	MULTIBURST
FREQUENCY Control	As is
BURST	On

c. Use a module output cable borrowed from an adjacent TSG module to apply the spare module output signal from the TSG6 to one of the 1410 mainframe rear-panel Module Output connectors. Further information is provided in part c of step 7.

d. Alternately terminate and unterminate the spare TSG6 signal that is applied to the Module Output connector.

e. CHECK—for 1% or less change in amplitude of the signal displayed on the test oscilloscope crt. (An alternate method would be to terminate and short the spare TSG6 module output signal and check for a 1% or less change.)

f. Connect a terminated 500 mV, 3.58 MHz, sine-wave signal to the spare TSG6 module output connector.

g. CHECK—for 5 mV or less 3.58 MHz sine waves superimposed on the test oscilloscope waveform display.

h. Return the borrowed module output cable to its original TSG connector.

Optional Performance Check

After completing the Calibration Procedure, it is recommended that the TSG6 be checked for the performance requirements given in Table 4-3. The procedure for these checks can be found by referring to the Performance Check procedure in Section 2 of this manual.

Table 4-3

OPTIONAL PERFORMANCE CHECK

Section 2 Performance Check Step No.	Check
1	All high-range multiburst frequencies except 1.25 MHz.
2	All low-range marker frequencies except 500 kHz and 3.0 MHz. All high-range marker frequencies except 20 MHz.
5	First multiburst-packet amplitude in the Reduced mode: Low Range 428 mV ±12 mV High Range 428 mV ±16 mV
6	Multiburst-packet risetime: 400 ns ±60 ns.
9	Reduced amplitude continuous sweep flatness: Low Range 10 mV or less High Range 15 mV to 12 MHz; 20 mV to 20 MHz
10	Return loss: 30 dB or more to 20 MHz. Equivalent to 16 mV or less in amplitude when using 500 mV as the reference amplitude.

THEORY OF OPERATION

This section of the manual is divided into two parts. The first, an overview, provides a basic insight into the operation of the TSG6 by means of the block diagram. The second part provides detailed discussion of the individual circuits.

This circuit description is divided by diagrams. The circuit diagrams are blocked off according to circuit function. Circuit block titles serve as topics in the circuit description.

The block diagram and schematic diagrams are located on the foldout pages at the rear of the manual. Refer to the appropriate diagram when reading the circuit description.

BLOCK DIAGRAM

Circuits in the TSG6 employ power supplies of the 1410 and use the subcarrier, sync, blanking, and other timing signals from the installed SPG. The TSG6 circuits can be grouped in two main categories: Multiburst Logic (A60) and Multiburst Output (A61). These circuits are physically located on the corresponding circuit boards. The blocks will be described first for the Multiburst Output and then for the Multiburst Logic board.

MULTIBURST OUTPUT BOARD

Voltage-Controlled Oscillator

The voltage-controlled oscillator is the central block within the TSG6. The block accepts voltage-control and enable inputs, and generates a triangle-shaped waveform suitable for driving the function generator. The oscillator consists of a voltage-controlled current source which charges or discharges a capacitor. The direction of the current is determined by a set of comparators which compare the triangle voltage with set voltage limits. The front-panel FREQ RANGE switch parallels the timing capacitor with an additional capacitance in the low range.

Function Generator

The function generator is a piece-wise linear approximation to a sinusoidal waveform. It is accomplished with ten breakpoints (five positive and five negative) using Schottky barrier diodes. The diodes and resistive thin-film network are contained in a custom hybrid integrated circuit. A dual-tracking 3.00 V power supply for the hybrid is included in the block. The input to the hybrid is a linear voltage from −6 V to +6 V, and the output from it is a sinusoidal current into a virtual ground.

Attenuator Network

The attenuator network selects full or reduced amplitude of multiburst, manual, or sweep sine-wave amplitudes. This circuit determines which output of the diode-shaper network is connected to the output circuit.

Envelope Shaping

The burst-packet modulator amplitude modulates the continuous-wave input from the attenuator network. A balanced modulator is used to obtain the controlled risetime and falltime of the burst packets. Sinusoidal shaping of these edges is approximated.

Color-Burst Modulator

The color burst is generated by a balanced modulator with switching input driven by a regenerated color subcarrier and the linear input driven by a filtered burst gate. The output is bandpass filtered and resistively coupled to the output buffer amplifier.

Sync and Luminance Filters, and Buffer Amplifier

Five-pole low-pass filters are used to shape sync and luminance currents from the Multiburst Logic board. The risetime of the sync filter is 130 ns, and the risetime of the luminance filter is 250 ns. Plug jumpers on the Multiburst Logic board allow for steering the sync and luminance into either filter. Luminance information consists of markers and pedestal in COMPOSITE mode and markers in CONTINUOUS mode. The filters are resistively coupled to the buffer amplifier.

Output Amplifier

The sine-wave component of the output is connected directly to the input stage of the output amplifier. The sync, luminance, and color burst are connected through the buffer amplifier to reduce interference with the sweep signal. The output amplifier will drive two loads.

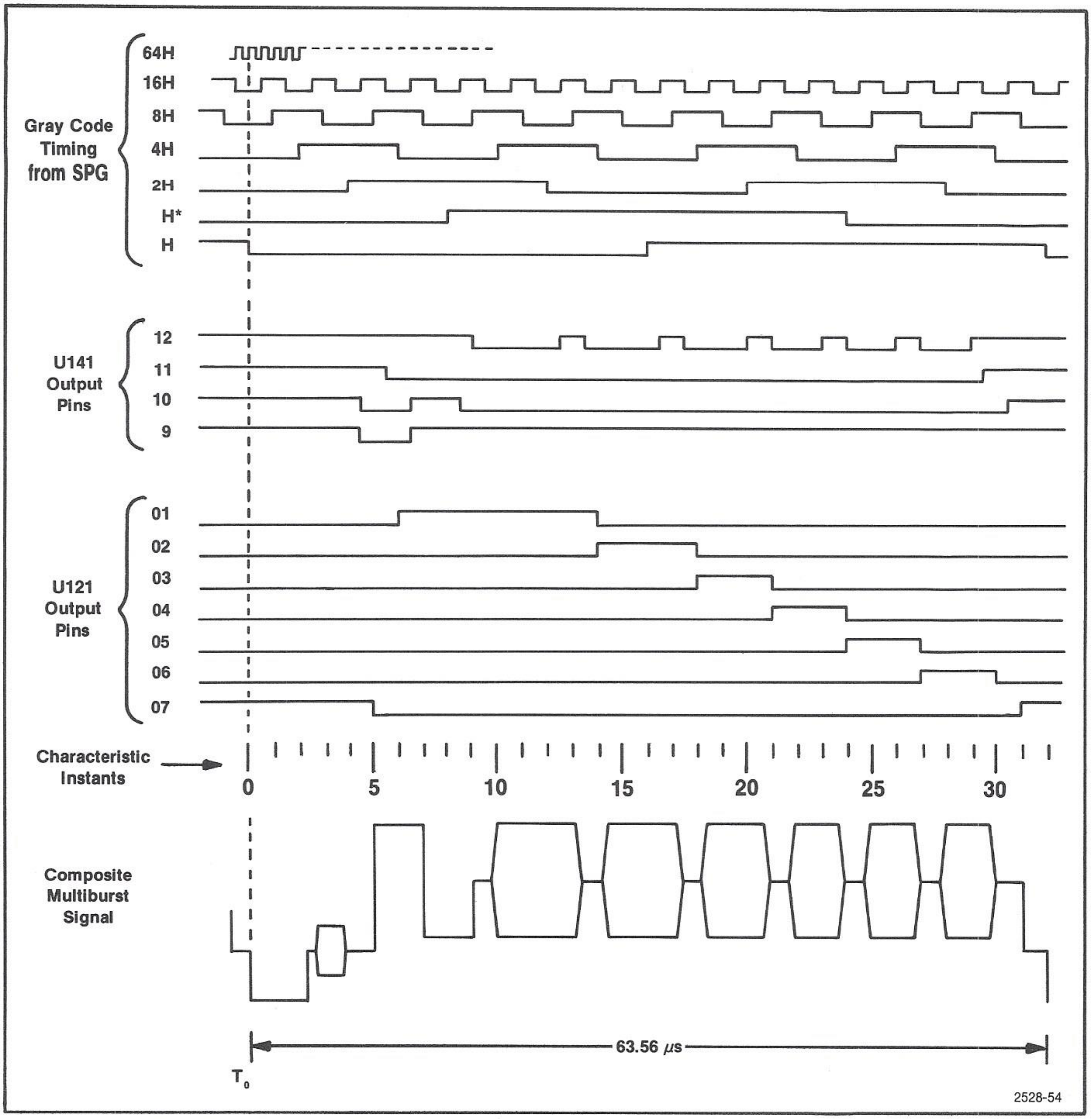


Fig. 5-1. Timing diagram for line timing of the TSG6 multiburst signal.

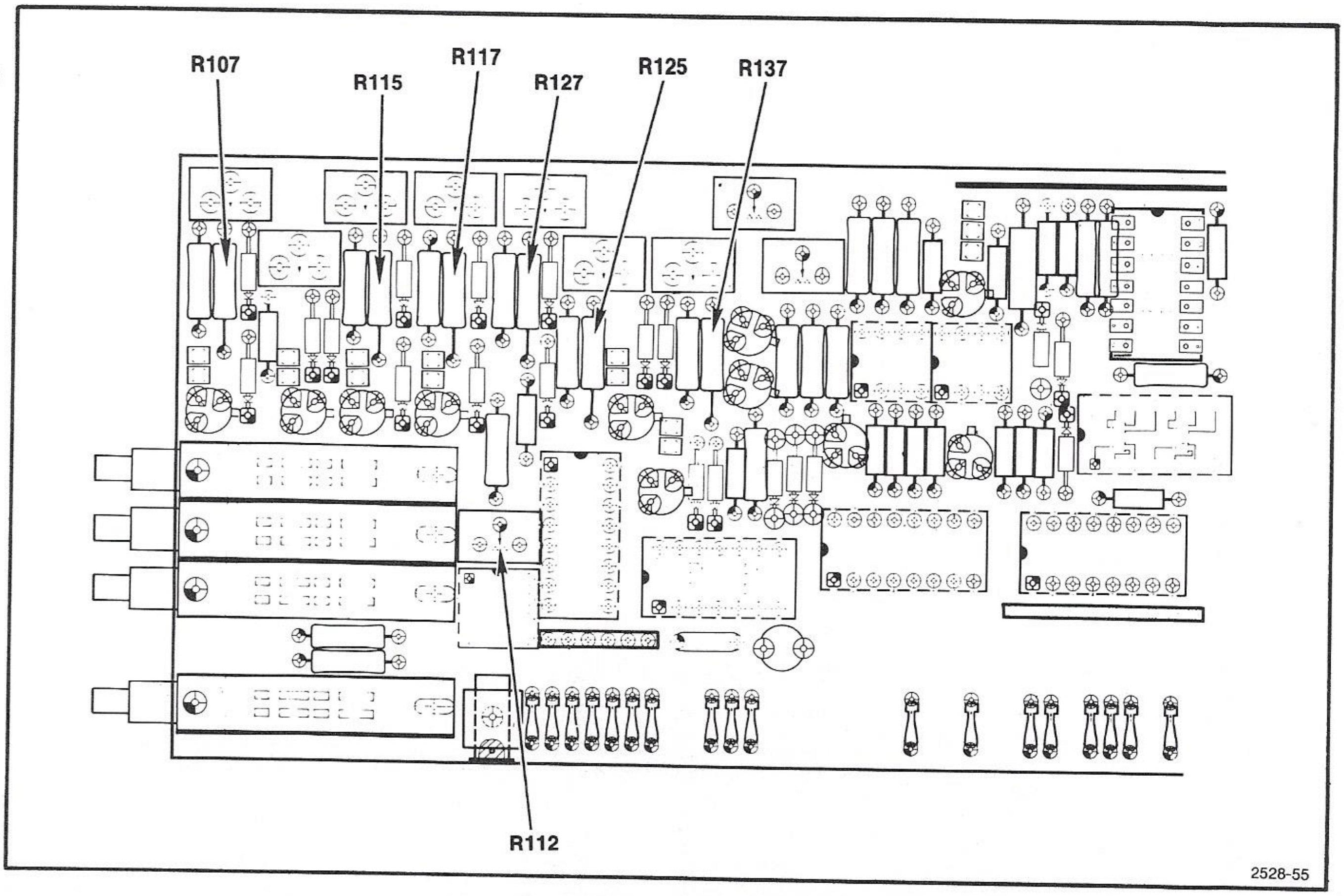


Fig. 5-2. Location of resistors that control high-range multiburst packet frequencies. Partial view of A60 Multiburst Logic board.

Luminance Current Source Selection

The Luminance Current Sources consist of Q275, Q286, Q284, Q287, Q285, Q294, and Q295. Q275 is the current driver for sync. The other transistors are connected in parallel for generation of setup and FULL/REDUCED AMPLitude markers. P280 and P281 allow for connection of these nodes to either filter. Each current source has been made adjustable to allow for minimization of circuits in the path of the sine-wave output from the hybrid U390 on diagram 2. (Adjustment of the output amplifier master gain R489 to obtain the desired sine-wave amplitude may require readjustment of these current sources.)

Subcarrier Limiter

Color subcarrier from the SPG is buffered by Q193 and Q213. Q214 drives the tank circuit consisting of L211, R222, C223, C224, C222, and R232. Q223 serves as both a limiter and gate for regenerated subcarrier. Subcarrier is gated on across the interface only during horizontal blanking.

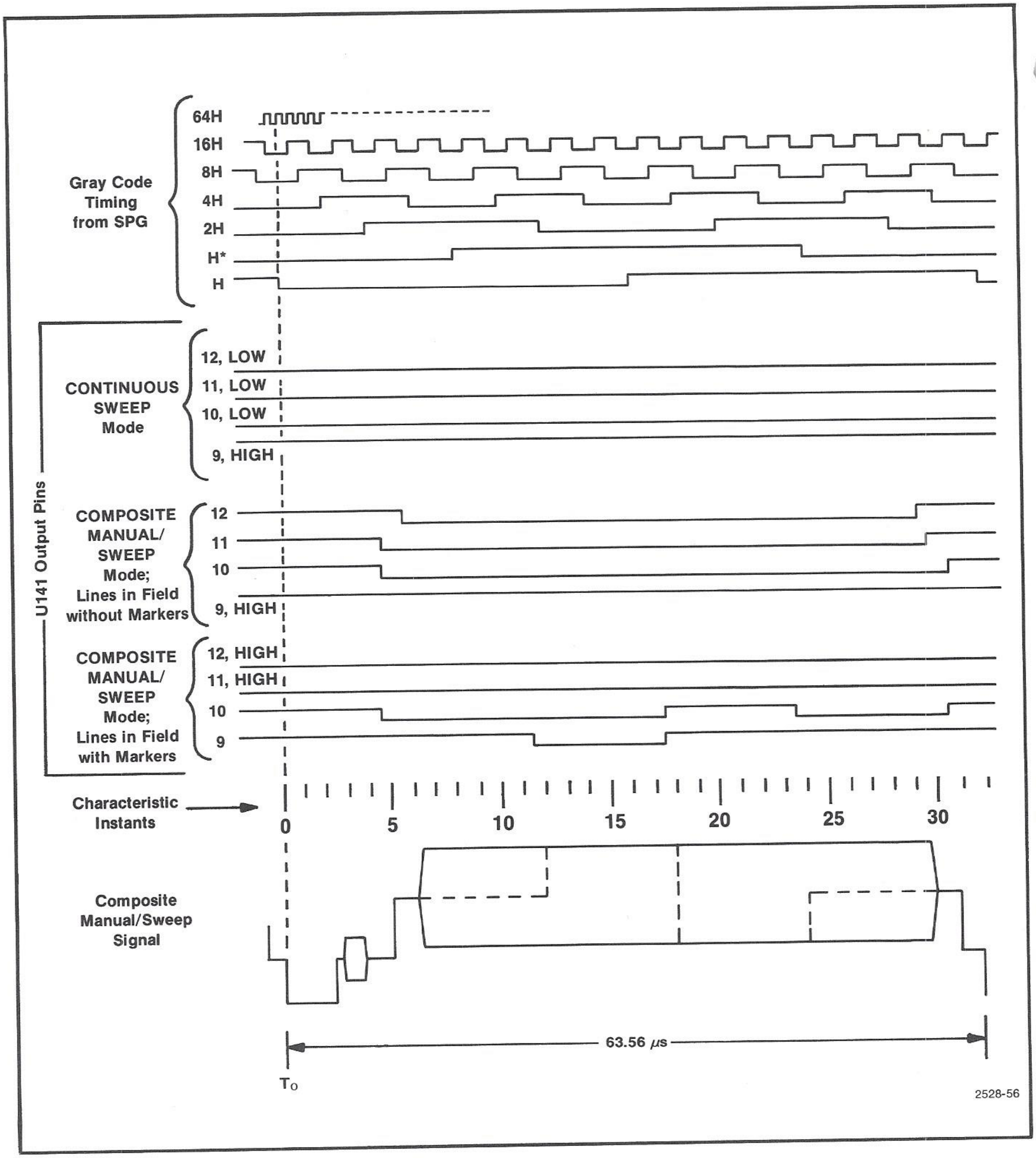


Fig. 5-3. Timing diagrams for line timing of the TSG6 composite manual/sweep signal.

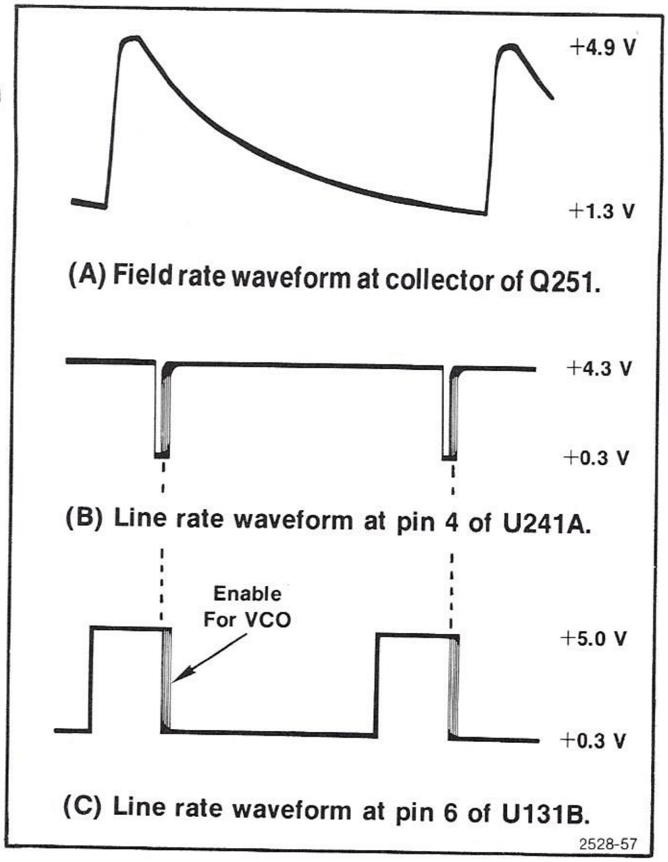


Fig. 5-4. Illustrating U241A circuit operation.

MULTIBURST OUTPUT DIAGRAM ⟨2⟩

Voltage-Controlled Oscillator

The Voltage-Controlled Oscillator consists of: (1) a paraphase input amplifier, (2) unswitched current source of value I, (3) switched current source of value 2I, (4) current switches, (5) slew-rate limiting capacitors, (6) amplification stages, (7) level-sense latching comparators, and (8) start/stop logic. The operation of the VCO will be discussed first in terms of the simplified diagram (see Fig. 5-5) and then by schematic diagram.

The triangle waveform is generated by charging or discharging a grounded capacitor from a current source. A steady current is always flowing into the capacitor from the current source (I). A current source (2I) is switched in to discharge the capacitor at the same rate as which it is charged (I − 2I = −I). The complementary voltage sources (V) are derived from the input by paraphase amplification.

The voltage across the capacitor is amplified by a unity-gain amplifier with FET input and bipolar output. The output of the amplifier is attenuated and compensated to drive a pair of latching comparators. One comparator senses the positive excursion of the triangle and the other senses the negative excursion. The comparators then drive the switch to establish charging or discharging of the capacitor.

The input to the VCO is a current source from the Multiburst Logic board. This current source drives a 3.01 kΩ resistance (R305) to −15 V, establishing the voltage input to the VCO. The input stage consists of U305 and Q315. It generates the voltage inputs to the controlled current sources. The I current source consists of U315 and Q325. Q344 is a buffer stage to isolate Q325 from the large voltage swings occurring on the capacitor and also to compensate for current loss in the switch. The 2I current source consists of U308 and Q348. Adjustments are provided to compensate for offset voltage in U308 and current ratio.

Q345 and Q346 are the current switches. When Q346 is active, the 2I current source is steered away from the capacitor. C345 and C336 set the HIGH range capacitance while C344, switched in on LOW range, establishes the ratio between HIGH and LOW range. Q343A and Q343B are a unity-gain FET amplifier to buffer the capacitor at low currents. Q352 and Q362 provide the current necessary to drive the diode function generator and the feedback network around the VCO. This feedback network, consisting of R384, R374, C383, R383, and R386, level shift and attenuate the triangle output to drive the ECL comparators, U357 and U354. Figure 5-6 is a timing diagram showing the operation of the comparators. Use is made of latching inputs and open-emitter output features of these comparators. The trip levels for the comparators are set by a dual-tracking power supply (U365).

A cycle of the VCO occurs as follows: Assume that the triangle signal at the output of J370 is starting to go positive. See Fig. 5-6. At this time, Q345 is turned off and Q346 is turned on; U354 is latched and U357 is unlatched. As the triangle signal goes through the positive trip voltage, Q_A (pin 7 of U357) goes high and unlatches U354. The unlatching of U354 causes $\overline{Q_B}$ (pin 8 of U354) to go low. The low at $\overline{Q_B}$ latches U357. At this time, Q345 is on and Q346 is off. This action causes the triangle signal at J370 to start going in a negative direction. As the triangle signal goes through the negative trip level, $\overline{Q_B}$ goes high and unlatches U357, thereby causing Q_A to go low. Q345 turns off, Q346 turns on, and the triangle signal starts going positive to repeat the cycle.

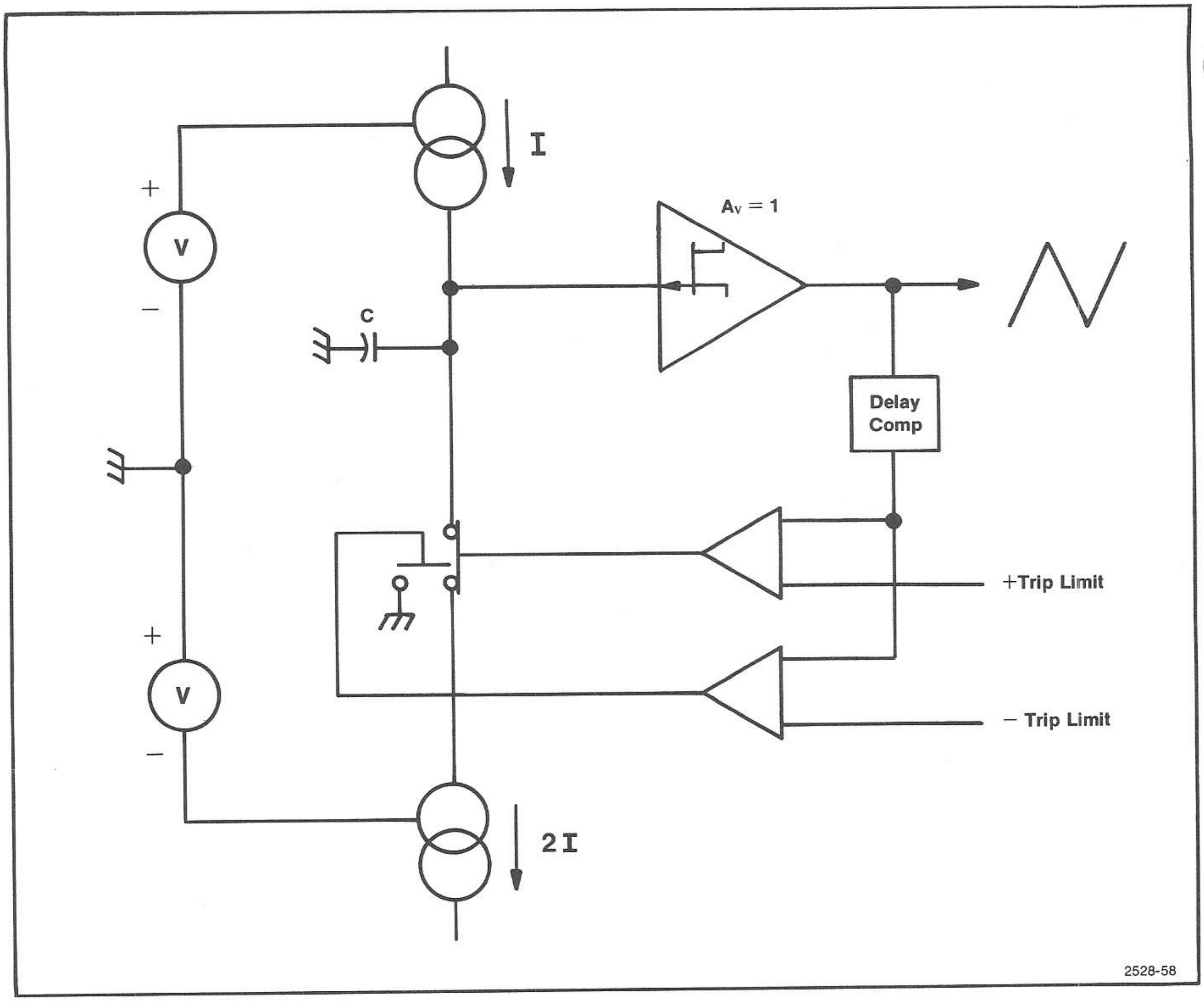


Fig. 5-5. Simplified diagram of Voltage-Controlled Oscillator.

In HIGH range mode, a correction signal from the input voltage is fed back into the power supply (U365) to compensate for comparator delay. U336, Q331, Q332, Q321, Q342, Q347, and Q339 provide start/stop operation of the VCO. Under normal operating conditions, either Q345 or Q346 is conducting. The EXCLUSIVE-OR operation (U336) senses the base voltages and forces this condition should both transistors become active simultaneously (such as on power-up). To disable the VCO, both transistors are turned on, both comparators are unlatched, and the capacitor is shorted to ground by Q342.

Function Generator

The diode function generator is contained in a custom hybrid integrated circuit (U390). The triangle output of the VCO is connected directly to the input (pin 23) of the hybrid. The hybrid operates off of symmetrical (+ and −) 3.00 V power supplies. The dual-tracking supplies are generated by U397; the positive from Q415, the negative from Q395. The hybrid provides two sets of outputs designed to drive a virtual ground. These outputs are set such as to produce the correct FULL/REDUCED AMPLitude ratio. Straps are inserted into the board according to the ratio selected for the generator (90/60 for NTSC).

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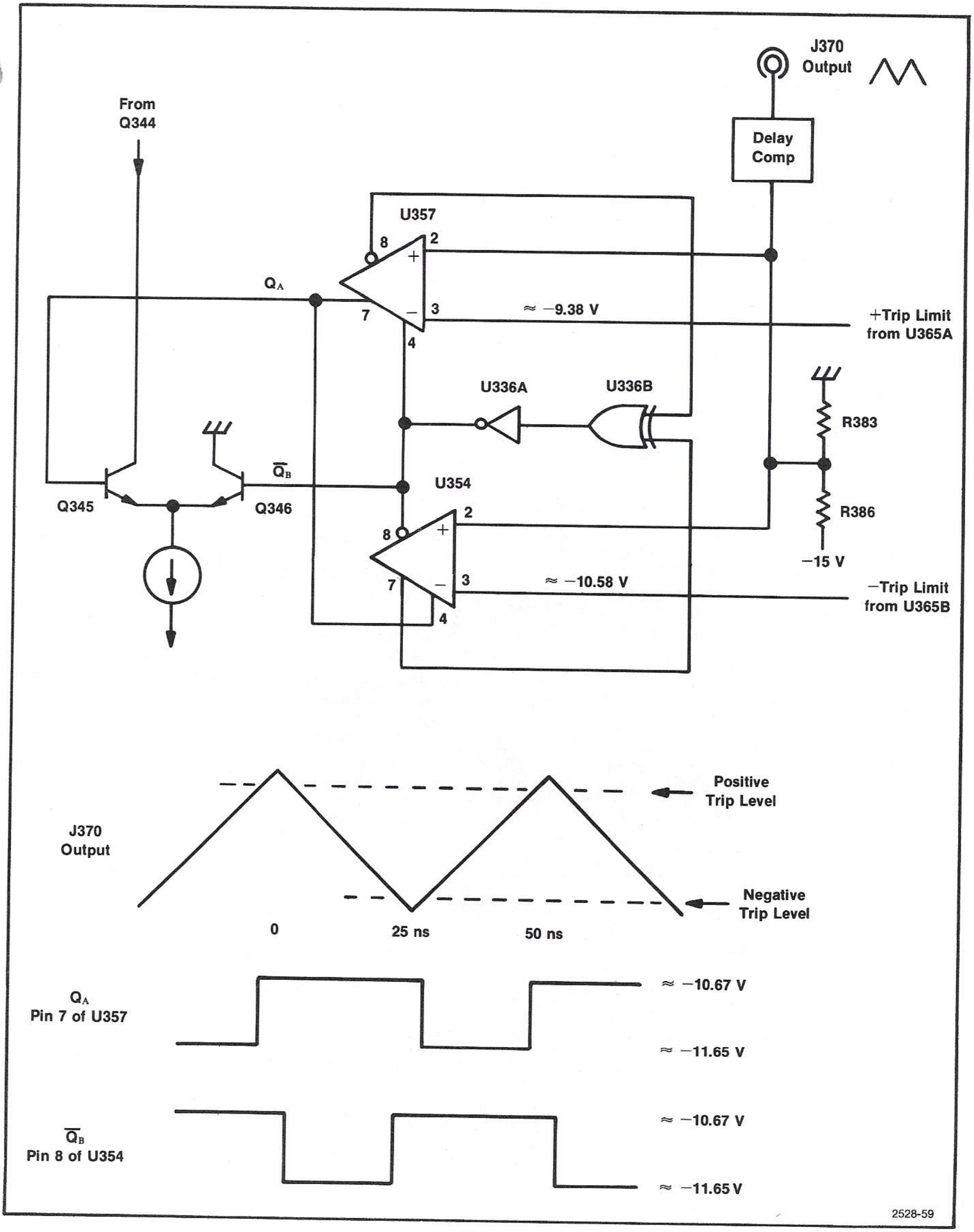

Fig. 5-6. Simplified schematic and timing diagrams showing the operation of the comparators.

NOTE

Pins 10 and 12 have been removed from the socket for U390 to reduce capacitive loading on unused outputs.

Attenuator Network

The attenuator network steers the selected output of the hybrid (U390) to the envelope shaping circuit. The full amplitude signal passes through Q424, while the reduced amplitude signal passes through Q426. Q432, Q433, and Q434 drive diode switches to U447. This IC, with associated circuitry, provides bias current in addition to the sine-wave signal current.

Envelope Shaping

The envelope shaping circuit is realized by a balanced modulator configuration with a monolithic transistor array U447. The shaped edges of the burst packets result from driving the upper set of transistors through the switching region with a ramp of controlled risetime and amplitude. As with the VCO, an I and 2I current-source configuration charges a capacitor to generate a ramp voltage. Q456 through R454 is the 2I current source, whereas R445 is the I current source. These currents and C444 set the risetime of the ramp. Q453 prevents the sine wave from running into vertical sync at the start of field 2. Q449 minimizes feed-through transients during the transition.

Color Burst Modulator

The color burst modulator is a balanced circuit using a standard modulator IC (U484). The switching input is driven directly from regenerated subcarrier on the Multiburst Logic board. The linear input is driven from the SPG burst gate through a three-pole low-pass filter. External current sources are used on the modulator to obtain required residual subcarrier specification. The output of the modulator is bandpass filtered and connected to the output buffer.

Sync and Luminance Filters, and Buffer Amplifier

Two filters, which are five-pole approximations to sin-squared shaping, are contained on the Multiburst Output board. One filter has a risetime of 130 ns, while the other has a risetime of 250 ns. The selection of filters is determined by jumpers on the Logic board. Factory-set positions are: (1) sync driver jumpered to 130 ns filter, and (2) luminance (markers and pedestal) jumpered to the 250 ns filter. These filters are terminated in 500 Ω to a buffer amplifier. The buffer amplifier (Q469 and Q524) isolates the filters (sync, luminance, and chrominance) from the sine-wave input to the output amplifier. The buffer amplifier also provides the dc bias current for the output amplifier stage.

Output Amplifier

Q448, Q478, Q506, Q508, and Q504 form a high open-loop gain, transimpedance amplifier with near zero input and output impedance. The closed-loop gain, Vout/Vin, is set by R477 and R489. The output amplifier combines the sweep and buffered sync, luminance, and chrominance signals to provide a composite video signal to the Module Output connector on the 1410 rear panel. The output amplifier is capable of driving two 75-ohm loads simultaneously; however, when two cables are connected to the module, unterminating one cable will interfere with the output from the other cable.

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

Cleaning

WARNING

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

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

CAUTION

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

The best way to remove heavy accumulations of dust is to blow it off with 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.

WARNING

THE FOLLOWING SHOULD BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.

Visual Inspection

Visually inspect the circuit boards during the maintenance routine for such defects as broken connectors, loose or disconnected pin connectors, improperly seated transistors and integrated circuits, and damaged components. Make sure that the boards are properly seated on the 1410 mainframe Interface pins. The boards should be parallel to each other and held firmly by the spacer bars provided for this purpose.

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

Static-Sensitive Parts

CAUTION

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

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

Table 6-1

Semiconductor Categories	Relative Degradation Level[a]
MOS or CMOS microcircuits or discretes or linear microcircuits with MOS Inputs	1 (most sensitive)
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETS	6
Linear Microcircuits	7
Low-power Schottky TTL	8
TTL	9 (least sensitive)

[a]Voltage equivalent for item: 1 = 100 to 500 V; 2 = 200 to 500 V; 3 = 250 V; 4 = 500 V; 5 = 400 to 600 V; 6 = 600 to 800 V; 7 = 400 to 1000 V (est); 8 = 900 V; 9 = 1200 V. Volts on 100 pF capacitor discharged through series resistance of 100 ohms.

CAUTIONS TO BE AWARE OF IN SERVICING STATIC-SENSITIVE EQUIPMENT

1. *Minimize the handling of static-sensitive parts.*
2. *Transport and store static-sensitive parts in their original containers, on a metal rail, or on conductive foam. Label any container having a static sensitive assembly or device.*
3. *Discharge the static charge on yourself by using a wrist strap before handling these devices. It is recommended that servicing of static-sensitive assemblies or devices be performed only at a static-free work station by qualified personnel.*
4. *Nothing capable of generating or holding a static charge should be allowed on the work station surface.*
5. *Keep the leads shorted together whenever possible.*
6. *Pick up the part by the body, never by the leads.*
7. *Do not subject the part to sliding movements over any surface.*
8. *Avoid handling parts in areas having a floor or work surface covering that contributes to the generation of a static charge.*
9. *Use a soldering iron that has a connection to earth ground.*
10. *Use any special anti-static suction type desoldering tool, such as Silverstat Soldapulit, or a wick-type desoldering device.*

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 is not operating to its full capability. To ensure correct and accurate operation, performance should be checked at regular intervals; for example, after 1000 hours of operation if used continuously, or every six months if used infrequently.

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

TROUBLESHOOTING

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

Diagrams

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

Circuit Boards

The circuit boards are outlined in black on the schematic diagrams. Circuit board illustrations are provided on the back of the foldout pages that precede the diagrams. The assembly number (for example, A60) assigned to each circuit board is an abbreviated method for identifying the board. The TSG6 contains two etched-circuit board assemblies: A60 Multiburst Logic and A61 Multiburst Output.

When troubleshooting the circuit boards in the TSG6, the use of an extender board facilitates access to the board connections and components. Placing the suspected circuit board on the extender board will save time in looking for faults. Carefully align the board pin connectors to ensure good contact.

CAUTION

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

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

The TSG6 circuit-board illustrations and schematic diagrams are arranged for simultaneous usage. The foldout page containing the circuit-board illustration opens to the left while the schematic diagram foldout page opens to the right. See Fig. 6-2.

Wire Color Code

Insulated wires are color-coded to facilitate circuit tracing.

Resistor Color Code

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

Capacitor Markings

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

Transistor and Integrated-Circuit Lead Configuration

Figure 6-1 illustrates the lead configurations for the socket-mounted transistors and integrated circuits (IC) used on the circuit board.

The socket for U390, located on A61 Multiburst Output board, was modified before the socket was installed on the board. Socket pin terminals No. 10 and 12 were removed to reduce capacitive loading on the unused outputs.

IC Diagrams

Positive logic functions of the ICs are shown in Section 9 of this manual.

Troubleshooting Equipment

The following test equipment is useful for troubleshooting the TSG6 circuit boards. Before using any test equipment to make measurements on static-sensitive devices, be certain that any voltage or current supplied by that test equipment to a circuit under test does not exceed the limits of the device to be tested.

1. **Test Oscilloscope.** For viewing waveforms at various test points in the circuit. Frequency response: dc to at least 50 MHz. It should be equipped with a 10X probe.

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

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

Troubleshooting Procedure

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

1. **Check Control Settings.** Incorrect control settings or wrong internal jumper positions can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control or jumper, refer to the Operating Instructions (Section 1) and Installation (Section 3).

2. **Check Associated Boards.** Before troubleshooting the TSG6 circuit boards, check that the 1410 mainframe is operating properly. Check that the TSG6 circuit boards are making good contact through the interconnecting pins. Make sure that other boards on the Interface board are not defective. Check that the test oscilloscope probe, if used, is not defective and is properly compensated.

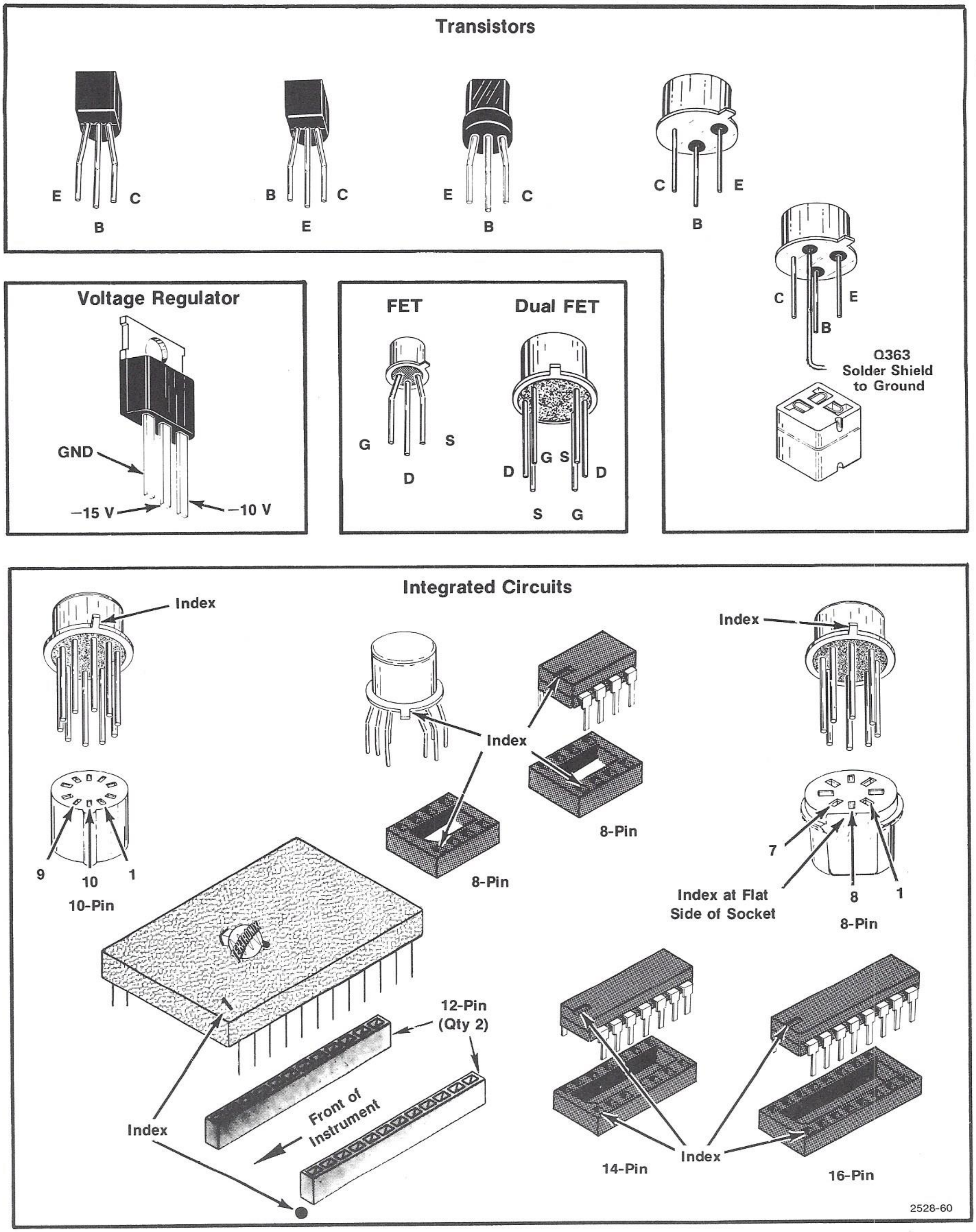

Fig. 6-1. Basing diagrams for semiconductors.

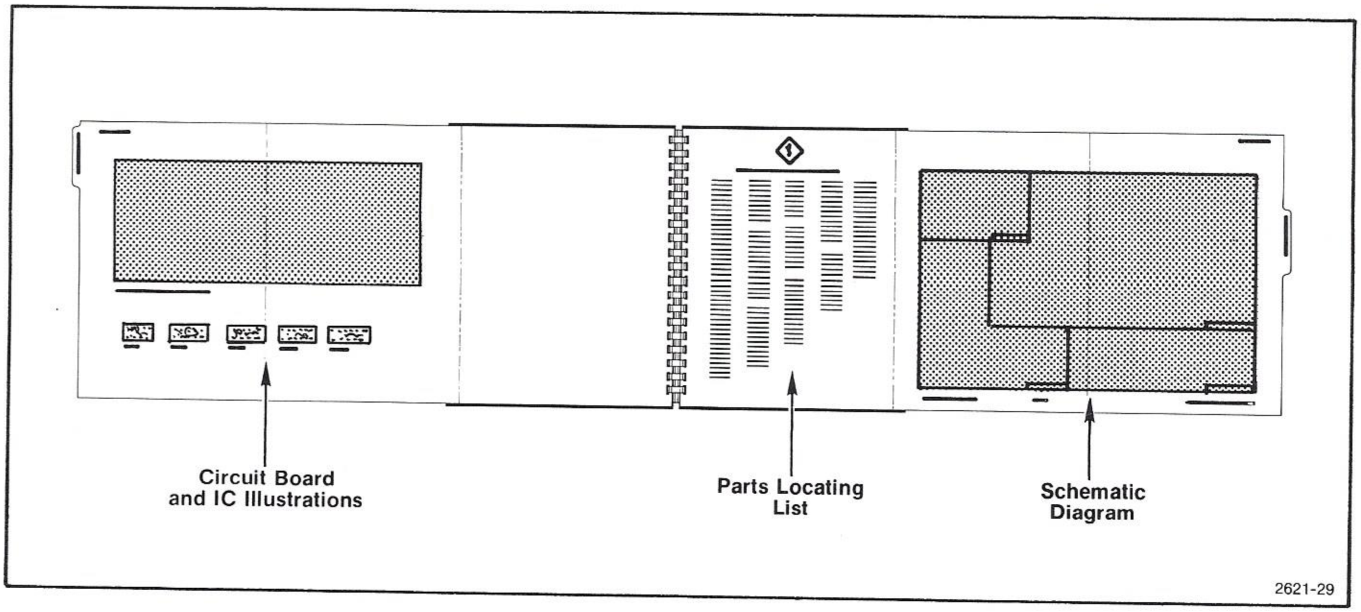

Fig. 6-2. Using the schematic diagram and circuit board illustration simultaneously.

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

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

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

CAUTION

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

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

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

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

c. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. Use an ohmmeter, set to the 1 k 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. Check for an open circuit 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.

CORRECTIVE MAINTENANCE

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

Obtaining Replacement Parts

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

Parts Location

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

Selected Components

During calibration at the factory, the values of some resistors located on A60 Multiburst Logic board (diagram 1) are selected, if necessary, to make the TSG6 meet performance requirements. Table 6-2 lists these components, their value limits, and the reason for selection.

Table 6-2

SELECTED COMPONENTS

Circuit Number	Nominal	Value Limits	Select to Obtain
R115	54.9 kΩ	±3%	3.50 MHz high-range multiburst frequency.
R117	28.0 kΩ	±3%	5.50 MHz high-range multiburst frequency.
R127	15.8 kΩ	±3%	8.00 MHz high-range multiburst frequency.
R125	15.8 kΩ	±5%	10.0 MHz high-range multiburst frequency.
R137	17.4 kΩ	±5%	12.0 MHz high-range multiburst frequency.
R252	7.68 kΩ	±10%	Optimum filled-in appearance of 500 kHz multiburst packet.
R169	16.5 kΩ	±10%	>4.5 MHz stop frequency in low-range last burst variable mode.
R167	30.9 kΩ	±10%	<3.8 MHz start frequency in low-range last burst variable mode.
R367	2.0 kΩ	1.0 kΩ to 2.0 kΩ	Minimizes 2nd harmonics in high range-mode.
R373	10 kΩ	10 kΩ to 100 kΩ	Minimizes 3rd harmonics in low range manual mode at 6 MHz.

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

In order to work on one of the circuit boards in the TSG6, it is necessary to extend it above the 1410 Mainframe. An Extender board is provided with the 1410 for this purpose. It will allow access to components while retaining connection to the 1410 power supplies and signal interface lines.

To remove a TSG6 circuit board for mounting on an Extender board, proceed as follows:

1. Note the location of the multi-pin connector on the board. Disconnect the multi-pin connector from the board.

2. Grasp the TSG6 board at both ends and pull straight up from the Interface board until the physical connections between the Interface pins and the TSG6 board connectors are disconnected. Remove the board by tilting the rear of the board upward and pulling up and back.

3. Install the Extender board in the location of the removed TSG6 board.

4. Mount the removed board on the Extender board. Do not allow the Extender board pins to protrude above the TSG6 board female connectors; otherwise, the pins may contact components on the TSG6 board. Reconnect the multi-pin connector(s) to the TSG6 board.

5. To re-install the TSG6 board on the 1410 Interface board, reverse the order of removal. Use the mating plastic guides to align the TSG6 board connectors with the Interface board pins. Seat the TSG6 board firmly on the Interface board. Re-connect the multi-pin connector to the TSG6 board.

Extracting Integrated Circuits

An extracting tool should be used to remove the packaged integrated circuits used in the TSG6. A tool for this purpose 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.

Pushbutton Switch Replacement

Use the following procedure to remove a pushbutton switch.

1. Before removing a single pushbutton switch, such as the BURST switch, check that the pushbutton is set to the out (released) position. This position causes the pushbutton actuating arm to move forward so it will clear the rear retainer clip (see Fig. 6-3). Before removing a self-canceling switch assembly such as the MULTIBURST/SWEEP/MANUAL switch, be sure that all the pushbuttons for this type of switch are set to their out position.

2. Remove the switch extender(s) by pulling it straight off.

3. For a single pushbutton switch, such as the BURST switch, carefully pry back the rear retainer clip with the tip of a small screwdriver. Remove the switch by lifting the switch body up and back from the front retainer clip. To remove a self-canceling switch assembly such as the MULTIBURST/SWEEP/MANUAL switch, all three switch bodies must be released from their rear retainer clips to remove the complete switch assembly.

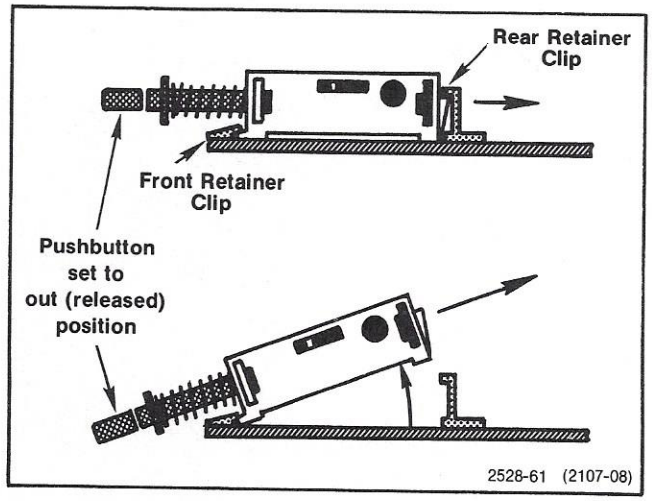

Fig. 6-3. Removing a pushbutton switch.

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
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
14193	CAL-R, INC.	1601 OLYMPIC BLVD.	SANTA MONICA, CA 90404
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
34335	ADVANCED MICRO DEVICES	901 THOMPSON PL.	SUNNYVALE, CA 94086
52769	SPRAGUE GOODMAN ELEC., INC.	134 FULTON AVENUE	GARDEN CITY PARK, NY 11040
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
57668	R-OHM CORP.	16931 MILLIKEN AVE.	IRVINE, CA 92713
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A60	670-5507-00			CKT BOARD ASSY:MULTIBURST LOGIC	80009	670-5507-00
A61	670-5508-00	B010100	B010610	CKT BOARD ASSY:MULTIBURST OUTPUT	80009	670-5508-00
A61	670-5508-01	B010611		CKT BOARD ASSY:MULTIBURST OUTPUT	80009	670-5508-01
C130	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C131	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	55C144
C151	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C157	285-0808-00			CAP.,FXD,PLSTC:0.1UF,10%,50V	56289	LP66A1A104K004
C191	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C192	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C193	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	0831610Y5P0102D
C221	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C222	283-0615-00			CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
C223	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
C224	281-0226-00			CAP.,VAR,PLSTC:5.5-65PF,100V	52769	GXD38000
C230	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C240	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C243	283-0646-00			CAP.,FXD,MICA D:170PF,1%,100V	00853	D151E171F0
C244	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C263	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C290	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C291	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C292	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C306	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C307	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	04222	3431-025E-225M
C308	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C311	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D153F1050F0
C321	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	04222	3431-025E-225M
C323	283-0615-00			CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
C324	283-0615-00			CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
C328	281-0221-00	XB010611		CAP.,VAR,CER DI:2-10PF,100V	59660	513-013A 2 0-10
C331	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C332	283-0616-00			CAP.,FXD,MICA D:75PF,5%,500V	00853	D155E750J0
C336	281-0139-00			CAP.,VAR,CER DI:2.5-9PF,100V	59660	518-023 A 2.5-9
C337	283-0601-00			CAP.,FXD,MICA D:22PF,10%,300V	00853	D153C220K0
C341	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C344	283-0706-00			CAP.,FXD,MICA D:91PF,+/-1PF,500V	00853	D155F910F0
C345	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
C355	283-0363-00			CAP.,FXD,CER DI:2.2PF,0.25%,2KV	72982	838-000C0K229C
C356	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C359	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C361	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	04222	3431-025E-225M
C363	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C364	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C383	281-0198-00			CAP.,VAR,AIR DI:1.7-11PF,250V	74970	187-0306-105
C384	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	72982	8131N031Z5U0105Z
C393	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C404	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	59660	838 533X5F0 2715
C405	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	59660	838 533X5F0 2715
C412	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C413	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	72982	8131N031Z5U0105Z
C417	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C420	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C428	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	72982	8121N083Z5U0104Z
C441	283-0597-00			CAP.,FXD,MICA D:470PF,10%,300V	00853	D153E471K0
C443	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C444	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	59660	855-536Y5E0222J
C463	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA

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C468	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	72982	8121N083Z5U0104Z
C470	283-0785-00			CAP.,FXD,MICA D:250PF,1%,500V	09023	CD15FD251F03
C472	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
C475	283-0632-00			CAP.,FXD,MICA D:87PF,1%,100V	00853	D151E870F0
C485	283-0725-00			CAP.,FXD,MICA D:214PF,1%,500V	00853	D155F2140F0
C486	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C488	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	04222	3431-025E-225M
C490	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C492	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C495	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C501	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C502	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C504	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	04222	3431-025E-225M
C505	281-0209-00			CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0303-105
C511	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C514	283-0663-00			CAP.,FXD,MICA D:16.8PF,+/-0.5PF,500V	00853	D155C16R8D0
C515	283-0663-00			CAP.,FXD,MICA D:16.8PF,+/-0.5PF,500V	00853	D155C16R8D0
C525	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C531	283-0785-00			CAP.,FXD,MICA D:250PF,1%,500V	09023	CD15FD251F03
C532	283-0781-00			CAP.,FXD,MICA D:27PF,5%,500V	09023	CD15ED270J03
C533	283-0728-00			CAP.,FXD,MICA D:120PF,1%,500V	00853	D155F121F0
C534	283-0600-00			CAP.,FXD,MICA D:43PF,5%,500V	00853	D105E430J0
C535	283-0663-00			CAP.,FXD,MICA D:16.8PF,+/-0.5PF,500V	00853	D155C16R8D0
C536	283-0644-00			CAP.,FXD,MICA D:150PF,1%,500V	00853	D155F151F0
C537	283-0634-00			CAP.,FXD,MICA D:65PF,1%,100V	00853	D151E650F0
C538	283-0601-00			CAP.,FXD,MICA D:22PF,10%,300V	00853	D153C220K0
CR104	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR105	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR106	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR107	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR114	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR115	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR116	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR117	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR124	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR127	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR132	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR133	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR134	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR135	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR136	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR141	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR142	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR163	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR165	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR196	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR228	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR232	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR233	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR234	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR235	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR244	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR251	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR253	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR263	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR264	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR271	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

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CR272	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR273	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR274	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR280	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR281	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR282	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR283	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR284	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR285	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR286	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR291	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR292	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR293	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR294	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR295	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR296	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR363	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR371	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR423	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR424	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR455	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR456	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR460	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR461	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR462	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
L211	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
L471	114-0310-00			COIL,RF:VARIABLE,22-80UH	80009	114-0310-00
L475	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
L485	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
L531	114-0310-00			COIL,RF:VARIABLE,22-80UH	80009	114-0310-00
L533	114-0254-00			COIL,RF:30-60UH,CORE NOT REPLACEABLE	80009	114-0254-00
L535	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
L537	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
P515	119-1158-00			RES-CONN ASSY:	80009	119-1158-00
Q104	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q105	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q114	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q115	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q122	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q132	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q136	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q137	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q142	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q152	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q158	151-0207-00			TRANSISTOR:SILICON,NPN	03508	X32D6191
Q172	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q193	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q213	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q214	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q223	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q251	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q264	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q275	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q284	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q285	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00

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Q286	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q287	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q294	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q295	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q315	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q321	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q325	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q331	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q332	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q339	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q342	151-1022-00			TRANSISTOR:FET,N-CHAN,SI,F1782,TO-18	17856	FN1234
Q343	151-1032-00			TRANSISTOR:SILICON,FET,DUAL	17856	DN399
Q344	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q345	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS8802-1
Q346	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS8802-1
Q347	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q348	151-0437-00			TRANSISTOR:SILICON,NPN,SEL FROM 2N5769	80009	151-0437-00
Q352	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q362	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q363	151-0333-00	B010100	B010222	TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q363	151-0212-00	B010223		TRANSISTOR:SILICON,NPN	04713	SRF 518
Q371	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q395	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q415	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q424	151-0438-00			TRANSISTOR:SILICON,PNP,SEL FROM SPS6927	80009	151-0438-00
Q426	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q427	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q432	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q433	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q434	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q435	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q440	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q449	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q453	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q456	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q463	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q469	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
Q478	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q488	151-0438-00			TRANSISTOR:SILICON,PNP,SEL FROM SPS6927	80009	151-0438-00
Q504	151-0411-00			TRANSISTOR:SILICON,NPN	04713	SRF709
Q506	151-0438-00			TRANSISTOR:SILICON,PNP,SEL FROM SPS6927	80009	151-0438-00
Q508	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q524	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
R101	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R102	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R106	321-0338-00			RES.,FXD,FILM:32.4K OHM,1%,0.125W	91637	MFF1816G32401F
R107	321-0634-00			RES.,FXD,FILM:84.65K OHM,0.25%,0.125W	91637	CMF55-116D84651C
R108	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R109	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R112	311-1240-00			RES.,VAR,NONWIR:25K OHM,10%,0.50W	73138	72-30-0
R113	321-0370-00			RES.,FXD,FILM:69.8K OHM,1%,0.125W	91637	MFF1816G69801F
R114	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R115	321-0360-00			RES.,FXD,FILM:54.9K OHM,1%,0.125W	91637	MFF1816G54901F
R116	321-0273-00			RES.,FXD,FILM:6.81K OHM,1%,0.125W	91637	MFF1816G68100F
R117	321-0332-07			RES.,FXD,FILM:28K OHM,0.1%,0.125W	91637	MFF1816C28001B
R118	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102

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R119	311-1239-00			RES.,VAR,NONWIR:2.5K OHM,10%,0.50W	73138	72-26-0
R120	307-0540-00			RES,NTWK,FXD,FI:(5) 1K OHM,10%,0.7W	01121	206A102
R123	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R124	321-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.125W	91637	MFF1816G37400F
R125	321-0651-00			RES.,FXD,FILM:15.8K OHM,0.25%,0.125W	91637	MFF1816C15801C
R126	321-0257-00			RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816G46400F
R127	321-0651-00			RES.,FXD,FILM:15.8K OHM,0.25%,0.125W	91637	MFF1816C15801C
R128	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102
R129	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102
R133	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R134	321-0357-00			RES.,FXD,FILM:51.1K OHM,1%,0.125W	91637	MFF1816G51101F
R136	321-0241-00			RES.,FXD,FILM:3.16K OHM,1%,0.125W	91637	MFF1816G31600F
R137	321-0674-00			RES.,FXD,FILM:17.4K OHM,0.5%,0.125W	24546	NC55C1742D
R138	311-1242-00			RES.,VAR,NONWIR:200K OHM,10%,0.50W	02111	63X-204-T602
R139	311-1243-00			RES.,VAR,NONWIR:500K OHM,10%,0.50W	73138	72-34-0
R141	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R142	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R143	321-0373-00			RES.,FXD,FILM:75K OHM, 1%,0.125W	91637	MFF1816G75001F
R144	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
R145	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R146	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102
R147	321-0294-00			RES.,FXD,FILM:11.3K OHM,1%,0.125W	91637	MFF1816G11301F
R148	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
R149	321-0414-00			RES.,FXD,FILM:200K OHM,1%,0.125W	91637	MFF1816G20002F
R151	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R152	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R153	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R156	311-1460-00	B010100	B010292	RES.,VAR NONWIR:10K OHM,20%,1W	01121	73J1G040L103M
R156	311-2061-00	B010293		RES.,VAR,NONWIR:PNL,10K OHM,10%,0.5W	01121	73J1G040L103U
R157	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R158	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R160	307-0445-00			RES NTWK,FXD,FI:4.7K OHM,20%,(9) RES	91637	MSP10A01-472M
R162	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R163	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R164	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R166	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R167	321-0336-00			RES.,FXD,FILM:30.9K OHM,1%,0.125W	91637	MFF1816G30901F
	----- -----			(NOMINAL VALUE,SELECTED)		
R168	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R169	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
	----- -----			(NOMINAL VALUE,SELECTED)		
R170	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R172	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R178	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R179	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	91637	MFF1816G14001F
R185	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R186	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R187	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R190	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R191	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R192	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R193	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R194	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R198	307-0540-00			RES,NTWK,FXD,FI:(5) 1K OHM,10%,0.7W	01121	206A102
R204	321-0208-00			RES.,FXD,FILM:1.43K OHM,1%,0.125W	91637	MFF1816G14300F
R205	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R221	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

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R222	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R224	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R225	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R227	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R228	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R230	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R232	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
R234	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R240	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R242	321-0257-00			RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816G46400F
R243	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R251	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R252	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	91637	MFF1816G76800F
	----- -----			(NOMINAL VALUE,SELECTED)		
R253	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R254	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R260	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R261	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R262	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R263	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R265	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R268	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R270	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R271	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R272	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R275	321-0329-00			RES.,FXD,FILM:26.1K OHM,1%,0.125W	91637	MFF1816G26101F
R276	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	91637	MFF1816G64901F
R277	321-0387-00			RES.,FXD,FILM:105K OHM,1%,0.125W	91637	MFF1816G10502F
R278	311-1246-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	02111	63X-503-T602
R279	311-1246-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	02111	63X-503-T602
R280	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R286	311-0325-00			RES.,VAR,NONWIR:2.5M OHM,20%	12697	381-CM39666
R288	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R289	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R291	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R295	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R296	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R297	321-0325-00			RES.,FXD,FILM:23.7K OHM,1%,0.125W	91637	MFF1816G23701F
R298	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R299	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R305	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R306	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R308	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R309	311-1241-00			RES.,VAR,NONWIR:100K OHM,10%,0.5W	32997	3386X-T07-104
R311	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R312	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R313	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R314	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R315	321-0078-00			RES.,FXD,FILM:63.4 OHM,1%,0.125W	91637	MFF1816G63R40F
R316	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R317	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R318	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R319	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R322	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R323	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R324	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R325	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025

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R326	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R327	321-0174-00			RES.,FXD,FILM:634 OHM,1%,0.125W	91637	MFF1816G634R0F
R328	321-0105-00			RES.,FXD,FILM:121 OHM,1%,0.125W	91637	MFF1816G121R0F
R329	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R331	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R332	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R334	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R335	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R336	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R337	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R339	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R340	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R341	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R342	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R346	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R348	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R349	311-1920-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-190-0
R350	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R351	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R352	321-0103-00			RES.,FXD,FILM:115 OHM,1%,0.125W	91637	MFF1816G115R0F
R353	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R354	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R359	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R360	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R361	321-0103-00			RES.,FXD,FILM:115 OHM,1%,0.125W	91637	MFF1816G115R0F
R364	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R365	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R366	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R367	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
	----- -----			(NOMINAL VALUE,SELECTED)		
R368	321-0703-00			RES.,FXD,FILM:2.19K OHM,0.25%,0.125W	24546	NE55E2191C
R369	311-1917-00			RES.,VAR,NONWIR:TRMR,5K OHM,10%,0.5W	73138	72-198-0
R370	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R372	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R373	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
	----- -----			(NOMINAL VALUE,SELECTED)		
R374	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R375	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R376	321-0830-03			RES.,FXD,FILM:2.41K OHM,0.25%,0.125W	91637	MFF1816D24100C
R377	321-0257-09			RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816C46400F
R378	321-0256-07			RES.,FXD,FILM:4.53K OHM,0.1%,0.125W	91637	MFF1816C45300B
R379	311-1920-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-190-0
R380	321-0771-01			RES.,FXD,FILM:50 OHM,0.5%,0.125W	91637	MFF1816G50R00D
R381	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
R383	321-0208-00			RES.,FXD,FILM:1.43K OHM,1%,0.125W	91637	MFF1816G14300F
R384	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R385	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R386	321-0612-00			RES.,FXD,FILM:500 OHM,1%,0.125W	91637	MFF1816G500R0F
R387	321-1645-03			RES.,FXD,FILM:841 OHM,0.25%,0.125W	91637	MFF1816D84100C
R388	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R389	311-1920-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-190-0
R393	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R394	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R395	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R396	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R399	311-1236-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
R402	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315

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R403	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R405	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R406	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R407	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R408	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R409	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R415	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R416	321-0276-00			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R417	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R418	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R420	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R421	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R422	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R425	321-0291-00			RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816G10501F
R427	321-0233-00			RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
R429	311-1920-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-190-0
R430	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R434	321-0257-00			RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816G46400F
R435	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R436	321-0215-00			RES.,FXD,FILM:1.69K OHM,1%,0.125W	91637	MFF1816G16900F
R437	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R438	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R439	311-1244-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3386X-T07-101
R440	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R441	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R442	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R443	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R444	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R445	321-0313-00			RES.,FXD,FILM:17.8K OHM,1%,0.125W	91637	MFF1816G17801F
R446	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R447	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R448	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R450	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R451	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R452	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R454	321-0237-00			RES.,FXD,FILM:2.87K OHM,1%,0.125W	91637	MFF1816G28700F
R455	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R456	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R457	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R458	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R459	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R460	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R462	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R463	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R464	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R465	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R466	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R467	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R469	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R471	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R474	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R476	321-0199-06			RES.,FXD,FILM:1.15K OHM,0.25%,0.125W	91637	MFF1816C11500C
R477	321-0199-00			RES.,FXD,FILM:1.15K OHM,1%,0.125W	91637	MFF1816G11500F
R478	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R479	311-1140-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.5W	32997	3386JT07101
R480	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R481	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R482	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R483	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R484	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R485	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R487	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R489	311-1236-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
R490	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R491	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R492	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R493	311-1936-00			RES.,VAR,NONWIR:CKT BD,50 OHM,20%,0.5W	73138	MODEL 72X
R494	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R495	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R496	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R497	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R498	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R501	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R507	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R508	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R512	308-0076-00			RES.,FXD,WW:300 OHM,5%,3W	14193	SA30300 OHM 5%
R513	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R514	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R516	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R517	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R518	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R519	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R522	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R523	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R525	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R527	321-0612-00			RES.,FXD,FILM:500 OHM,1%,0.125W	91637	MFF1816G500R0F
R528	321-0612-00			RES.,FXD,FILM:500 OHM,1%,0.125W	91637	MFF1816G500R0F
S100	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5MM,W/2 CONTACTS	80009	263-0010-00
S102 S103 S104	263-0015-02			SWITCH PB ASSY:3 LCH,7.5MM,6 CONTACTS	80009	263-0015-02
S300 S302 S303 S335	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5MM,W/2 CONTACTS	80009	263-0010-00
T474	120-1070-00			TRANSFORMER,RF:TOROID,12 TURNS QUADFILAR	80009	120-1070-00
U112	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U121	160-0157-00			MICROCIRCUIT,DI:32 X 8 PROM,PROGRAMMED	80009	160-0157-00
U131	156-0382-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)
U141	160-0159-00			MICROCIRCUIT,DI:256 X 4 PROM,PROGRAMMED	80009	160-0159-00
U143	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U154	156-1114-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	CA3160E
U161	156-0392-00			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	34335	SN74LS175N OR J
U162	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0383-00
U169	156-0480-00			MICROCIRCUIT,DI:QUAD 2-INPUT AND GATE	01295	SN74LS08(N OR J)
U171	156-0382-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)
U173	156-0385-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0385-00
U179	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U189	156-0093-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0093-00
U199	156-0382-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)
U209	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0383-00
U219	156-0385-00			MICROCIRCUIT,DI:HEX.INVERTER	80009	156-0385-00
U239	156-0382-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U241	156-0733-00			MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0733-00
U244	156-0784-00	B010100	B010747	MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	01295	SN74LS163AN
U244	156-0784-02	B010748		MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+
U249	160-0158-00			MICROCIRCUIT,DI:32 X 8 PROM,PROGRAMMED	80009	160-0158-00
U254	156-0784-00	B010100	B010747	MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	01295	SN74LS163AN
U254	156-0784-02	B010748		MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+
U261	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0383-00
U264	156-0784-00	B010100	B010747	MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	01295	SN74LS163AN
U264	156-0784-02	B010748		MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+
U305	156-0921-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	CA3140S
U308	156-0686-00			MICROCIRCUIT,LI:OPNL AMPL,HIGH IMPEDANCE	02735	CA3130S
U315	156-0770-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LF356H
U336	156-0295-00			MICROCIRCUIT,DI:TRIPLE EXCL OR EXCL NOR	80009	156-0295-00
U338	156-0277-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	MICROA7805UC
U354	156-0362-00			MICROCIRCUIT,LI:ECL COMPARATOR	34335	AM685HL
U357	156-0362-00			MICROCIRCUIT,LI:ECL COMPARATOR	34335	AM685HL
U365	156-1191-00			MICROCIRCUIT,LI:BI-FET OPNL AMPL	01295	TL072ACP
U390	155-0195-00			MICROCIRCUIT,LI:HYBRID SHAPERCIRCUIT	80009	155-0195-00
U397	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U447	156-0534-00	B010100	B010967	MICROCIRCUIT,LI:DUAL DIFF AMPL,14 LD DIP	80009	156-0534-00
U447	156-0534-01	B010968		MICROCIRCUIT,LI:DUAL DIFF AMPL,BURN-IN	02735	CA3102EX
U484	156-0130-00	B010100	B010747	MICROCIRCUIT,LI:MODULATOR/DEMODULATOR	80009	156-0130-00
U484	156-0130-02	B010748		MICROCIRCUIT,LI:MODULATOR/DEMODULATOR,SCRN	04713	SC77162GH
VR164	152-0662-00			SEMICOND DEVICE:ZENER,0.4W,5V,1%	04713	SZG195
VR325	152-0395-00			SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	14552	TD332317
VR356	152-0689-00			SEMICOND DEVICE:ZENER,0.4W,5%,3.9V	80009	152-0689-00
VR360	152-0265-00			SEMICOND DEVICE:ZENER,0.4W,24V,5%	04713	SZG35009K8
VR387	152-0486-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	80009	152-0486-00
VR393	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL
VR412	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL
VR442	152-0127-00			SEMICOND DEVICE:ZENER,0.4W,7.5V,5%	04713	SZG35009K2

SERVICING ILLUSTRATIONS

The circuit board illustrations in this section serve as an aid to the service technician who selects the jumper positions and performs the calibration procedure.

Solid lines for the jumpers are the factory-set positions. Dotted lines indicate the other choices.

The connecting information and circuit number of the multi-pin connectors are given as an aid when installing or servicing the TSG6.

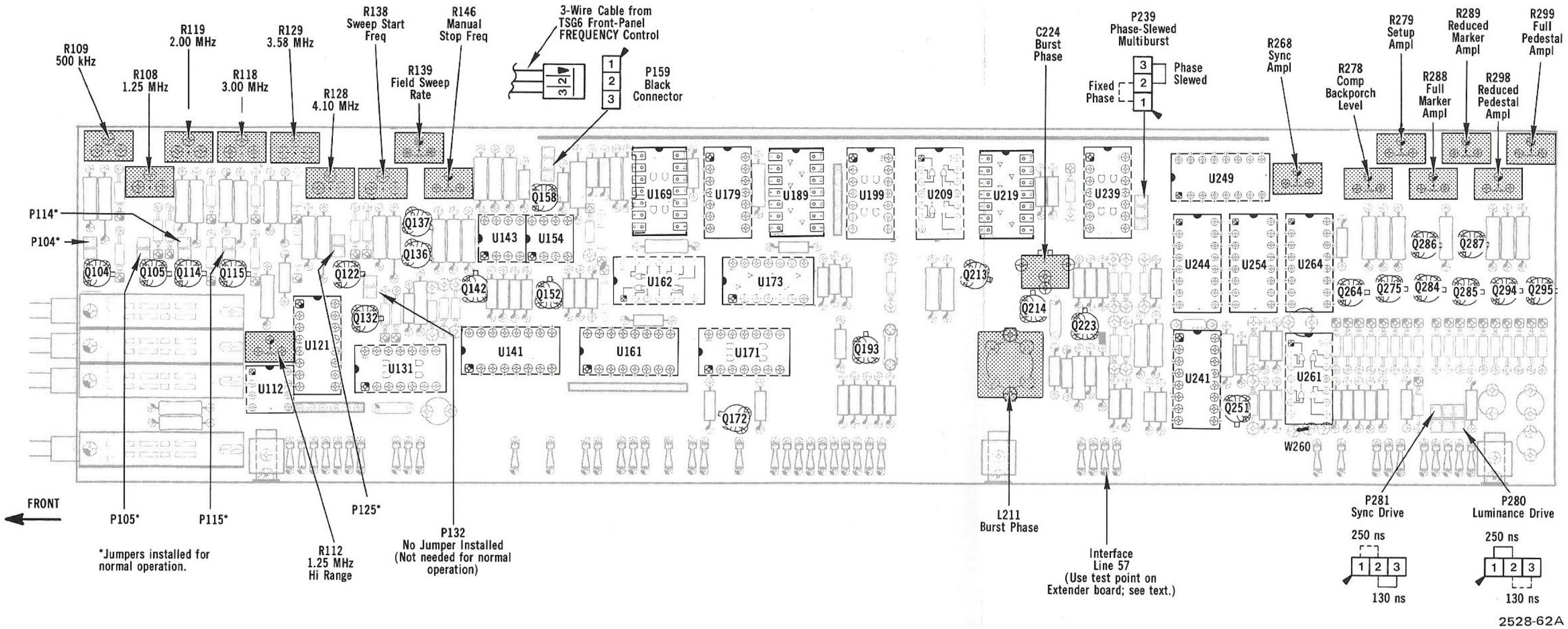


FIG. 8-1. A60 MULTIBURST LOGIC ADJUSTMENT AND JUMPER LOCATIONS.

NOTE

The Module Output multi-pin connector, that connects to pins 1 and 2 of P515, and its coaxial cable are EIA color coded according to Module Location Number: Module Location 1 = Brown, Module Location 2 = Red, etc. This coding method matches the 1410 rear-panel Module Output connector numbering sequence: J1 = Module Location 1, J2 = Module Location 2, etc. Knowing this information enables the user to easily identify the source of the 1410 Module Output signal.

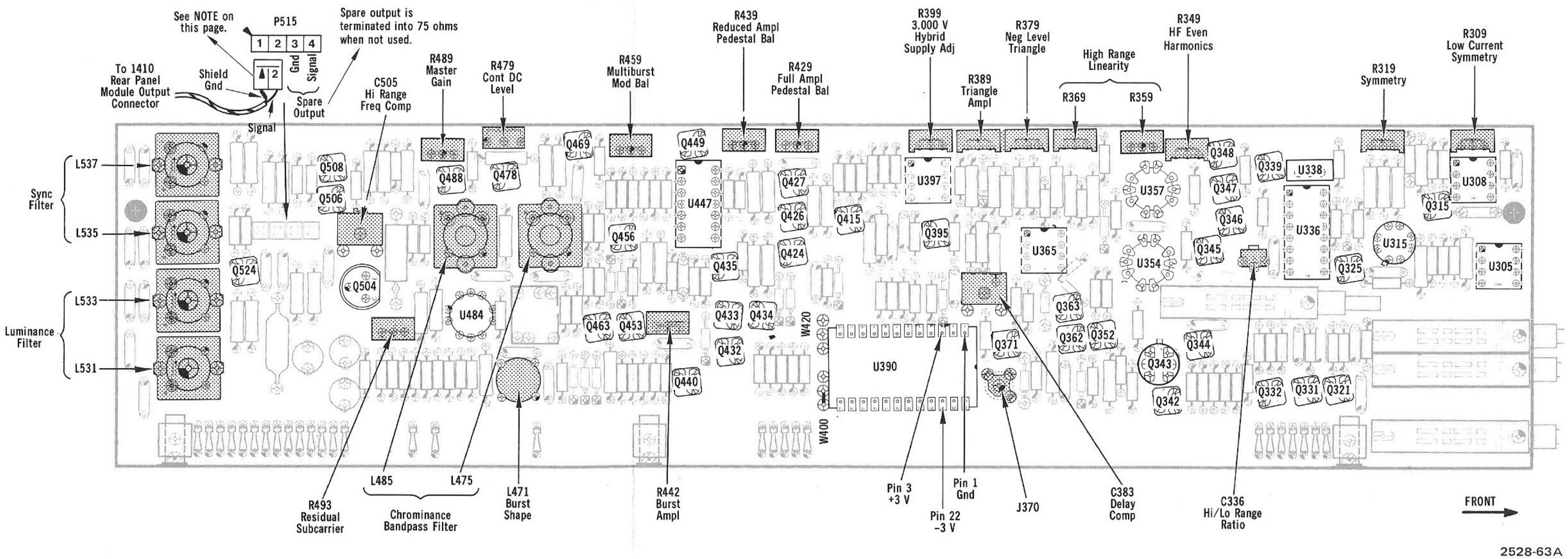
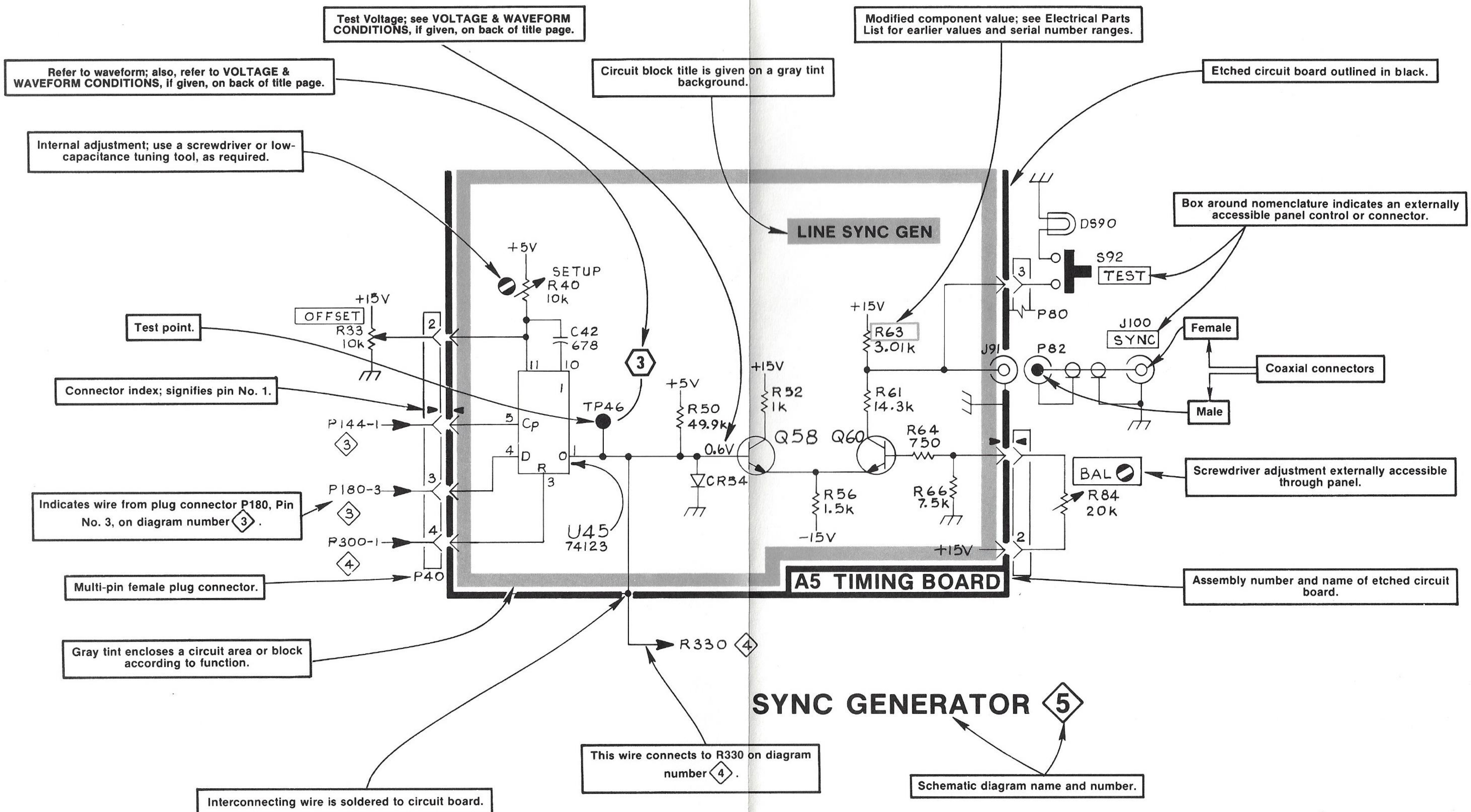


FIG. 8-2. A61 MULTIBURST OUTPUT ADJUSTMENT LOCATIONS.



SCHEMATIC EXAMPLE

(2234)2238-50

DIAGRAMS & 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 Y32.2-1975 and IEEE No. 315 March 1971. Logic symbology is based on ANSI Y32.14-1973 (IEEE Std. 91-1973). Logic symbols depict the logic function performed and may differ from the manufacturer's data.

Component values

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

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

Resistors = Ohms (Ω).

Semiconductor Types

Refer to the Replaceable 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	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.

WAVEFORM CONDITIONS

Waveform photographs in this section were taken with a TEKTRONIX C-59 Oscilloscope Camera mounted on a TEKTRONIX 7603 Oscilloscope. Plug-in units for the 7603 Oscilloscope are as follows: 7A13 Differential Comparator, 7A26 Dual-Trace Amplifier, and a 7B53A Dual Time Base. To obtain the four-trace logic timing waveforms, another 7A26 Dual-Trace Amplifier was used in place of the 7A13.

All Waveforms in this section were photographed as shown. The TSG6 front-panel controls were set as follows except when indicated above the waveform:

FREQ RANGE	LOW
MARKERS	On
COMPOSITE/CONTINUOUS	COMPOSITE
AMPL	FULL
MULTIBURST/SWEEP/MANUAL	MULTIBURST
FREQUENCY Control	Fully ccw
BURST	On

External triggering from the 1410 Comp Sync signal was used. The oscilloscope Triggering Level control was used to obtain line rate or field rate triggering, depending on the signal repetition rate.

The dc offset feature of the 7A13 differential Comparator was used to position those waveforms having high dc levels into view and to obtain the dc levels recorded at the right side of the waveform. All waveforms were dc coupled except as indicated below the waveform.

NOTE

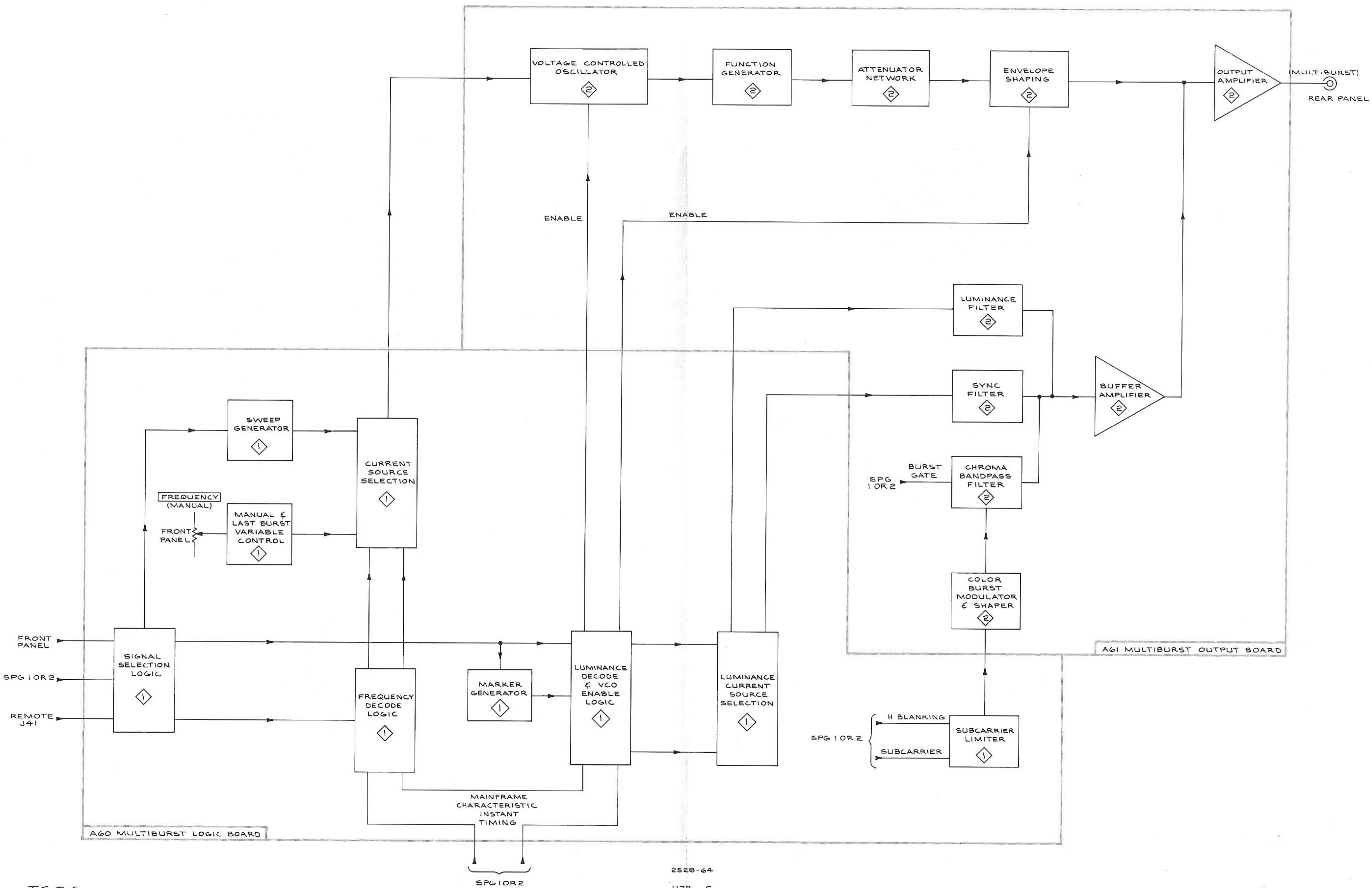
Additional waveforms and logic timing diagrams are provided in Section 5, Theory of Operation.

All waveforms and dc levels are not absolute, and may vary between instruments because of component and calibration tolerances.

All internal jumpers have been set to their factory-set positions.

CAUTION

Avoid accidental shorts that may damage components when connecting the oscilloscope probes to the circuit board component leads; particularly, when connecting the probe to the emitter of Q352. Set the 1410 mainframe Power switch to Off while making connections.



TSG6

2528-64
1178

BLOCK DIAGRAM

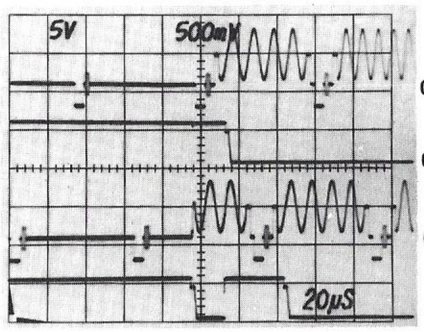
WAVEFORMS FOR DIAGRAM ⟨1⟩

Refer to waveform conditions given on back of SECTION 9—DIAGRAMS foldout page (located at start of this section).

SWEEP Mode

TSG6 Module Output ⟨1⟩

TSG6 Module Output ⟨1⟩

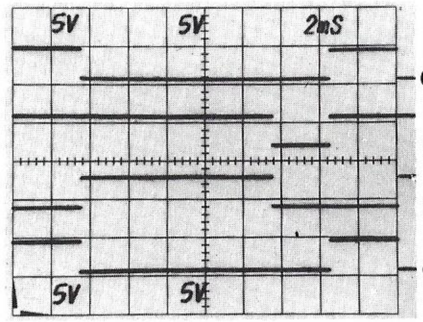


0 V
0 V
0 V
0 V

Double exposure showing start of Field 1 and Field 2 sweeps respectively.

SWEEP Mode

⟨5⟩ ⟨6⟩ ⟨7⟩ ⟨8⟩

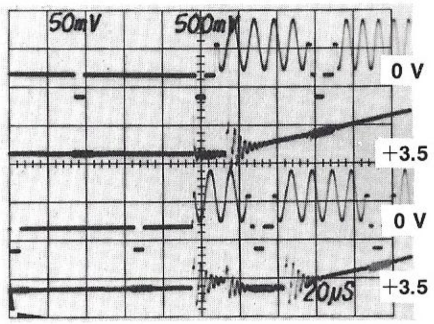


0 V
0 V
0 V
0 V

SWEEP, BURST Off, Mode. FREQUENCY control set fully ccw.

TSG6 Module Output ⟨2⟩

TSG6 Module Output ⟨2⟩

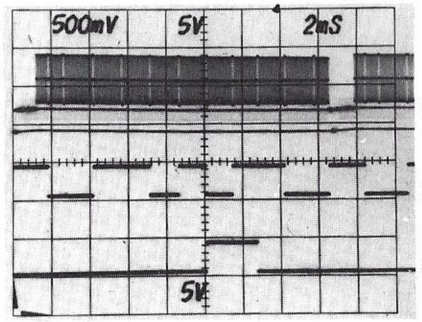


0 V
+3.5 V
0 V
+3.5 V

Double exposure showing start of Field 1 and Field 2 sweeps respectively. 7A13 Bandwidth switch was set to 5 MHz for waveform ⟨2⟩

HIGH FREQ RANGE SWEEP Mode

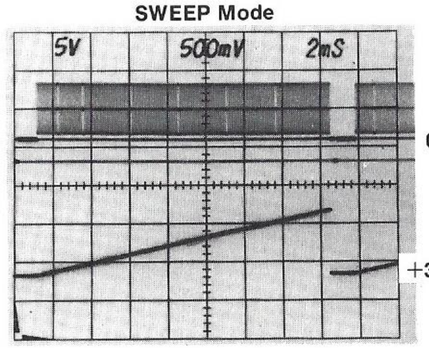
TSG6 Module Output ⟨3⟩ ⟨4⟩



0 V
0 V
0 V

SWEEP Mode

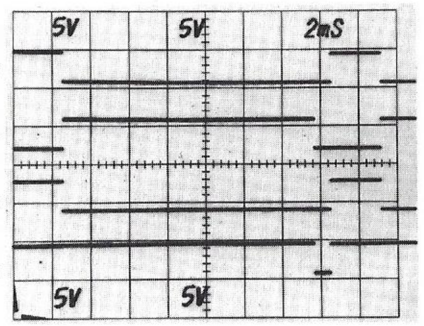
TSG6 Module Output ⟨2⟩



0 V
+3.5 V

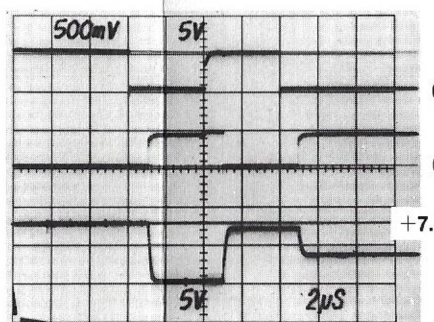
HIGH FREQ RANGE SWEEP Mode

⟨5⟩ ⟨6⟩ ⟨7⟩ ⟨8⟩



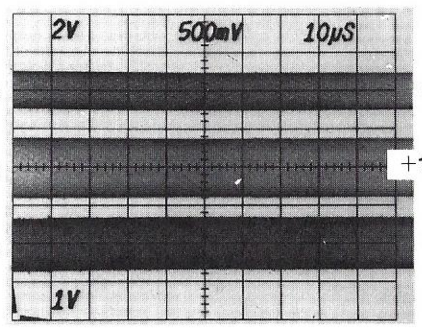
0 V
0 V
0 V
0 V

⟨12⟩ ⟨13⟩ ⟨14⟩



0 V
0 V
+7.4 V

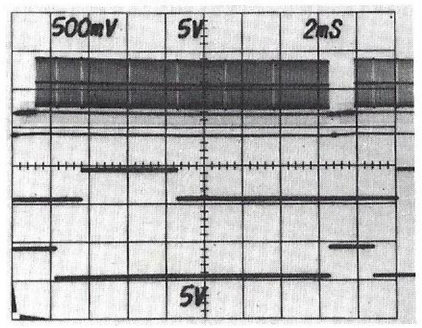
⟨16⟩ ⟨17⟩ ⟨18⟩



0 V
+15 V
0 V

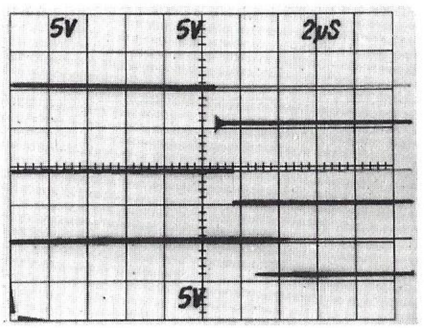
SWEEP Mode

TSG6 Module Output ⟨3⟩ ⟨4⟩



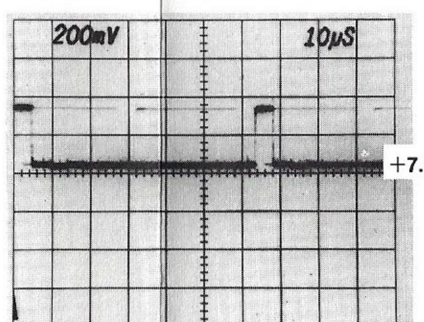
0 V
0 V
0 V

⟨9⟩ ⟨10⟩ ⟨11⟩



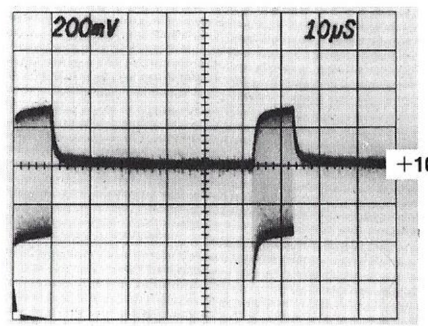
0 V
0 V
0 V

⟨15⟩



+7.2 V

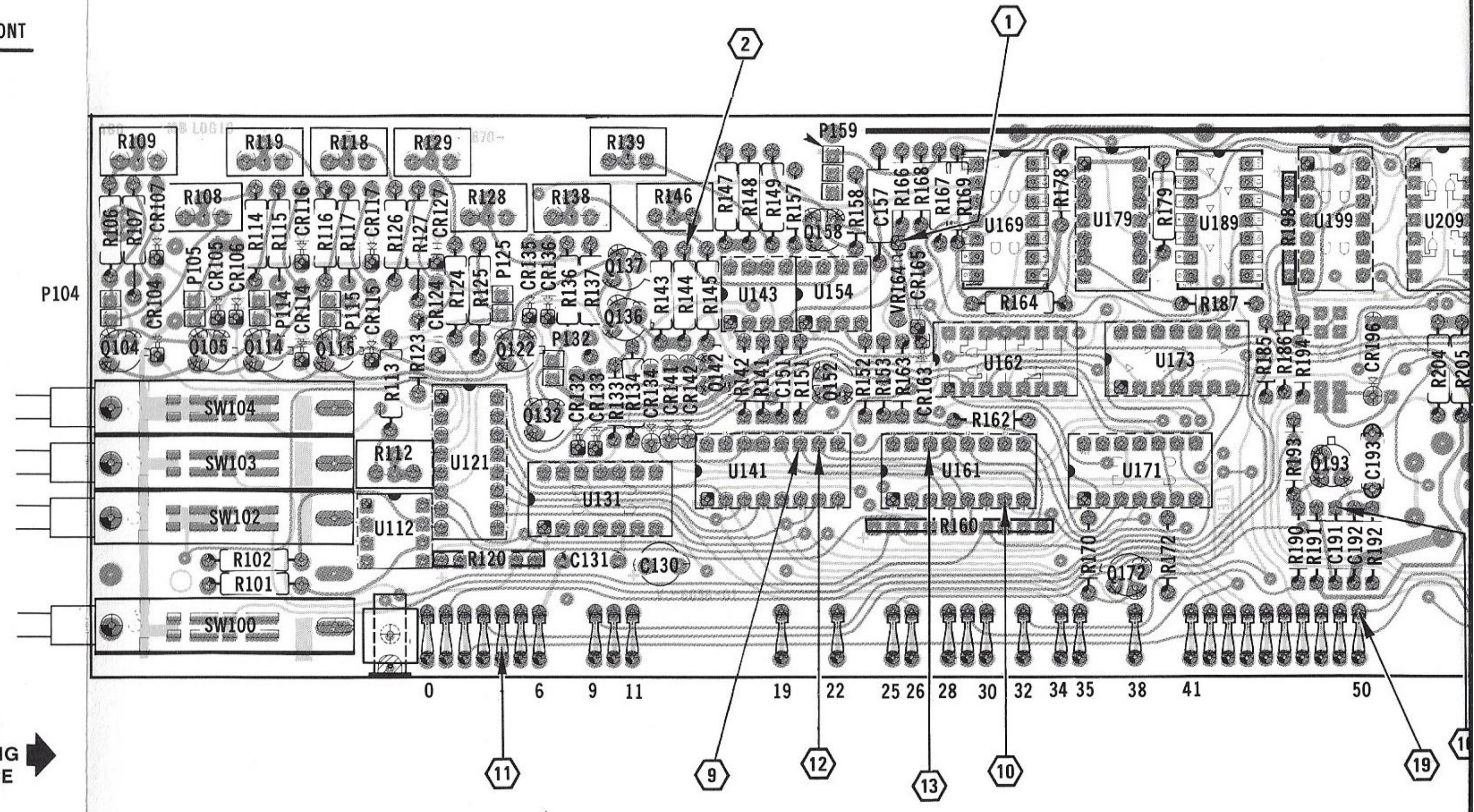
⟨19⟩



+10 V

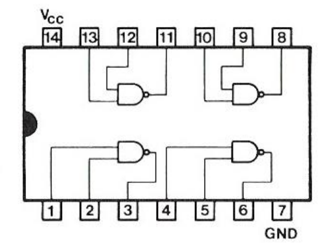
FRONT

P104

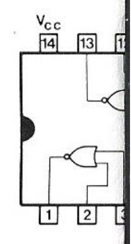


CIRCUIT NUMBERING SEQUENCE

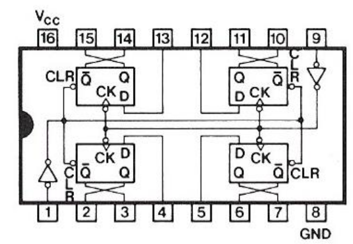
A60 MULTIBURST LOGIC BOARD



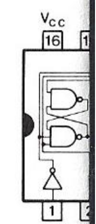
74LS00



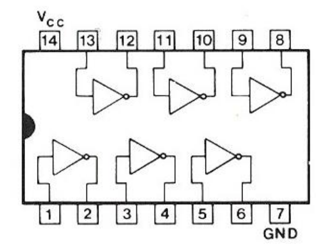
74LS



74LS175

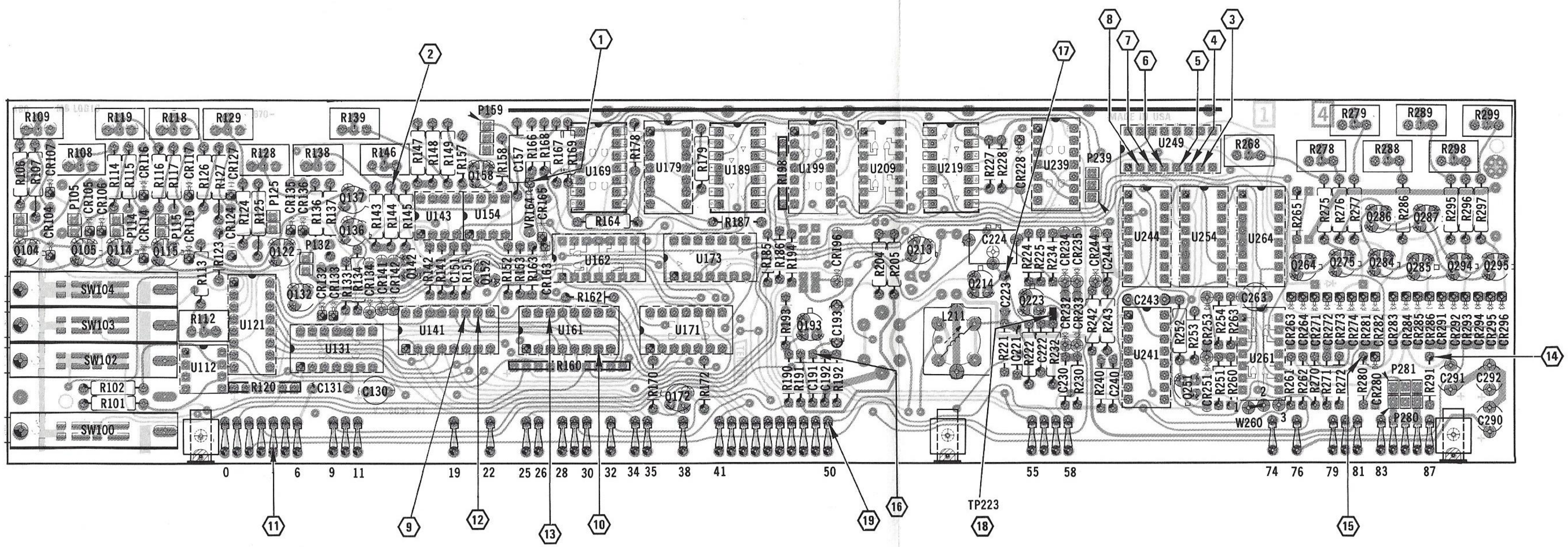


74L



7416

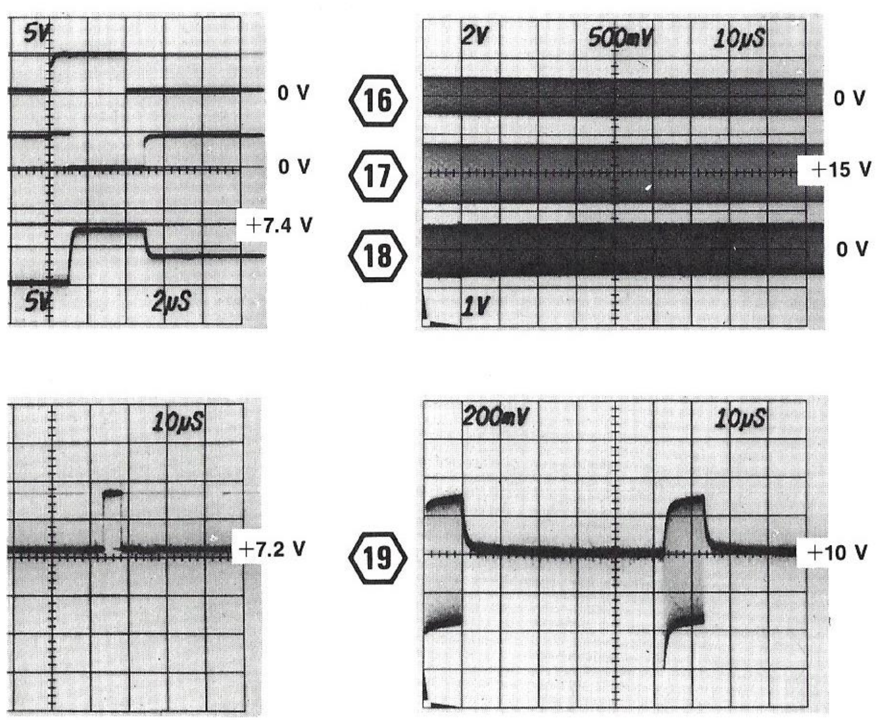
OFFSET

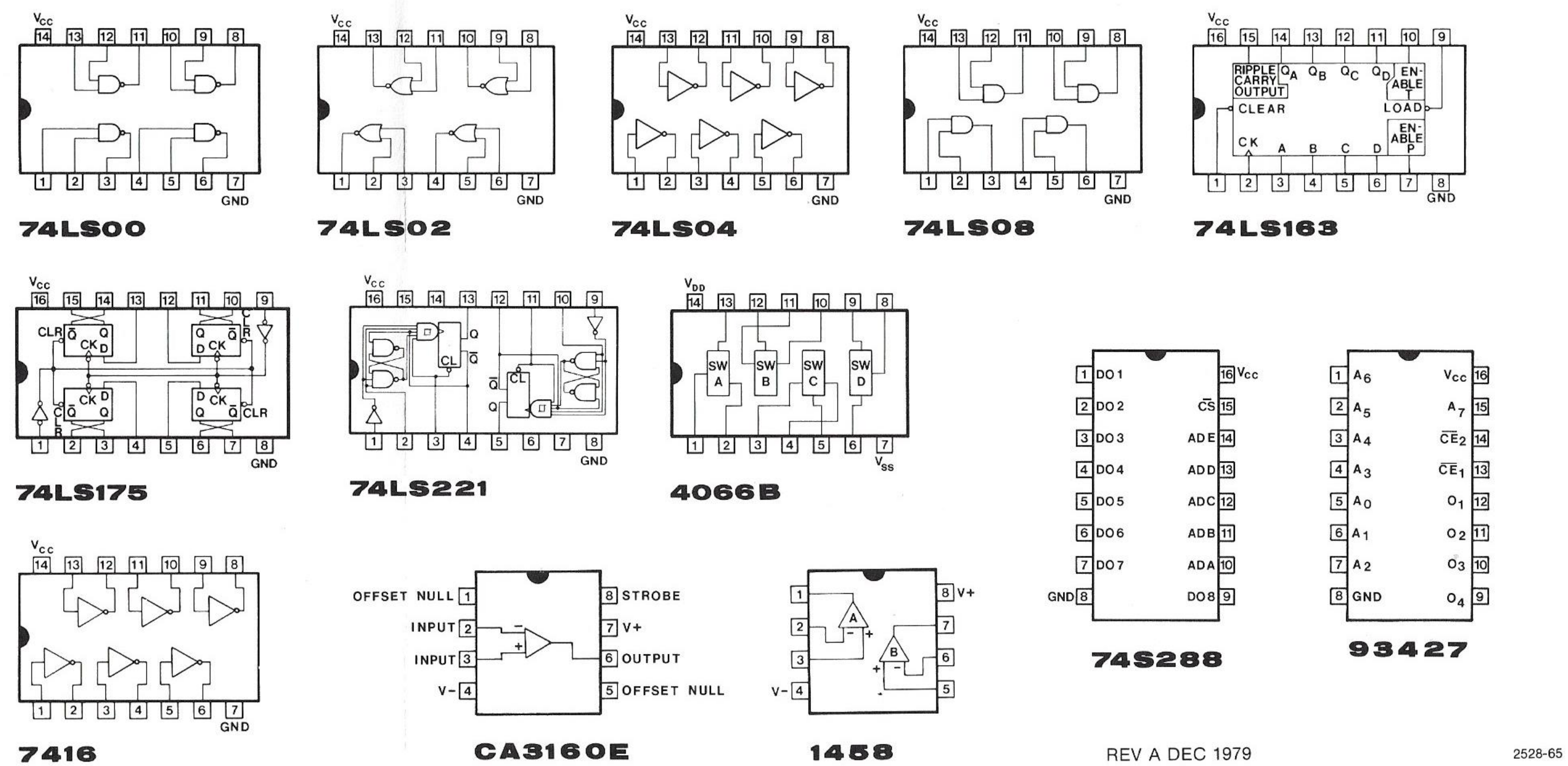


TOP

BOTTOM

A60 MULTIBURST LOGIC BOARD





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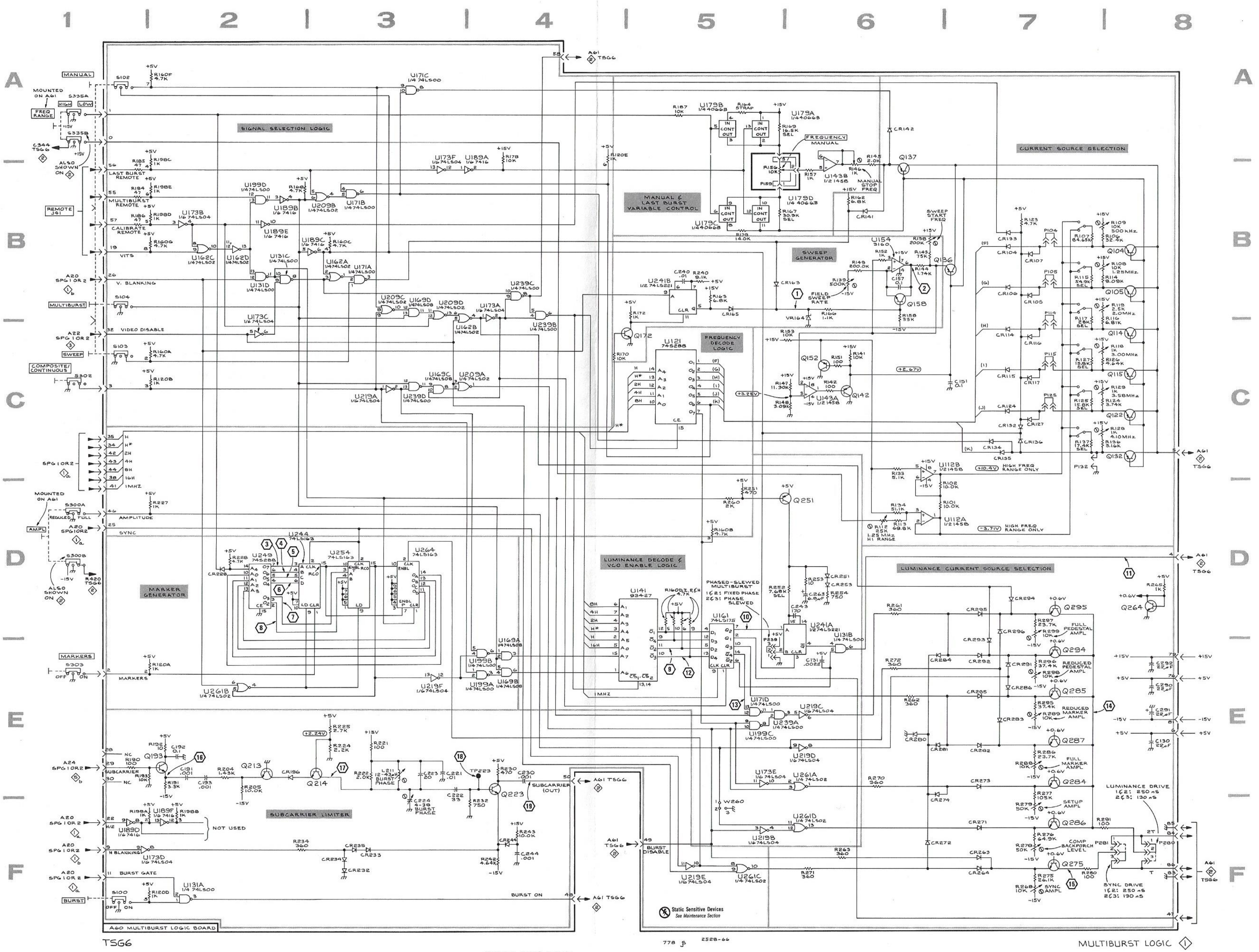
1

MULTIBURST LOGIC
PARTS LOCATING CHART

C130	E8
C131	E6
C151	C7
C157	B6
C191	E2
C192	E2
C193	E2
C221	E3
C222	E3
C223	E3
C224	F3
C230	E4
C240	B5
C243	D6
C244	F4
C263	D6
C290	E8
C291	E8
C292	E8
CR104	B7
CR105	B7
CR106	B7
CR107	B7
CR114	C7
CR115	C7
CR116	C7
CR117	C7
CR124	C7
CR127	C7
CR132	C7
CR133	B7
CR134	C7
CR135	C7
CR136	C7
CR141	B6
CR142	A6
CR163	B6
CR165	B5
CR196	E2
CR228	D2
CR232	F3
CR233	F3
CR234	F3
CR235	F3
CR244	F4
CR251	D6
CR253	D6
CR263	F7
CR264	F7
CR271	F7
CR272	F6
CR273	E7
CR274	E6
CR280	E6
CR281	E6
CR282	E7
CR283	E7
CR284	E6
CR285	E7
CR286	E7
CR291	E7
CR292	E7
CR293	D7
CR294	D7
CR295	D7
CR296	D7
L211	E3
P104	B7
P105	B7
P114	B7
P115	C7
P125	C7
P132	C7
P159	B5
P239	E5
P280	F8
P281	F8
Q104	B8
Q105	B8
Q114	C8
Q115	C8
Q122	C8
Q132	C8
Q136	B7
Q137	A6
Q142	C6
Q152	C6
Q158	B6
Q172	C5
Q193	E2
Q213	E2
Q214	E3
Q223	E4
Q251	D6
Q264	D8
Q275	F7
Q284	E7
Q285	E7
Q286	F7
Q287	E7
Q294	E7
Q295	D7
R101	D7
R102	D7
R106	B8
R107	B7
R108	B8
R109	B8
R112	D6
R113	D6
R114	B8
R115	B7
R116	B8
R117	B7
R118	C8
R119	B8
R120A	E2
R120B	C2
R120D	F2
R120E	A4
R123	B7
R124	C8
R125	C7
R126	C8
R127	C7
R128	C8
R129	C8
R133	C6
R134	D6
R136	C8
R137	C7
R138	B6
R139	B6
R141	C6
R142	C6
R143	B6
R144	B6
R145	A6
R146	B6
R147	C5
R148	C5
R149	B6
R151	C6
R152	B6
R153	C6
R156	B5
R157	B6
R158	B6
R160A	C2
R160B	D5
R160C	B3
R160D	D5
R160E	D5
R160F	A2
R160G	B2
R160H	D5
R160I	D5
R162	B6
R163	B5
R164	A5
R166	B6
R167	B6
R168	B2
R169	A6
R170	C4
R172	B5
R178	A4
R179	B5
R185	B1
R186	B1
R187	A5
R190	E1
R191	E2
R192	E2
R193	E1
R194	B1
R198A	F1
R198B	F2
R198C	B2
R198D	B2
R198E	B2
R204	E2
R205	E2
R221	E3
R222	E3
R224	E3
R225	E3
R227	D2
R228	D2
R230	E5
R232	F4
R234	F2
R240	B5
R242	F4
R243	F4
R251	D5
R252	D5
R253	D6
R254	D6
R260	D5
R261	D6
R262	E6
R263	F6
R265	D8
R268	F7
R270	E6
R271	F6
R272	E6
R275	F7
R276	F7
R277	E7
R278	F7
R279	F7
R280	F7
R286	E7
R288	E7
R289	E7
R291	F8
R295	E7
R296	E7
R297	D7
R298	E7
R299	D7
S100	F1
S102	A1
S103	C1
S104	B1
S300A	D1
S300B	D1
S302	C1
S303	E1
S335A	A1
S335B	A1
TP223	E4
U112A	D7
U112B	C7
U121	C5
U131A	F2
U131B	D6
U131C	B2
U131D	B2
U141	D5
U143A	C6
U143B	B6
U154	B6
U161	D5
U162A	B3
U162B	C3
U162C	B2
U162D	B2
U169A	E4
U169B	E4
U169C	C3
U169D	B3
U171A	B3
U171B	B3
U171C	A3
U171D	E5
U173A	B4
U173B	B2
U173C	B2
U173D	F2
U173E	E5
U173F	A3
U179A	A6
U179B	A5
U179C	B5
U179D	B6
U189A	A4
U189B	B2
U189C	B3
U189D	F1
U189E	B2
U189F	F2
U199A	E4
U199B	E4
U199C	E5
U199D	B2
U209A	C4
U209B	B3
U209C	B3
U209D	B3
U219A	C3
U219B	F5
U219C	E6
U219D	E6
U219E	F5
U219F	E3
U239A	E6
U239B	C4
U239C	B4
U239D	C3
U241A	D6
U241B	B5
U244	D2
U249	D2
U254	D3
U261A	E6
U261B	E2
U261C	F5
U261D	F6
U264	D3
VR164	B6
W260	F5



TSG6

REV A DEC 1979

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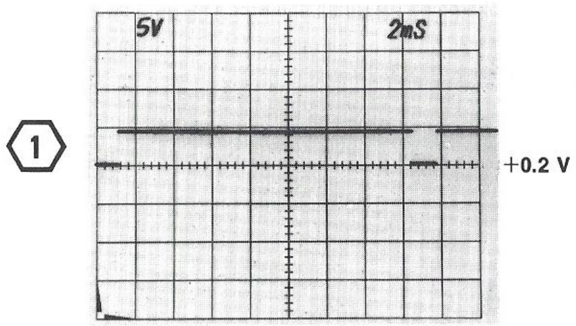
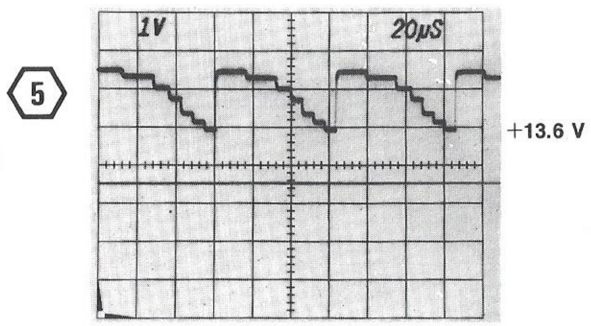
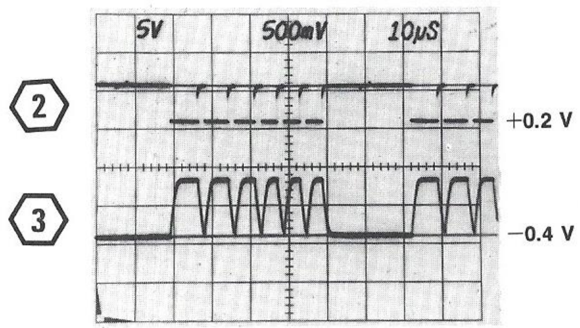
MULTIBURST LOGIC ①

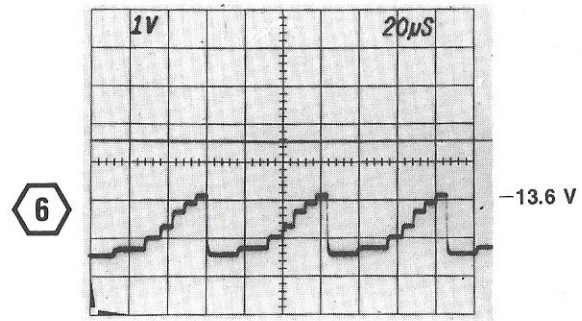
WAVEFORMS FOR DIAGRAM ⟨2⟩

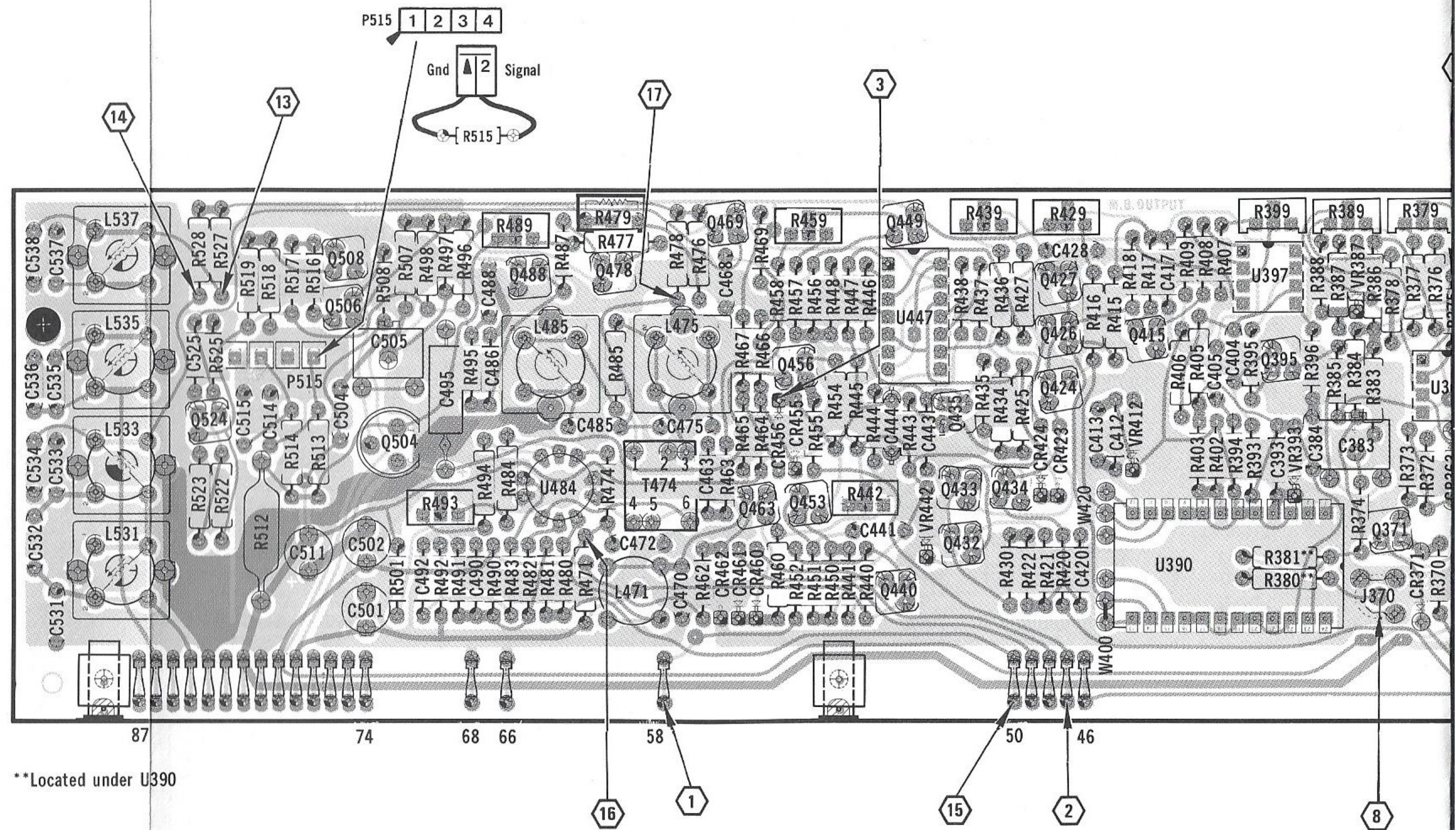
Refer to waveform conditions given on back of SECTION 9—DIAGRAMS foldout page (located at start of this section)







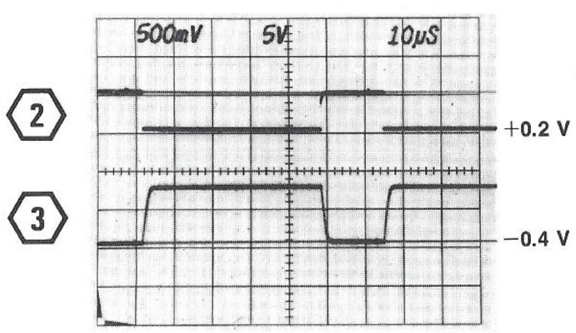


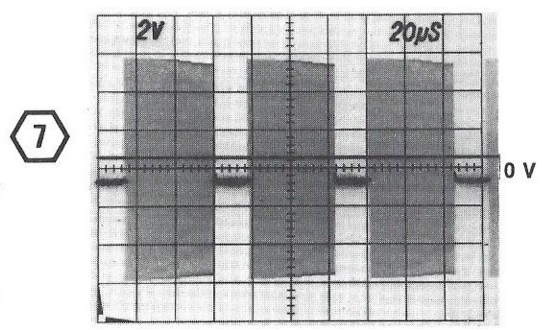


**Located under U390

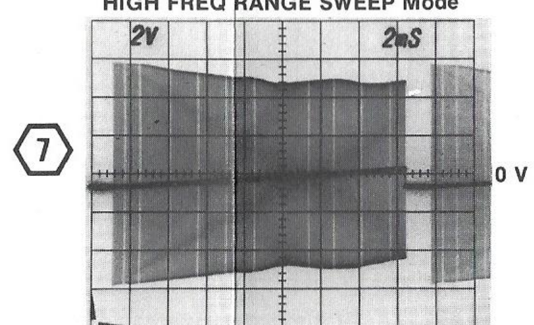
A61 MULTIBURST OUTPUT BOARD

SWEEP or MANUAL Mode

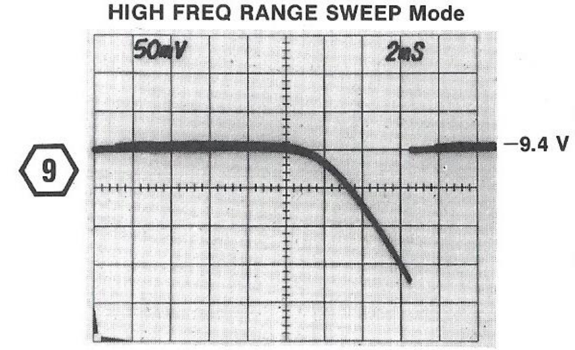




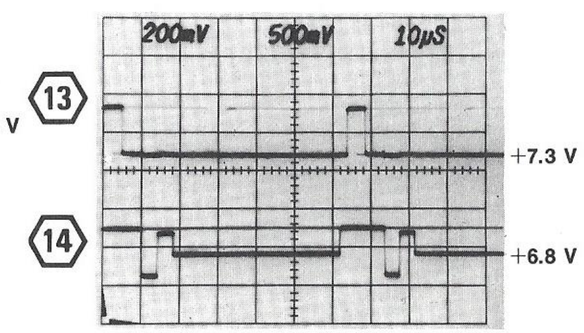
HIGH FREQ RANGE SWEEP Mode



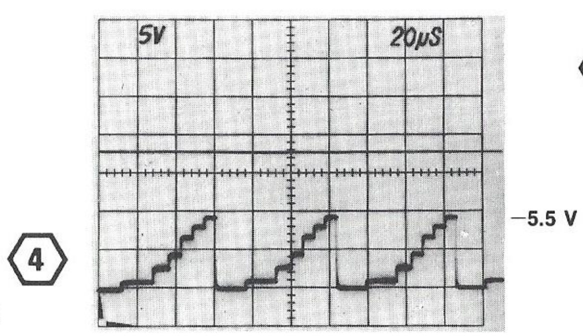
HIGH FREQ RANGE SWEEP Mode

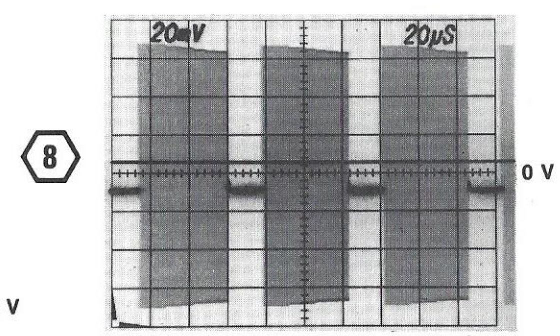


7A13 Bandwidth switch was set to 5 MHz.



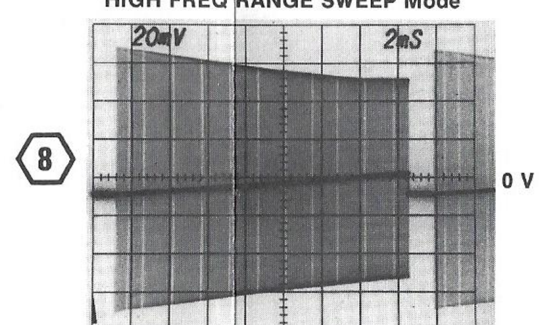
AC COUPLED





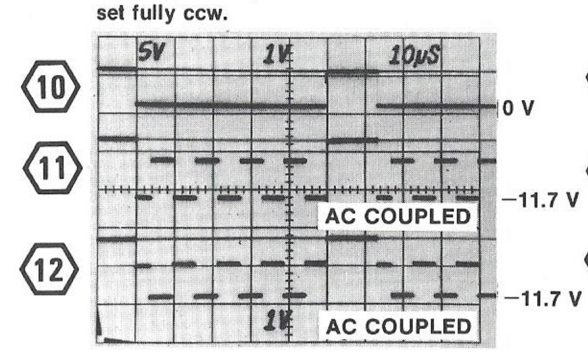
J370 signal is applied via a 50-ohm adapter cable and 50-ohm termination to the oscilloscope vertical input.

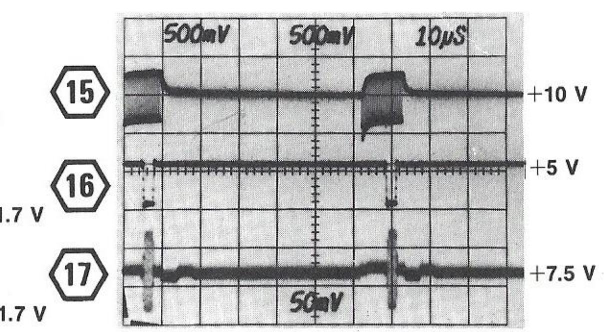
HIGH FREQ RANGE SWEEP Mode



J370 signal is applied via a 50-ohm adapter cable and 50-ohm termination to the oscilloscope vertical input.

MANUAL Mode; FREQUENCY control set fully ccw.





AC COUPLED

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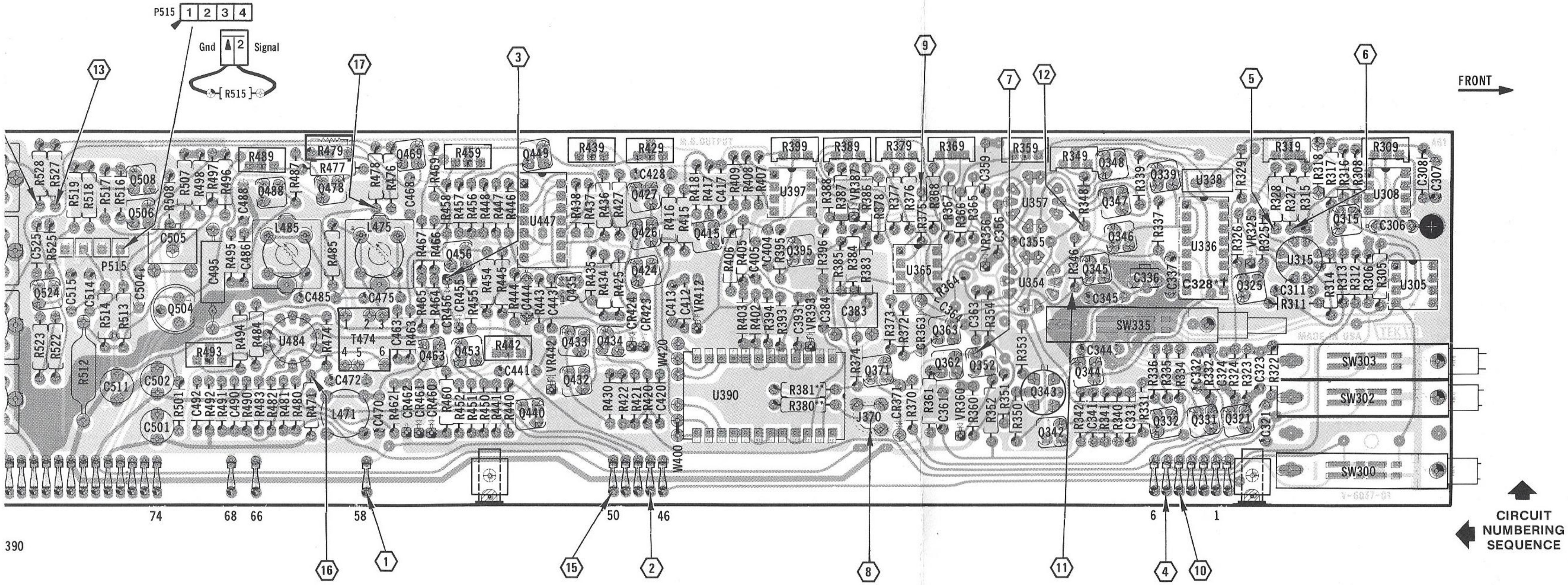
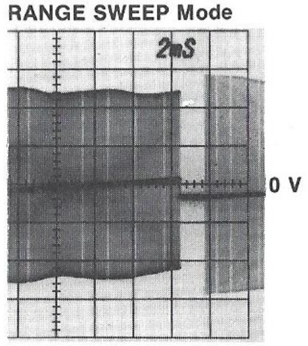


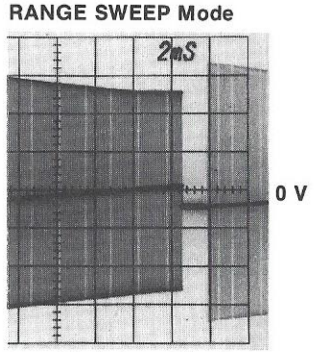
A61 MULTIBURST OUTPUT BOARD

TOP BOTTOM

RANGE SWEEP Mode

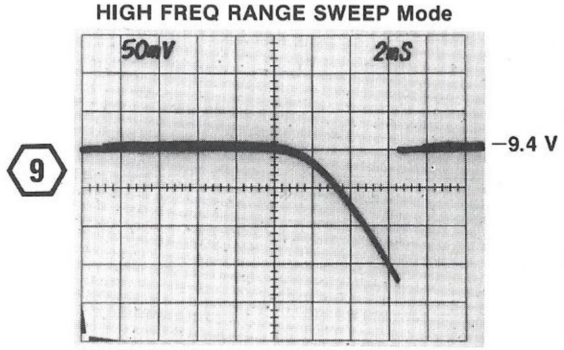


RANGE SWEEP Mode

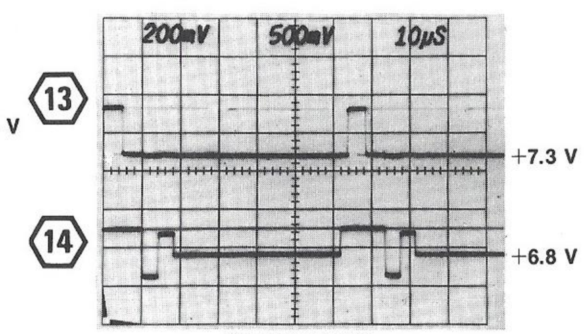


s applied via a 50-ohm and 50-ohm termination cope vertical input.

HIGH FREQ RANGE SWEEP Mode

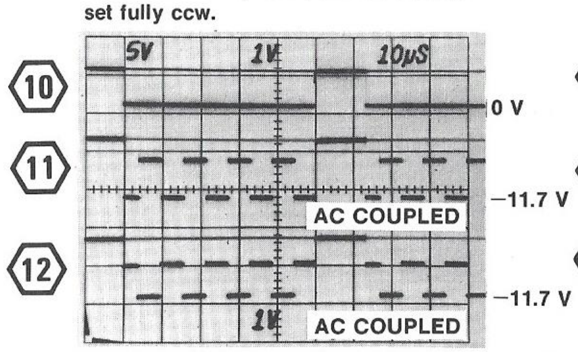


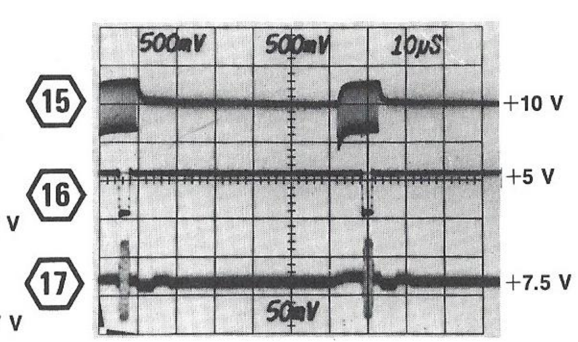
7A13 Bandwidth switch was set to 5 MHz.



AC COUPLED

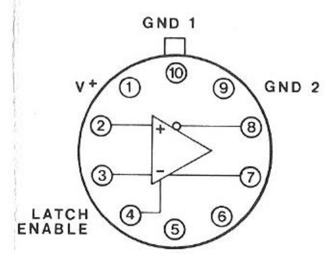
MANUAL Mode; FREQUENCY control set fully ccw.



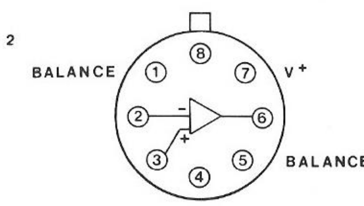


AC COUPLED

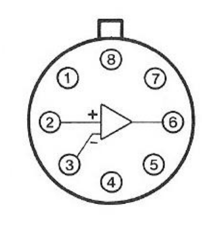
REV AUG 1981



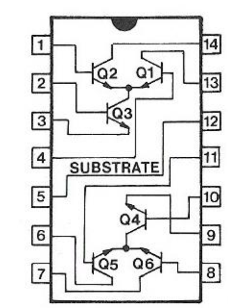
AM685



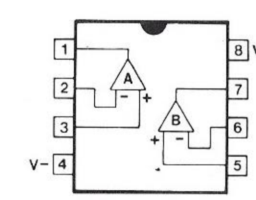
LF356H



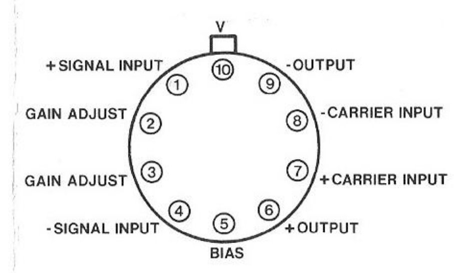
CA3130



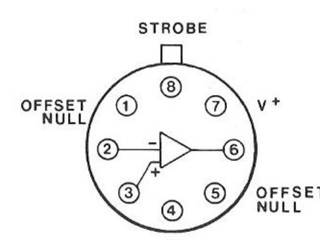
CA3102E



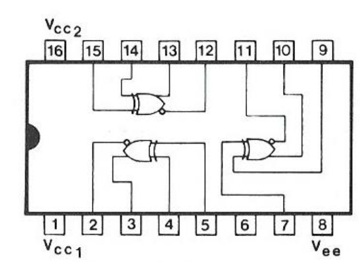
1458



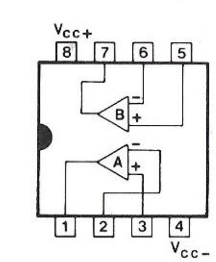
MC1496G



CA3140



MC10107



TL072

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MULTIBURST OUTPUT PARTS LOCATING CHART

C306	E2
C307	F2
C308	F2
C311	D2
C321	B8
C323	F3
C324	F3
C328†*	E3
C331	D2
C332	F3
C336	D2
C337	E3
C341	C1
C344	D2
C345	D2
C355	E3
C356	B8
C358	D4
C359	D3
C361	D3
C363	D2
C364	E4
C383	D4
C384	C4
C393	C4
C404	B3
C405	B3
C412	C4
C413	C4
C417	A3
C420	C5
C428	C6
C441	B5
C443	B6
C444	B5
C463	E6
C468	B7
C470	F5
C472	F6
C475	E7
C485	E7
C486	C7
C488	C7
C490	E6
C492	F7
C495	C8
C501	B8
C502	B8
C504	D7
C505	C7
C511	B8
C514	D8
C515	D8
C525	E7
C531	E5
C532	E5
C533	E5
C534	E6
C535	D5
C536	E5
C537	E5
C538	E6
CR363	F4
CR371	E4
CR423	C5
CR424	C5
CR455	B5
CR456	B5
CR460	F5
CR461	F5
CR462	F5
J370	C3
L471	F5
L475	E6
L485	E6
L531	E5
L533	E5
L535	E5
L537	E5
P515	D8
Q315	D2
Q321	F3
Q325	C2
Q331	E3
Q332	F2
Q339	E2
Q342	D2
Q343A	C2
Q343B	D2
Q344	C2
Q345	E2
Q346	E2
Q347	D2
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Q352	D3
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Q371	E4
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Q432	C5
Q433	C5
Q434	C5
Q435	B6
Q440	B5
Q449	B6
Q453	B5
Q456	B5
Q463	F5
Q469	E7
Q478	C7
Q488	C7
Q504	C8
Q506	C8
Q508	C8
Q524	E7
R305	D1
R306	D1
R308	E2
R309	E2
R311	E3
R312	D1
R313	D2
R314	C2
R315	F2
R316	D2
R317	E1
R318	E2
R319	F2
R322	F3
R323	F3
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R383	E4
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R386	E4
R387	A3
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R389	D4
R393	B4
R394	B3
R395	B3
R396	B3
R399	B2
R402	B3
R403	B4
R405	B3
R406	B3
R407	B2
R408	B3
R409	B3
R415	C5
R416	B5
R417	B3
R418	C5
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R421	C5
R422	C5
R425	B7
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R434	B7
R435	B6
R436	C6
R437	B6
R438	B6
R439	C6
R440	B4
R441	B5
R442	F5
R443	B6
R444	B6
R445	B5
R446	B6
R447	B6
R448	B6
R450	B5
R451	B5
R452	B4
R454	B5
R455	B4
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R465	B5
R466	B5
R467	B5
R469	B5
R471	F6
R474	F6
R476	E7
R477	D7
R478	E7
R479	D7
R480	E6
R481	E6
R482	E6
R483	F6
R484	F6
R485	E6
R487	C7
R489	D7
R490	E6
R491	E6
R492	F7
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R495	C7
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R497	C7
R498	C7
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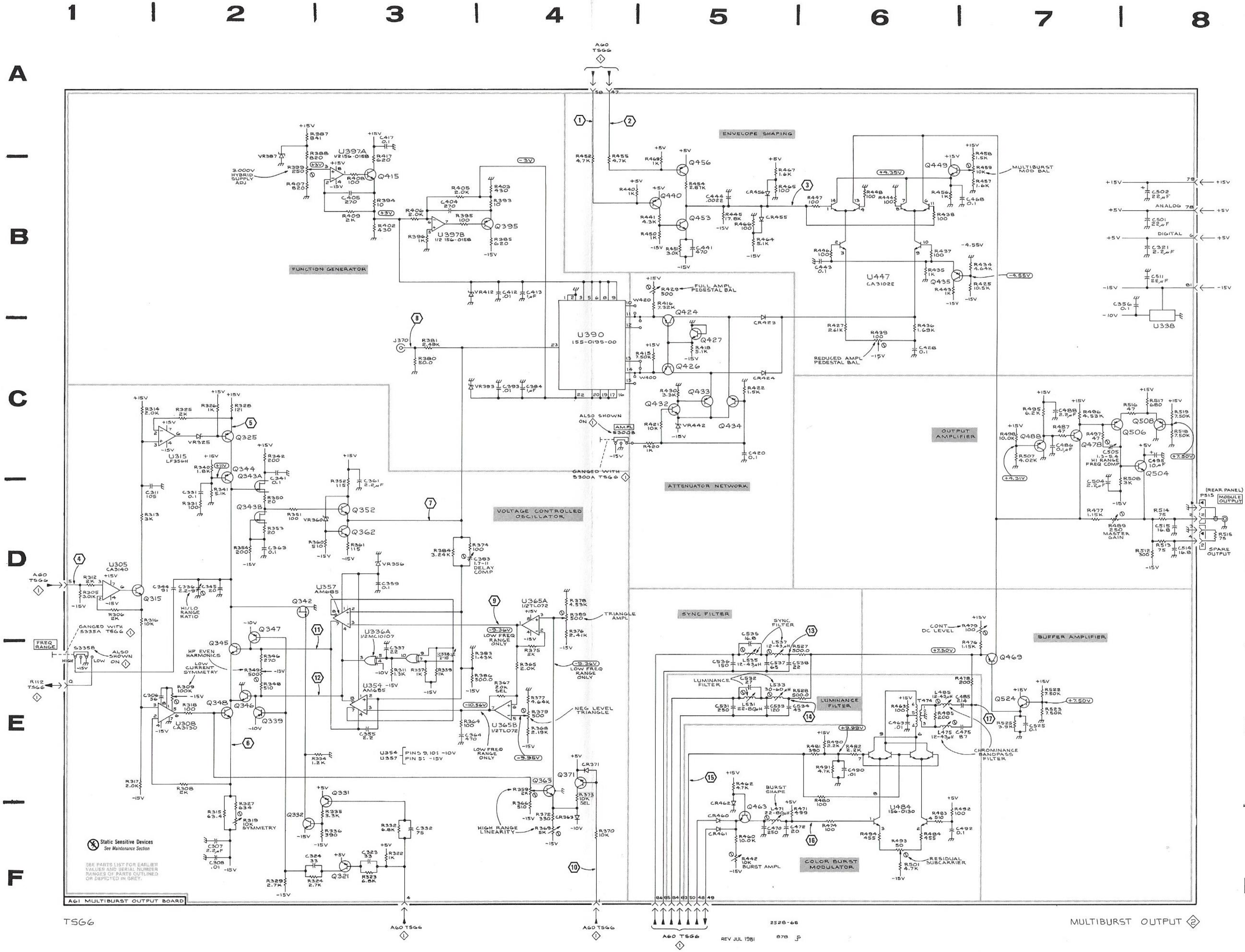
R508	C8
R512	D8
R513	D8
R514	D8
R516	C8
R517	C8
R518	C8
R519	C8
R522	E7
R523	E7
R525	E7
R527	E6
R528	E6
S300B	C4
S335B	E1
T474	E6
U305	D1
U308	E2
U315	C2
U336A	D3
U336B	E3
U338	C8
U354	E3
U357	D3
U365A	D4
U365B	E4
U390	C4
U397A	A3
U397B	B3
U447	B6
U484	F6
VR325	C2
VR356	D2
VR360	D3
VR387	B1
VR393	C4
VR412	C4
VR442	C5
W400	C5
W420	B5

†Located on back of board

***See Parts List for serial number ranges.**


FUNCTION GENERATOR
ENVELOPE SHAPING
VOLTAGE CONTROLLED OSCILLATOR
ATTENUATOR NETWORK
OUTPUT AMPLIFIER
SYNC FILTER
LUMINANCE FILTER
BUFFER AMPLIFIER
COLOR BURST MODULATOR
Static Sensitive Devices
See Maintenance Section
A61 MULTIBURST OUTPUT BOARD

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

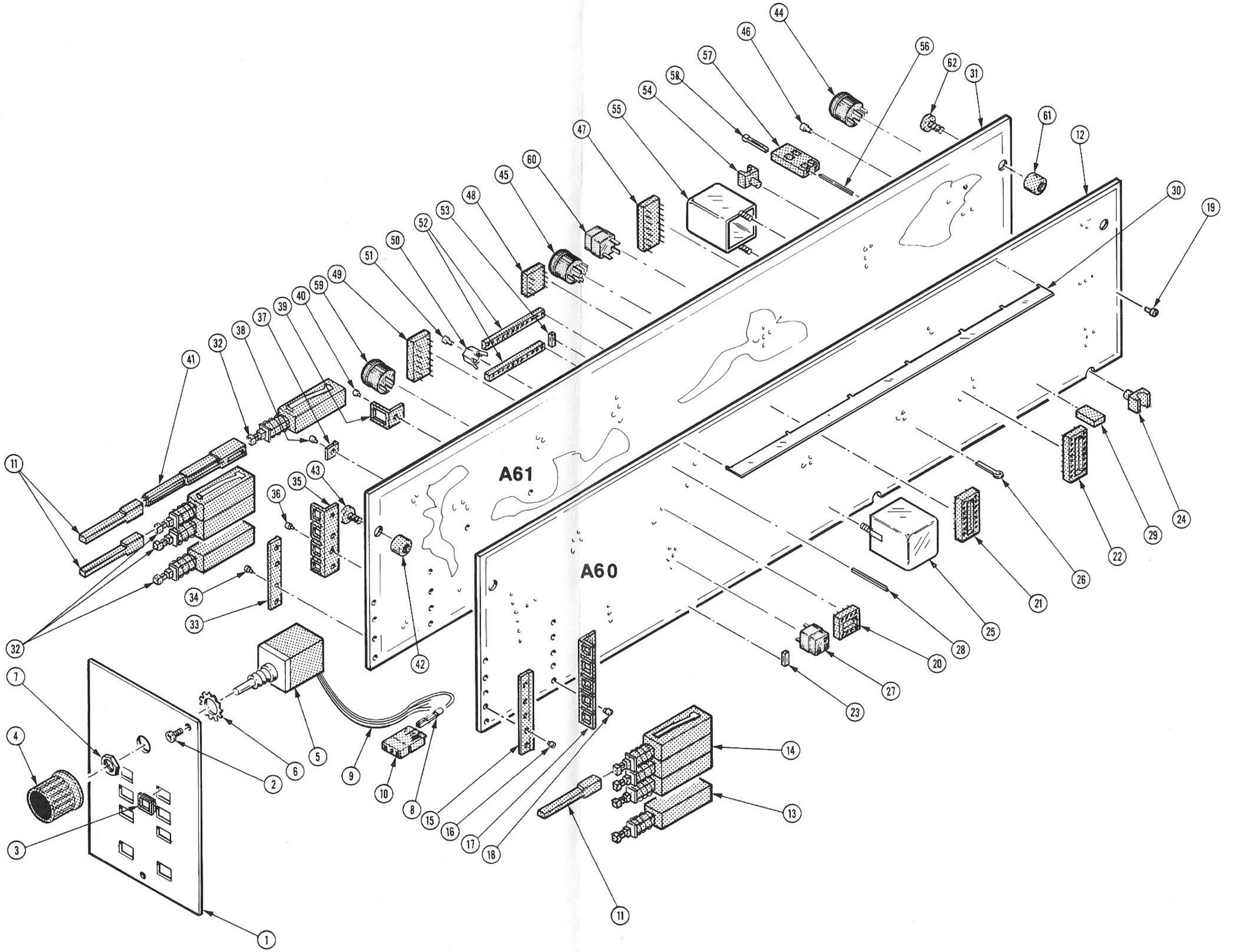
CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OREGON 97005
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
07707	USM CORP., USM FASTENER DIV.	510 RIVER RD.	SHELTON, CT 06484
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
23880	STANFORD APPLIED ENGINEERING, INC.	340 MARTIN AVE.	SANTA CLARA, CA 95050
26365	GRIES REPRODUCER CO., DIV. OF COATS AND CLARK, INC.	125 BEECHWOOD AVE.	NEW ROCHELLE, NY 10802
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-1	333-2430-00			1	PANEL,FRONT:	80009	333-2430-00
					(ATTACHING PARTS)		
-2	213-0277-00			2	SCR,TPG,THD FOR:2-56 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-3	426-1206-00			8	FRAME,PUSH BTN:MOMENTARY,GRAY PLASTIC	80009	426-1206-00
-4	366-0497-00			1	KNOB:GY,0.127 ID X0.706 OD	80009	366-0497-00
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
-5	----- -----			1	RES.,VAR NONWIR:(SEE R156 REPL)		
					(ATTACHING PARTS)		
-6	210-1026-00			1	WASHER,LOCK:0.26 ID,INTL,0.025 THK,STL	78189	1114-00
-7	210-0465-00			1	NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
					- - - * - - -		
	198-4060-00			1	WIRE SET,ELEC:	80009	198-4060-00
-8	131-0621-00			3	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-9	175-0826-00			AR	. WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
-10	352-0199-00			1	. CONN BODY,PL,EL:3 WIRE BLACK	80009	352-0199-00
-11	366-1691-00			8	PUSH BUTTON:GY,1.2 L	80009	366-1691-00
	334-1378-00			1	PLATE,IDENT:MKD SERIAL NO.	80009	334-1378-00
-12	----- -----			1	CKT BOARD ASSY:MULTIBURST LOGIC(SEE A60 REPL)		
-13	----- -----			1	. SWITCH PB ASSY:1 PUSH(SEE S100 REPL)		
-14	----- -----			1	. SWITCH PB ASSY:3 LCH(SEE S102,S103,S104 REPL)		
-15	343-0495-05			1	. CLIP,SWITCH:FRONT,7.5MM X5 UNIT	80009	343-0495-05
					(ATTTACHING PARTS)		
-16	210-3033-00			5	. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					- - - * - - -		
-17	343-0499-05	B010100	B012126	1	. CLIP,SWITCH:REAR,7.5MM X 5 UNIT	80009	343-0499-05
	343-0499-14	B012127		1	. CLIP,SWITCH:7.5MM X 5 UNIT	80009	343-0499-14
					(ATTACHING PARTS)		
-18	210-3033-00			5	. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					- - - * - - -		
-19	136-0252-07			15	. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-20	136-0514-00			3	. SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-21	136-0269-02			12	. SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-22	136-0260-02	B010100	B010747	8	. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
	136-0260-02	B010748		5	. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-23	136-0328-03			45	. SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
-24	214-2440-00			3	. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-25	337-1417-00			1	. SHIELD,ELEC:0.55 SQ X 0.685 INCH HIGH	80009	337-1417-00
-26	214-0579-00			1	. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-27	136-0220-00	B010100	B010253	22	. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
	136-0220-00	B010254		8	. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
-28	131-0608-00			21	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	131-0589-00			3	. TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-29	131-0993-00			8	. BUS,CONDUCTOR:2 WIRE BLACK	00779	850100-01
-30	131-0998-00			1	. BUS BAR:9 TERM,8.132"LONG,CUT TO FIT	80009	131-0998-00
-31	----- -----			1	CKT BOARD ASSY:MULTIBURST OUTPUT(SEE A61 REPL)		
-32	----- -----			4	. SWITCH PB ASSY:1 PUSH		
	----- -----			-	. (SEE S300,S302,S303,S335 REPL)		
-33	343-0495-04			1	. CLIP,SWITCH:FRONT,7.5 MM,4 UNIT	80009	343-0495-04
					(ATTACHING PARTS)		
-34	210-3033-00			4	. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					- - - * - - -		
-35	343-0499-04	B010100	B012199	1	. CLIP,SWITCH:REAR,7.5MM X 4 UNIT	80009	343-0499-04
	343-0499-13	B012200		1	. CLIP,SWITCH:7.5MM X 4 UNIT	80009	343-0499-13
					(ATTACHING PARTS)		
-36	210-3033-00			4	. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					- - - * - - -		
-37	343-0495-01			1	. CLIP,SWITCH:FRONT,7.5 MM,1 UNIT	80009	343-0495-01
					(ATTACHING PARTS)		
-38	210-3033-00			1	. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					- - - * - - -		
-39	343-0499-01			1	. CLIP,SWITCH:REAR,7.5 MM,1 UNIT	80009	343-0499-01
					(ATTACHING PARTS)		
-40	210-3033-00			1	. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-41	384-1341-00			1	. EXTENSION SHAFT:2.183 INCH LONG,OFFSET	80009	384-1341-00
-42	385-0109-00			1	. SPACER,POST:0.312 L W/4-40 THD THRU,NYL	80009	385-0109-00
					(ATTACHING PARTS)		
-43	211-0040-00			1	. SCREW,MACHINE:4-40 X 0.25",BDGH PLSTC	26365	OBD
					- - - * - - -		
-44	136-0237-00			1	. SOCKET,PLUG-IN:8 CONTACT,ROUND	71785	133-98-12-062
-45	136-0241-00	B010100	B010747	3	. SKT,PL-IN ELEK:MICROCIRCUIT,10 CONT,PCB MT	71785	133-99-12-064
	136-0241-00	B010748		2	. SKT,PL-IN ELEK:MICROCIRCUIT,10 CONT,PCB MT	71785	133-99-12-064
-46	136-0252-07			9	. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-47	136-0260-02			1	. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-48	136-0514-00			4	. SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-49	136-0269-02			1	. SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-50	131-1003-00			1	. CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-51	136-0252-07			1	. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-52	136-0691-00			2	. SKT,PL-IN ELEK:MICROCKT,12 CONT LOW	23880	C5A-3200-12B
-53	136-0328-03			29	. SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
-54	214-2440-00			3	. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-55	337-1417-00			6	. SHIELD,ELEC:0.55 SQ X 0.685 INCH HIGH	80009	337-1417-00
-56	131-0589-00			4	. TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
	119-1158-00			1	. RES-CONN ASSY:	80009	119-1158-00
	321-0085-00			1	. . RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
-57	352-0198-06			1	. . HLDR,TERM CONN:2 WIRE BLUE	80009	352-0198-06
-58	131-0621-00			2	. . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-59	136-0183-00	B010100	B010253X	1	. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
-60	136-0220-00	B010100	B010253	35	. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
	136-0220-00	B010254		10	. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
-61	385-0109-00			1	. SPACER,POST:0.312 L W/4-40 THD THRU,NYL	80009	385-0109-00
					(ATTACHING PARTS)		
-62	211-0040-00			1	. SCREW,MACHINE:4-40 X 0.25",BDGH PLSTC	26365	OBD
					- - - * - - -		
					STANDARD ACCESSORIES		
	070-2528-00			1	MANUAL,TECH:INSTRUCTION	80009	070-2528-00

FIG. 1 EXPLODED



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.