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146/R146
NTSC TEST SIGNAL GENERATOR

INSTRUCTION MANUAL

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

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Product Group 20

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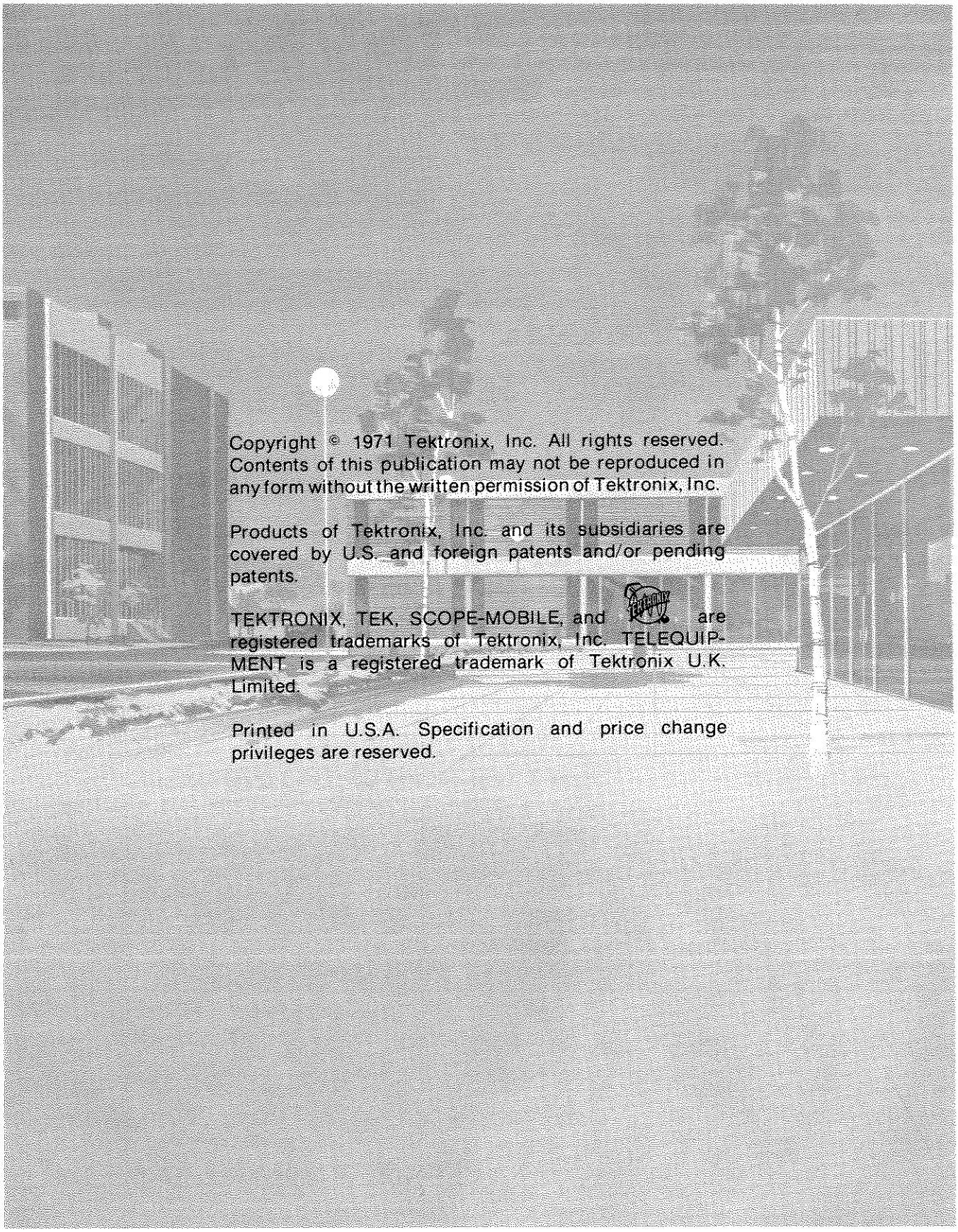

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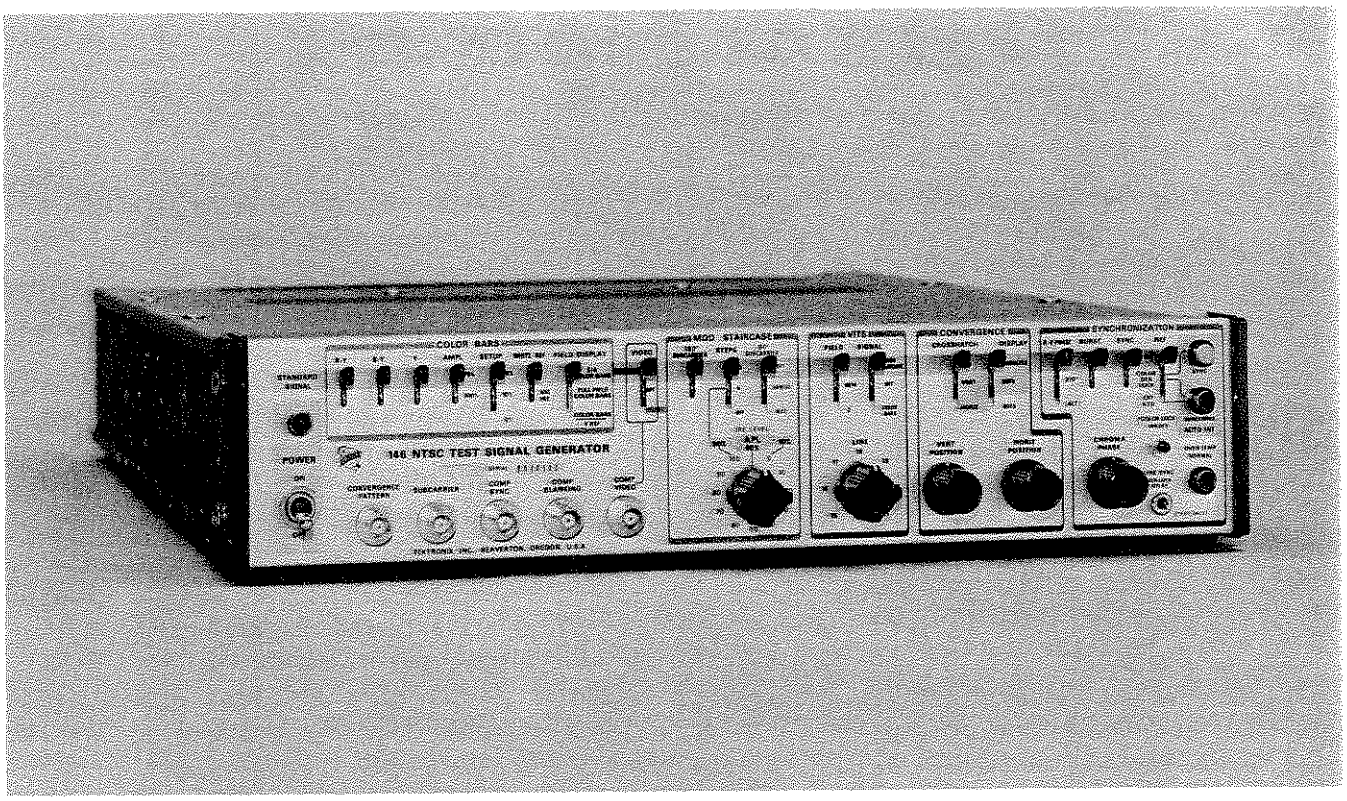
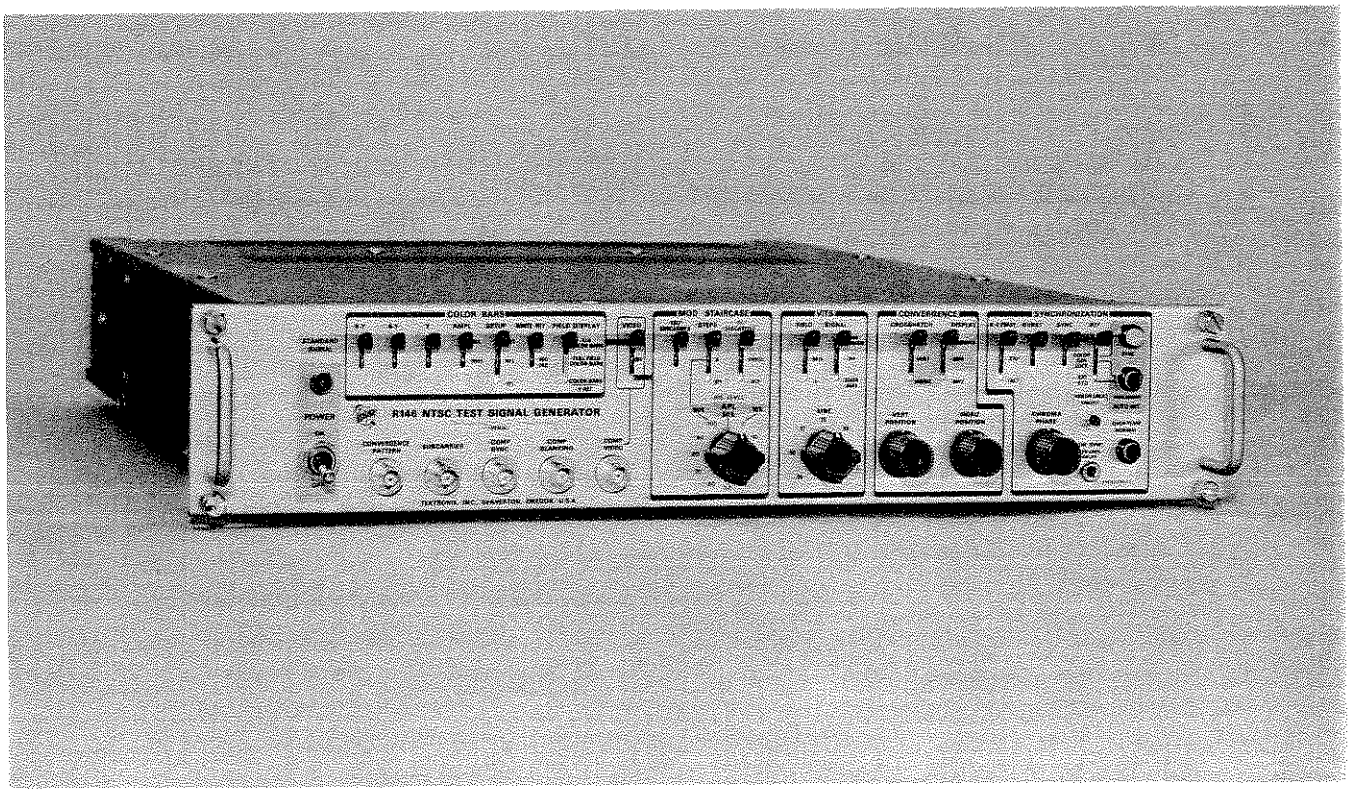


(A) 146 NTSC TEST SIGNAL GENERATOR (Bench Model).



(B) R146 NTSC TEST SIGNAL GENERATOR (Rackmount Model).

Fig. 1-1. The two models of the generator are electrically identical.

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SECTION 1
SPECIFICATION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

The 146[1] NTSC[2] TEST SIGNAL GENERATOR is a source of television test signals for 525-line, 60-Hz field standard NTSC color television systems.

Two operating modes provide either color bar or staircase test signals. In the COLOR BARS mode, three (user-selected) signals are available: EIA COLOR BARS, FULL FIELD COLOR BARS, and COLOR BARS/Y REF. In the staircase mode, two (user-selected) signals are available: 10 step (11 levels) with APL (Average Picture Level) selectable, and 5 step (6 levels) with APL fixed or selectable.

A CONVERGENCE PATTERN signal is available independent of all other output signals. The signal conforms to IRE (Institute of Radio Engineers) standard 54-23S1 on measuring scanning geometry and aspect ratio.

[1]**The 146/R146 are electrically identical. The 146 will be referred to in this manual.**

[2]**National Television System Committee.**

Provision is made for the 146 to be Gen-Locked (see Glossary of Terms, Section 2) to composite video from another source. Alternately, an externally generated CW subcarrier source may be substituted for the internal 3.58 MHz standard. Black Burst is available.

Other output signals are: SUBCARRIER, COMP SYNC, COMP BLANKING, BURST FLAG, HORIZ DRIVE, and VERT DRIVE.

ELECTRICAL CHARACTERISTICS

Performance Conditions

The specified limits of the instrument calibration characteristics are valid with the following conditions: the instrument must have been calibrated at an ambient temperature between +20°C and +30°C, operated within an ambient temperature of 0°C to +50°C, and must have a warm-up period of at least 10 minutes.

TABLE 1-1

STAIRCASE SIGNAL

Characteristic	Performance Requirement	Supplemental Information
Luminance Component		
Step Amplitude		
10 Step	71.5 mV within 3%.	
5 Step	143 mV within 1%.	
Overall		714 mV within 1%.
Step Risetime	260 ns within 15%.	
Aberrations	Within 2% of step amplitude.	
Step Duration		
10 Step		
Blanking Level		13.2 µs within 5%.
White Level		9.9 µs within 5%.
Intermediate Levels		3.3 µs within 5%.

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TABLE 1-1 (cont.)

Characteristic	Performance Requirement	Supplemental Information
5 Step		
Blanking Level		13.2 µs within 5%.
White Level		13.2 µs within 5%.
Intermediate Levels		6.6 µs within 5%.
Chrominance Component		
Amplitude	143 mV within 3%.	
Phase		180°
Differential Phase		
10%, 50%, and 90% APL		0.1° or less.
Differential Gain		
10%, 50%, and 90% APL		0.5% or less.
Subcarrier Envelope		
Risetime	400 ns within 15%.	
Duration	40 µs within 5%.	
Delay from Line Sync	16.1 µs within 5%.	
APL		APL specifications conform to IRE Standard 60-23S1.
Fixed		All active lines carry the modulated staircase signal with APL fixed at 50%.
Selectable	11 levels, equal within 2%.	Staircase signal is on every fifth line and the same line each frame. The IRE level of the other four lines can be selected from 0 IRE (10% APL) to 100 IRE (90% APL) in 10 equal increments.
Subcarrier Component		
OFF		No subcarrier.
UNMOD		30 mV within 5 mV (approximately 5 IRE units at 90°) during active line time of 52.3 µs.
MODULATED SUBCARRIER		30 mV within 5 mV for the first and last 13.2 µs of active line time. 286 mV within 3% (40 IRE) for the second 13.2 µs of active line time.
	572 mV within 3% (80 IRE) for the third 13.2 µs of active line time.	Phased at 90°.
	Incidental phase errors between 286 mV and 572 mV signals are 0.5° or less.	

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TABLE 1-2
COLOR BAR

Characteristic	Performance Requirement	Supplemental Information
Timing EIA COLOR BARS Color Bars		181 lines field 1; 181.5 lines field 2.
Duration	7.5 µs per bar (7 bars).	
—I, W, Q, B		60.5 lines field 1; 60 lines field 2.
—I, W, Q, Duration	9.4 µs.	
B Duration	24.1 µs.	
FULL FIELD COLOR BARS		241.5 lines per field.
Duration	6.6 µs (8 bars).	
Risetime	115 ns within 15%.	
COLOR BARS Y REF		100% saturated bars first 181 active lines per field; 0% saturated bars last 60 lines per field.
Chrominance Time Difference between Luminance and Chrominance	20 ns or less.	
Risetime	400 ns within 15%.	
B—Y, R—Y Quadrature Error	0.5° or less.	
R—Y Axis Phase Switcher	0.5° or less.	
Residual Subcarrier	At least 52 dB below 1 volt on white and black.	
Aberrations		Within 4% peak to peak of 1 volt.
Spurious Subcarrier		At least 52 dB below 1 volt, when viewed on a Type 529, except 30 dB down at the end of H Blanking.
Other Spurious Outputs		At least 52 dB below 1 volt, when viewed on a Type 529, except 30 dB down during sync and at the end of H Blanking.
Luminance and Chrominance	Absolute amplitudes of luminance signal, set-up, and sync are within 1% or 1.5 mV, whichever is greater, with respect to blanking.	
	Absolute amplitudes of all subcarrier frequency components (B—Y, R—Y) are within 3%.	
	With the red chrominance bar as an absolute reference, all other subcarrier frequency component amplitudes are within 1% or 1 mV plus the peak to peak residual subcarrier amplitude, whichever is greater, of their assigned values listed in Table 1-2.	
Blanking DC Level (With respect to ground)	0 volts within 50 mV.	

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TABLE 1-2 (cont.)

Characteristic	Performance Requirement				Supplemental Information			
Reference Amplitudes (mV)								
	Lum	Chroma (P-P)	B–Y (P-P)	R–Y (P-P)	Lum	Chroma (P-P)	B–Y (P-P)	R–Y (P-P)
Blanking Level	0	2.5 or less	- - - - -	- - - - -	*Same as color bar level as determined by Setup			
Sync	–285.7	2.5 or less	- - - - -	- - - - -				
Burst	0	285.7	285.7	0				
–I	*	285.7	155.6	239.6				
White Ref	714.3	2.5 or less	- - - - -	- - - - -				
Q	*	285.7	239.6	155.6				
Black	*	2.5 or less	- - - - -	- - - - -				
(75% Amplitude, 7.5% Setup)								
White	549.1	2.5 or less	- - - - -	- - - - -				
Yellow	494.6	445.1	434.7	95.6				
Cyan	400.4	625.9	146.5	608.5				
Green	345.9	588.3	288.2	512.9				
Magenta	256.7	588.3	288.2	512.9				
Red	202.2	625.9	146.5	608.5				
Blue	108.1	445.1	434.7	95.6				
Black	53.6	2.5 or less	- - - - -	- - - - -				
(75% Amplitude, 10% Setup)								
White					553.6	2.5 or less	- - - - -	- - - - -
Yellow					500.5	433.0	422.9	93.0
Cyan					408.9	609.0	142.6	592.1
Green					355.9	572.4	280.4	499.1
Magenta					269.1	572.4	280.4	499.1
Red					216.1	609.0	142.6	592.1
Blue					124.5	433.0	422.9	93.0
Black					71.4	2.5 or less	- - - - -	- - - - -
(75% Amplitude, 0% Setup)								
White					535.7	2.5 or less	- - - - -	- - - - -
Yellow					476.8	481.2	469.9	103.4
Cyan					375.0	676.7	158.4	657.9
Green					316.1	636.0	311.5	554.5
Magenta					219.6	636.0	311.5	554.5
Red					160.7	676.7	158.4	657.9
Blue					58.9	481.2	469.9	103.4
Black					0	2.5 or less	- - - - -	- - - - -

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TABLE 1-2 (cont.)

Characteristic	Performance Requirement				Supplemental Information			
	Lum	Chroma (P-P)	B—Y (P-P)	R—Y (P-P)	Lum	Chroma (P-P)	B—Y (P-P)	R—Y (P-P)
(100% Amplitude, 10% Setup)								
White					714.3	2.5 or less	- - - - -	- - - - -
Yellow					643.6	577.4	563.9	124.1
Cyan					521.4	812.0	190.1	789.5
Green					450.7	763.2	373.8	665.4
Magenta					335.0	763.2	373.8	665.4
Red					264.3	812.0	190.1	789.5
Blue					142.1	577.4	563.9	124.1
Black					71.4	2.5 or less	- - - - -	- - - - -
(100% Amplitude, 7.5% Setup)								
White					714.3	2.5 or less	- - - - -	- - - - -
Yellow					641.1	593.4	579.6	127.5
Cyan					516.1	834.6	195.4	811.4
Green					443.4	784.4	384.2	683.9
Magenta					324.5	784.4	384.2	683.9
Red					251.8	834.6	195.4	811.4
Blue					126.3	593.4	579.6	127.5
Black					53.6	2.5 or less	- - - - -	- - - - -
(100% Amplitude, 0% Setup)								
White					714.3	2.5 or less	- - - - -	- - - - -
Yellow					635.7	641.6	626.6	137.8
Cyan					500.0	902.3	211.2	877.2
Green					421.4	848.0	415.4	739.3
Magenta					292.9	848.0	415.4	739.3
Red					214.3	902.3	211.2	877.2
Blue					78.6	641.6	626.6	137.8
Black					0	2.5 or less	- - - - -	- - - - -

TABLE 1-3

COMP VIDEO

Characteristic	Performance Requirement	Supplemental Information
Outputs		Two
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	
Amplitude		1 volt into 75 ohms. (Refer to Reference Amplitudes)

[3] Return Loss measured with respect to 75 ohms.

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TABLE 1-3 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Line Blanking		11.1 µs[4].
Field Blanking		21 lines[4].
Front Porch Duration (See Fig. 1-2)	1.54 µs, ± 50 ns.	
Line Sync (See Fig. 1-2)		
Duration	4.71 µs, ± 50 ns.	
Rise and Fall time	115 ns, ± 10%.	
Breezeway (See Fig. 1-2)	750 ns, ± 50 ns.	
Burst Envelope (See Fig. 1-2)		
Duration	2.31 µs, ± 70 ns, 8 cycle minimum.	
Rise and Fall time	400 ns, ± 15%.	
Amplitude	286 mV within 3%.	

TABLE 1-4

PULSE OUTPUTS

Characteristic	Performance Requirement	Supplemental Information
COMP SYNC		
Outputs		Two
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Return Loss[3]	At least 30 dB to 5 MHz.	
Isolation	At least 40 dB.	
Rise and Fall time (See Fig. 1-3)	115 ns within 10%.	
Jitter		4 ns peak to peak or less.
Line Sync (See Fig. 1-3)		
Duration	4.71 µs within 50 ns.	
Period		63.56 µs[4].
Equalizing Pulse (See Fig. 1-3)		
Duration	2.33 µs within 50 ns.	
Sequence		3 lines[4].

[3] Return Loss measured with respect to 75 ohms.

[4] Digitally determined from 3.579545 MHz.

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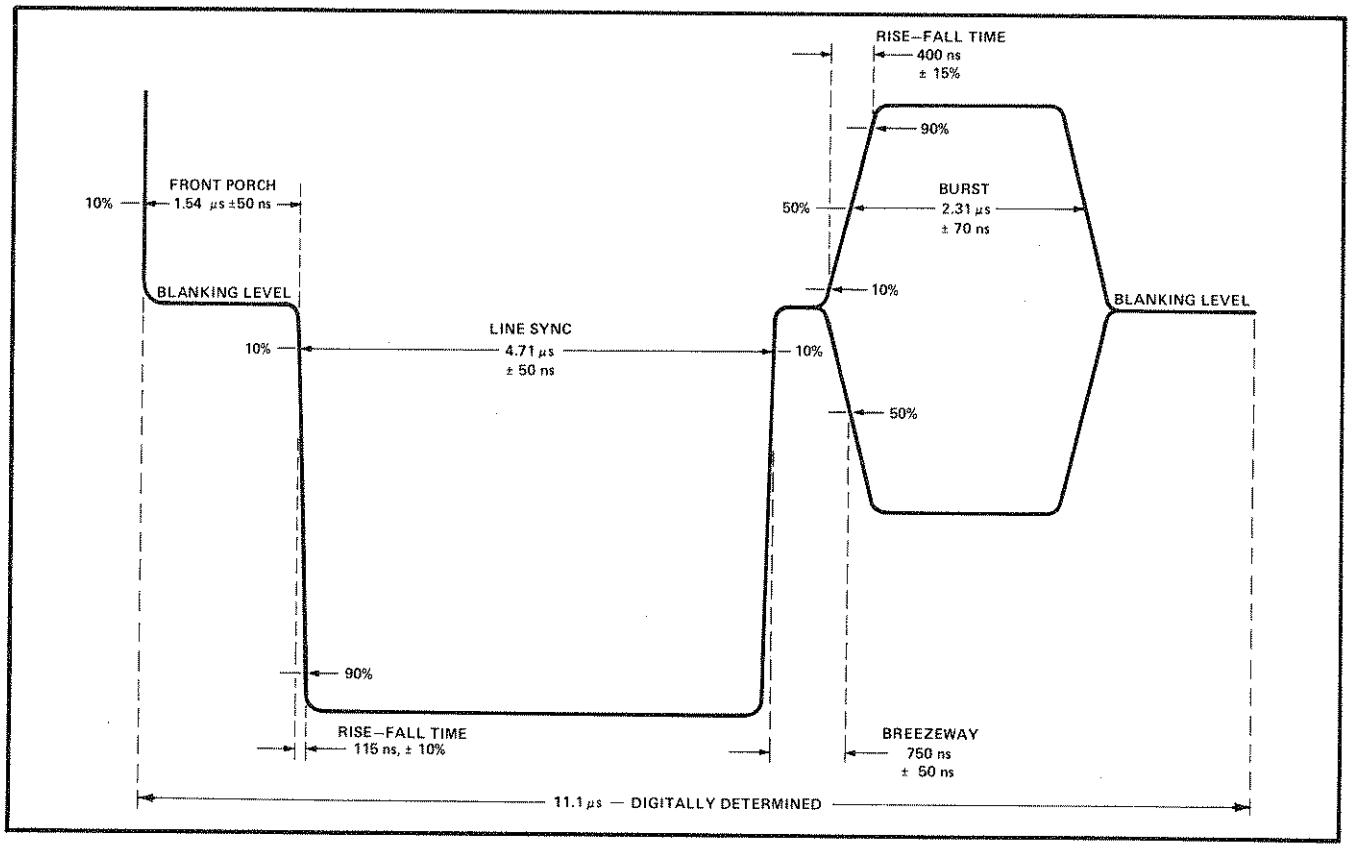

Fig. 1-2. Comp Video horizontal blanking details.

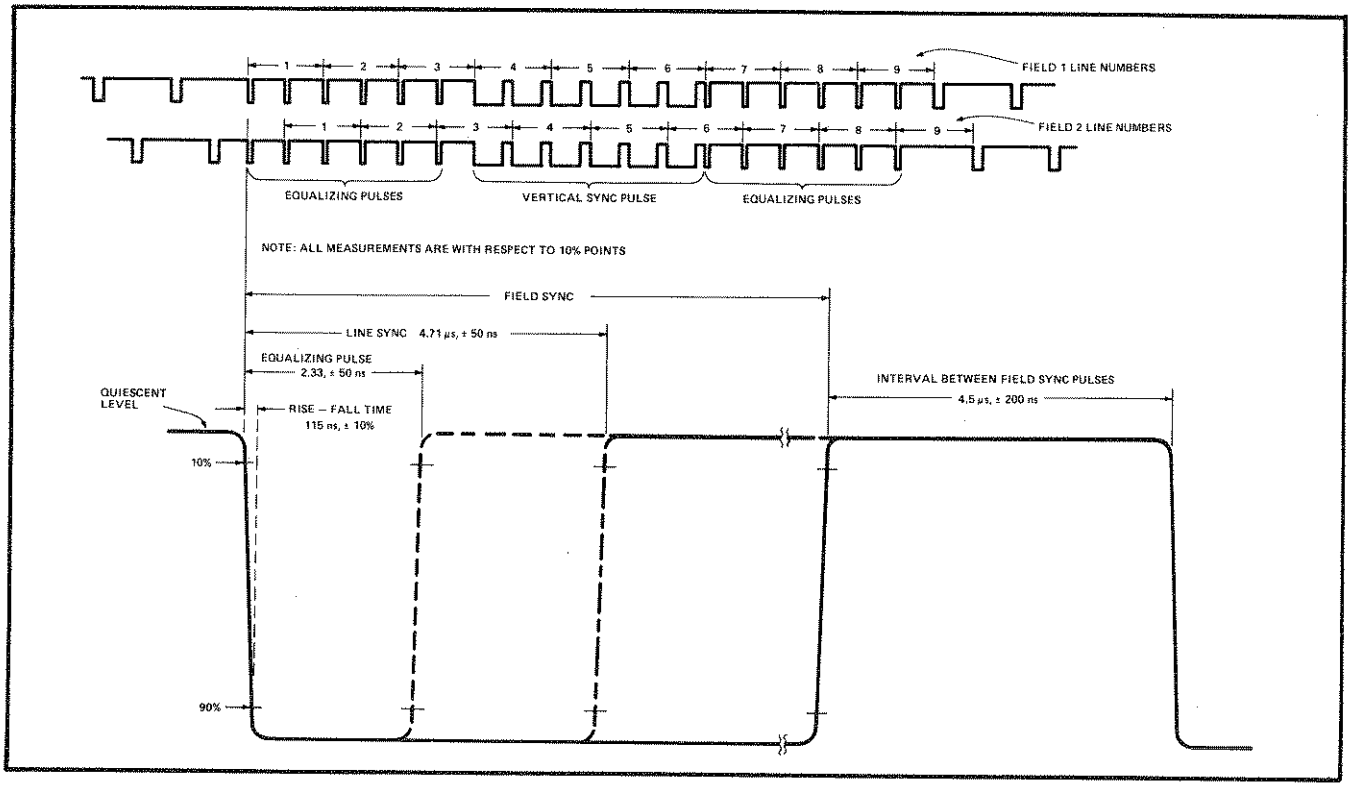

Fig. 1-3. Comp Sync blanking details.

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TABLE 1-4 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Field Sync (See Fig. 1-3)		
Sequence		3 lines[4].
Interval Between	4.5 µs within 200 ns.	
Period		262.5 lines[4].
SUBCARRIER		
Outputs		Two
Amplitude	2 volts, within 0.2 volt, into 75 ohms.	
Frequency	3.579545 MHz within 5 Hz.	
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	
Input (Loop-Thru)		
Amplitude	1 volt to 4 volt.	
Return Loss[3]	At least 46 dB.	
HORIZ DRIVE		
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Pulse Duration	6.35 µs within 5%.	
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	
VERT DRIVE		
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Pulse Duration		10.5 lines[4].
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	
COMP BLANKING		
Outputs		Two
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Duration		
Line		11.1 µs[4]
Field		21 lines[4]
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	

[3] Return Loss measured with respect to 75 ohms.

[4] Digitally determined from 3.579545 MHz.

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TABLE 1-4 (cont.)

Characteristic	Performance Requirement	Supplemental Information
BURST FLAG		
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Duration	2.43 µs within 100 ns.	Measured at 10% from quiescent.
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	

TABLE 1-5

COLOR GEN LOCK

Characteristic	Performance Requirement	Supplemental Information
GEN LOCK Input		
Amplitude	1 V, ± 6 dB.	(Minimum 0.5 V to 2 V maximum.)
Sync Source		Composite video or "black burst" sync negative.
Input Configuration		Loop-thru
Return Loss[3]	At least 46 dB to 5 MHz.	
Burst/Sync Ratio	Within 6 dB.	
GEN LOCK Performance (Subcarrier)		
Phase Error		Within 1° with input burst variation of ± 10 Hz from 3.579545 MHz, nominal burst level.
With Temperature Variation (OVEN TEMP NORMAL Lamp On)		Within 5°, with ambient temperature variation from 0°C to 50°C; within 1° for any 10° increment within this range.
With Input Signal Variation		Within 1° with input signal variation of 3 dB from 1.0 V. Within 3° with variation of burst/sync ratio of –6 dB to +10 dB.
Breezeway Stability (See Fig. 1-2 for location of Breezeway)		0.2° or less for burst timing errors including burst width variance, 8–11 cycles, and breezeway variance ± 0.28 µs.
Dynamic Burst Phase Stability		0.1° or less with APL variation from 10% to 90%.
Phase Error Due to Noise		Within 1° with RMS white noise 24 dB below 714 mV, picture signal peak to peak.
CHROMA PHASE Control		Greater than 360°.
Loss of Burst Lock		Loss of lock indicated by front-panel lamp. Internal subcarrier free runs at 3.579545 MHz within 5 Hz. Subcarrier is not locked (phase) to Sync if external Sync is present.

[3] Return Loss measured with respect to 75 ohms.

[4] Digitally determined from 3.579545 MHz.

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TABLE 1-5 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Loss of Sync		Loss of Sync indicated by front-panel lamp. Instrument returns instantly to internal color standard (burst loss indicator lamp also comes on).
GEN LOCK Performance (Sync)		
Delay Range	Adjustable so that output sync from 146 may be delayed from at least −3 μs to +1 μs.	Factory set to coincidence.
Delay Stability		Within 70 ns over the ambient temperature range of 0°C to 50°C.
Pull-In Time		200 ms (maximum).
Field/Frame Sync		Direct acting within 1 field. No time offset is provided.

TABLE 1-6

CONVERGENCE PATTERN

Characteristic	Performance Requirement	Supplemental Information
CONVERGENCE PATTERN		
Outputs		Two
Setup	7.5 IRE ± 1 IRE.	
Sync Amplitude	40 IRE, ± 2 IRE.	
Peak Level	77 IRE, ± 3 IRE.	
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	
Risetime	115 ns within 10%.	
Crosshatch Vertical Lines		
Repetition Rate		315 kHz.
POSITION Range	At least 3.2 μs.	
Pulse Polarity		Positive
Unblanked Pulses	16 or 17. (Depends on POSITION control.)	
Pulse Duration		
Crosshatch	225 ns within 15%.	
Dot	350 ns within 15%.	

[3] Return Loss measured with respect to 75 ohms.

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TABLE 1-6 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Crosshatch Horizontal Lines		
Repetition Rate		900 Hz.[4]
POSITION Range		At least 1.1 ms.
Pulse Polarity		Positive
Unblanked		13 to 14. (Depends on POSITION control.)
Pulse Duration		
Crosshatch		1 line at field rate.[4]
Dot		3 lines per frame.[4]
Displays Available	Crosshatch	Formed by "OR" gating of horizontal and vertical crosshatch lines.
	Vertical Lines Only.	
	Horizontal Lines Only.	
	Dots	Formed by "AND" gating of vertical and horizontal dot-forming lines.
	Crosshatch plus Dots.	Dots appear centered in rectangles formed by the crosshatch pattern.

TABLE 1-7

POWER SUPPLY

Characteristic		Performance Requirement	Supplemental Information
Line Voltage Range			
115 VAC	Low		90 V to 110 V.
	Medium		104 V to 126 V.
	High		112 V to 136 V.
230 VAC	Low		180 V to 220 V.
	Medium		208 V to 252 V.
	High		224 V to 272 V.
Crest Factor			At least 1.35.
Line Current			0.5 A (maximum).
Power			65 W (maximum).
Line Frequency Range			48 Hz to 66 Hz.

[4] Digitally determined from 3.579545 MHz.

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TABLE 1-8

PHYSICAL

Characteristic	Information	
Finish	Cabinet is blue-vinyl paint. Front panel is anodized aluminimum.	
Dimensions (Approximate)	Rackmount Version	Bench Version
Height	3 1/2 inches (overall)	3 1/2 inches (cabinet)
Width	19 inches (overall)	17 inches (cabinet)
Length	19 3/4 inches (overall)	19 inches (overall)
Length	18 1/2 inches (cabinet)	18 1/2 inches (cabinet)
Width	17 inches (cabinet) 17 1/2 inches (over sides)	18 inches (overall)
Height	- - - - - - - - - - - - - -	3 3/4 inches (overall)
Weight (Approximate)	18 1/2 pounds	17 3/4 pounds

ENVIRONMENTAL CHARACTERISTICS

The following environmental test limits apply when tested in accordance with the recommended test procedure. This instrument will meet the electrical performance requirements given in this section following an environmental test. Complete details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

TABLE 1-9

ENVIRONMENTAL

Characteristic	Information
Temperature	
Non-Operating Range	−40°C to +65°C.
Operating Range	0°C to +50°C.
Altitude	
Non-Operating Range	To 50,000 feet.
Operating Range	To 15,000 feet.

ACCESSORIES

Standard accessories supplied with this instrument can be found on the last page of the Mechanical Parts List illustrations. For additional accessories, see the current Tektronix, Inc. catalog.

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SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of this manual.

INSTALLATION

Rackmounting

Complete information for mounting the 146 in a rack is given in Section 7.

Operating Voltage

The 146 may be operated from either 115-VAC or 230-VAC (nominal) line voltage source. Quick-change line-voltage selector plugs, located under the fuse cover on the rear panel, change the transformer primary connections so the instrument will operate from one line voltage or the other (115 V or 230 V). In addition, the plugs permit one of three line voltage operating ranges to be selected. Table 2-1 lists the voltage ranges that enable the instrument DC power supplies to regulate properly.

To convert to a different line voltage, proceed as follows:

1. Disconnect the 146 from the power source.

TABLE 2-1

115/230 Voltage Selector Plug Position	Range Selector Plug Position	Nominal Line (center) Voltage	Line Voltage Plug Range[1]
115 V	LO (Low)	100 VAC	90 to 110 VAC
	M (Medium)	115 VAC	104 to 126 VAC
	HI (High)	124 VAC	112 to 136 VAC
230 V	LO (Low)	200 VAC	180 to 220 VAC
	M (Medium)	230 VAC	208 to 252 VAC
	HI (High)	248 VAC	224 to 272 VAC

[1] **Applicable when the line contains less than 2% total distortion.**

2. Unscrew the two captive screws holding the fuse cover. Remove the cover and attached fuses.

3. To convert to a different line voltage (115 V to 230 V), pull out the 115/230 Voltage Selector plug (see Fig. 2-1) then rotate the plug 180° and insert it into the opposite set of holes. The 115/230 Voltage Selector plug is located in the upper position for 115-V operation and in the lower position for 230-V operation.

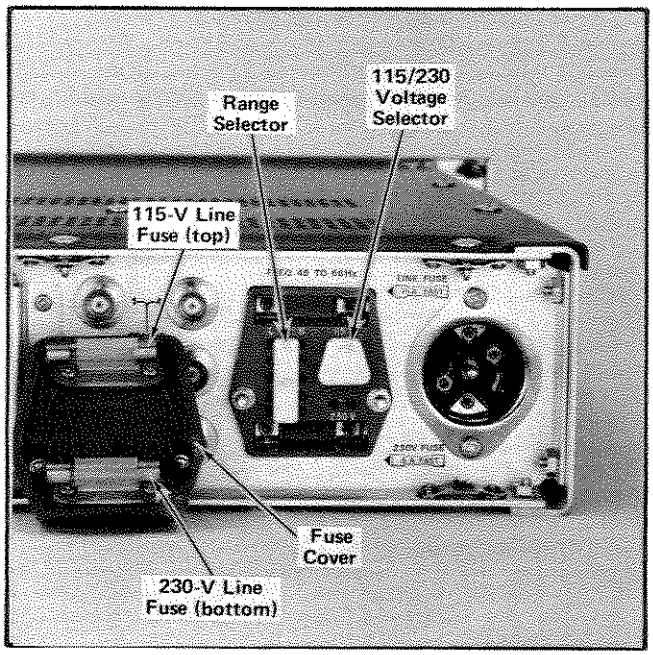

Fig. 2-1. Location of Range and Voltage Selector plugs with fuse cover removed. The plugs as shown are set for 115-V medium range operation.

4. To change the line-voltage operating range (LO, M or HI), pull out the Range Selector plug (see Fig. 2-1) and insert it in the desired hole locations. Select a range with a center voltage (see column 3 in Table 2-1) closely corresponding to the line voltage that will be applied in regular instrument operation.

5. Re-install the cover with two captive screws and fuses. Be sure the cover fits firmly against the rear panel. This indicates that the line fuses are seated properly in the fuse clips.

6. Before applying power to the instrument, check that the indicating tabs on the selector plugs protrude through the proper holes in the cover for the correct line voltage and the proper operating range.

CAUTION

The 146 should not be operated with the 115/230 Voltage Selector and/or Range Selector plugs in the wrong position for the line voltage applied.

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BASIC INFORMATION

Frequent check-out of color broadcast equipment is essential in providing realistic and accurate presentation of taped or live color scenes. In addition, rapid check-out of the signal monitoring instrument is highly desirable.

The 146 provides a high-quality composite video signal, complete with color components, suitable for checking calibration and operation of vectorscopes and TV waveform monitors.

The various components which comprise the composite color video signal can be added or removed from the composite signal by selecting appropriate positions of the front-panel controls of the 146. This permits the simulation of various broadcast equipment troubles, such as loss of sync signals, B—Y or R—Y components, etc.

The 146 also serves as an excellent teaching aid, since the composite video signal can be "built up", one component at a time. Also, both the familiar staircase and color bar test signals are available as part of the composite video signal.

Fig. 2-2 illustrates the 146 COLOR BARS FIELD DISPLAY signals that are available. These signals are useful for checking luminance, hue, and saturation levels.

Luminance, or brightness as perceived by the eye, is represented by the amplitudes of the step levels of the color bar signal between black and white levels. Since the eye is more sensitive to green, and less to blue light of equal energy, green is a bright color, blue is a dark color as conveyed by the luminance signal to monochrome TV receivers. The color bar steps are therefore arranged in descending luminance order starting with yellow, the brightest color, and ending with blue, the least bright color.

Chrominance consists of two additional quantities; hue and saturation. Hue is the attribute of color perception that determines whether the color is red, blue, green, or some other color. White, black and gray are not considered hues. In color TV systems, the hue is encoded as a phase angle of the signal with respect to a reference frequency (burst signal). See Fig. 2-3A.

Saturation is the degree to which a color (or hue) is diluted by white light. Percentage of saturation is used to distinguish between vivid and weak shades of the same hue. For example; vivid red is highly saturated while pink or pastel red has little saturation. One-hundred percent saturation represents full hue with no white dilution (see Fig. 2-3B). In a vector display, saturation is indicated by the length of the vector.

Fig. 2-4 illustrates the MOD STAIRCASE signals that are available. Each is modulated by the subcarrier (3.579545 MHz). The steps are equally spaced between black level and white level. Staircase signals are useful for checking the presence of non-linearity in video stages. Typical tests made with a modulated staircase are differential gain and differential phase.

Differential gain is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, presence of differential gain causes distortion of the saturation in areas between the light and dark portions of the screen.

Differential phase is phase modulation of the chrominance signal by the luminance signal. With differential phase present, color (hue) will vary with scene brightness in the reproduced color picture.

CONTROLS AND CONNECTORS

Introduction

The following describes the function or operation of the 146 controls and output connectors (see Fig. 2-5).

Front-Panel Controls and Selectors

COLOR BARS — Seven lever switches that select signal elements which make up the color bar test signals.

R—Y Switch: Up position turns on the R-Y (90°-270° axis) component of the color bar test signal, down position turns off the R—Y component.

B—Y Switch: Up position turns on the B—Y (0°-180° axis) component of colorbar test signal, down position turns off the B—Y component.

Y Switch: Up position turns on the luminance component of the color bar. Down position turns off the component.

AMPL Switch: Sets the amplitude of the color bar signal at 75% or 100% maximum amplitude.

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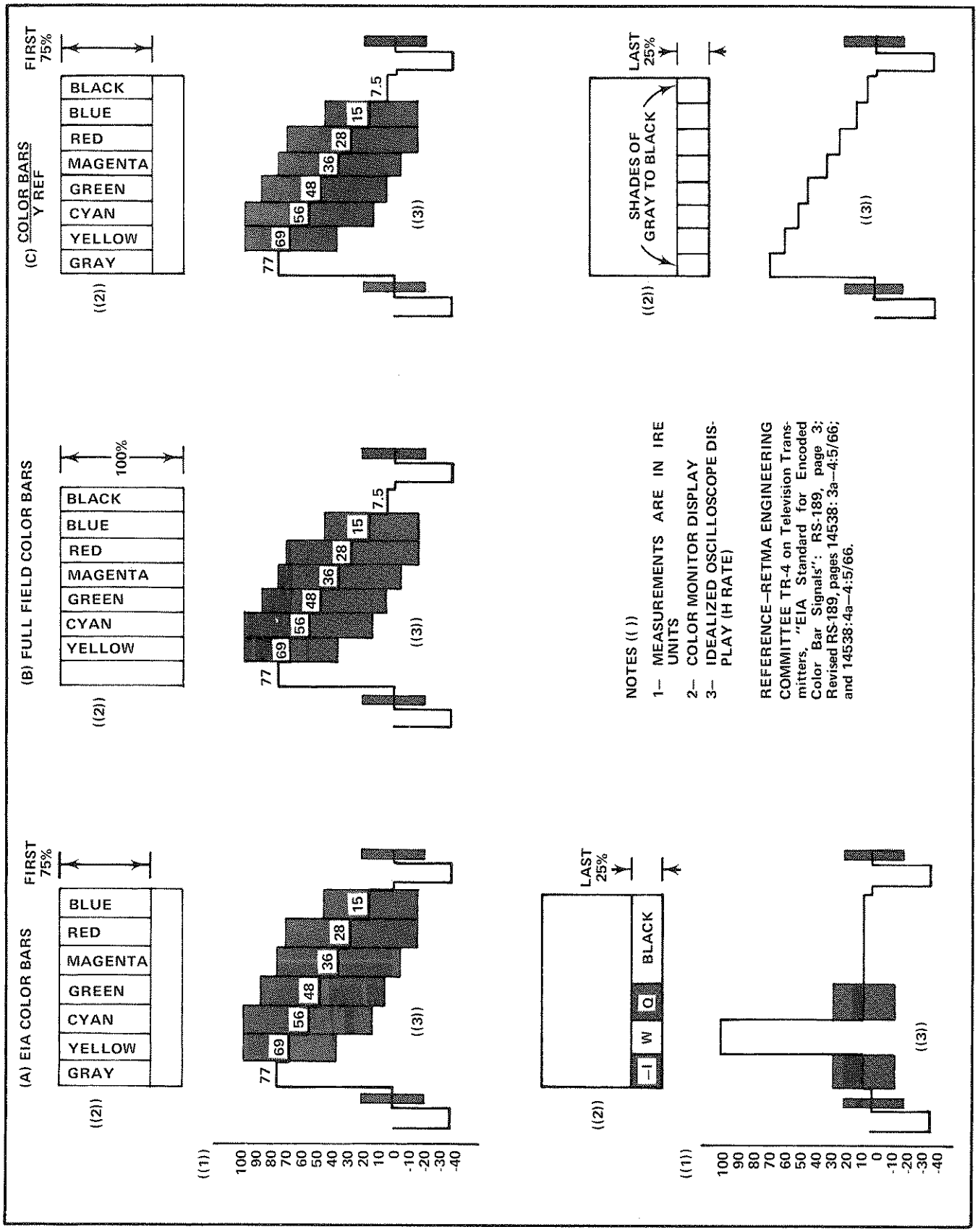

Fig. 2-2. Idealized illustrations with notes showing characteristics of the three COLOR BARS FIELD DISPLAY test signals.

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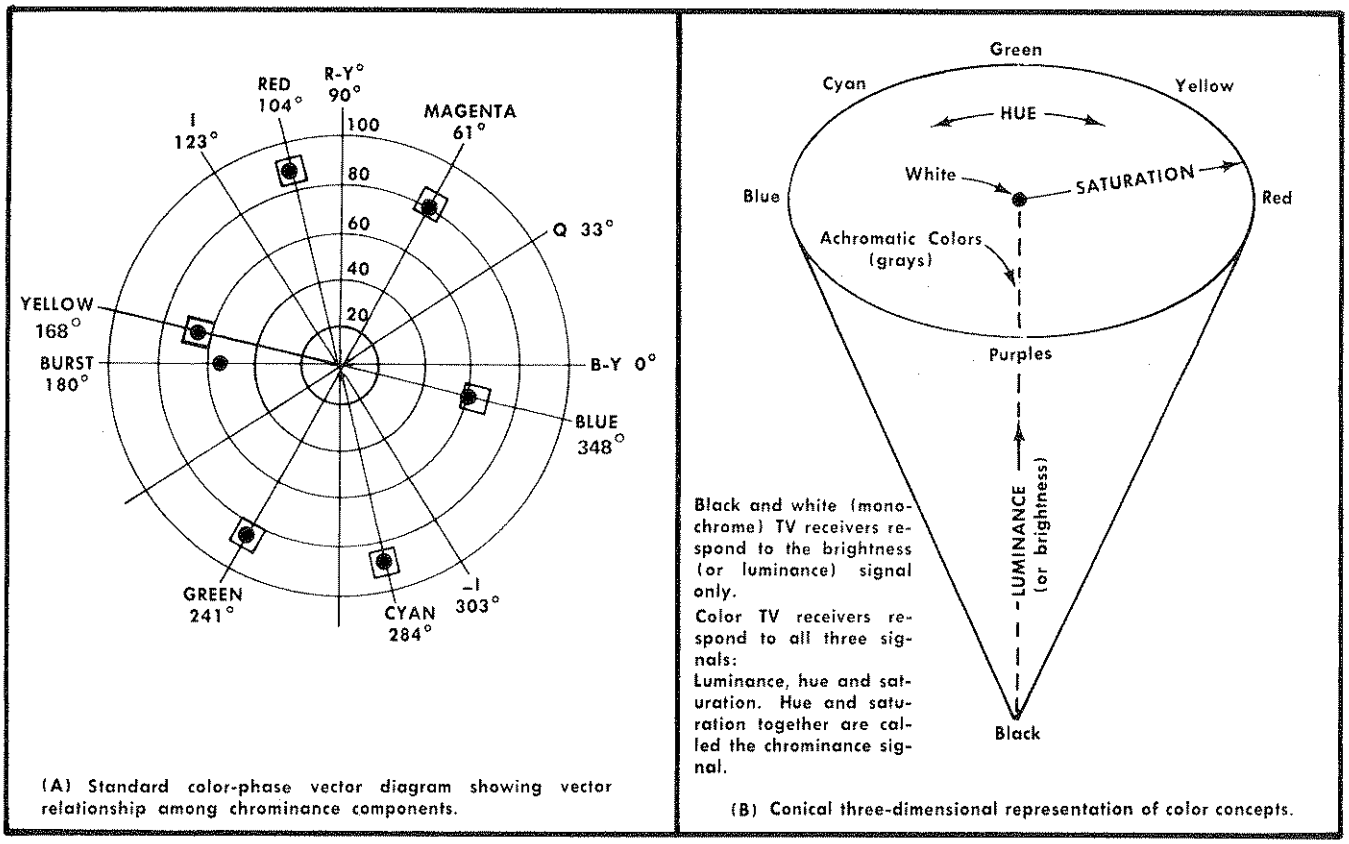
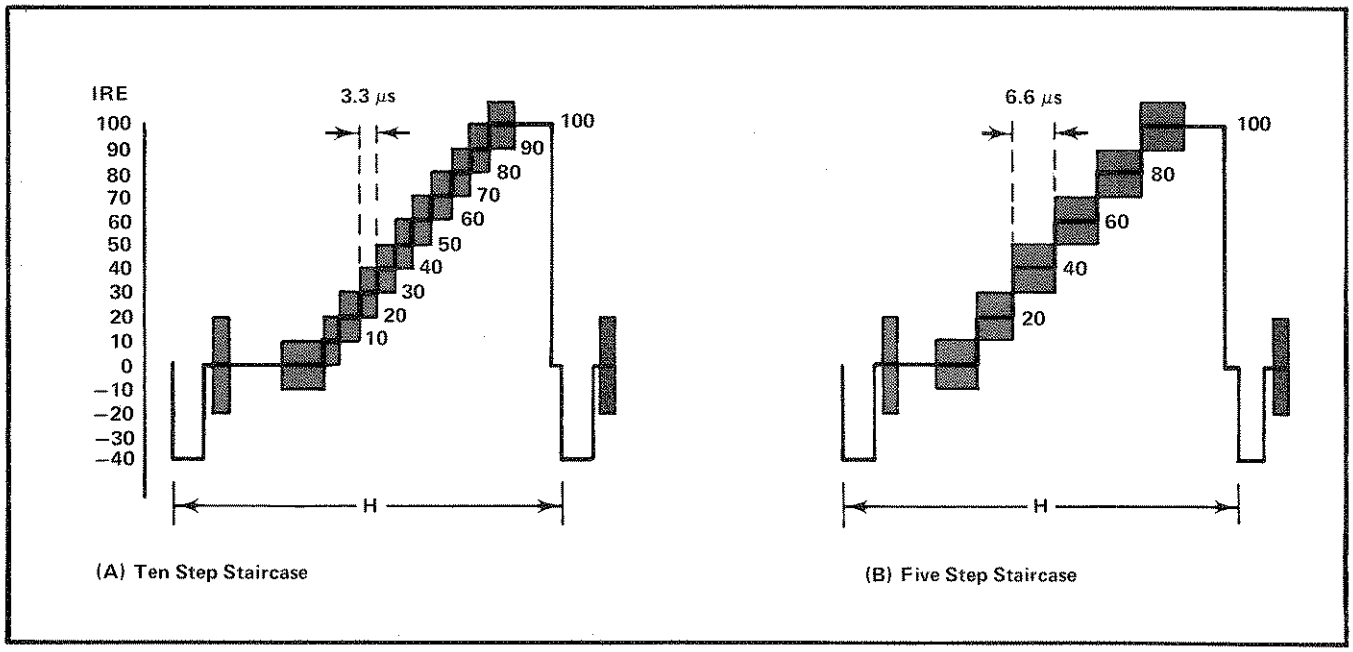


(A) Standard color-phase vector diagram showing vector relationship among chrominance components.

(B) Conical three-dimensional representation of color concepts.

Fig. 2-3. Illustrations showing the relationship between the basic color concepts and the standard color-phase vector diagram.



(A) Ten Step Staircase

(B) Five Step Staircase

Fig. 2-4. Idealized oscilloscope display showing characteristics of the 146 MOD STAIRCASE signal displays.

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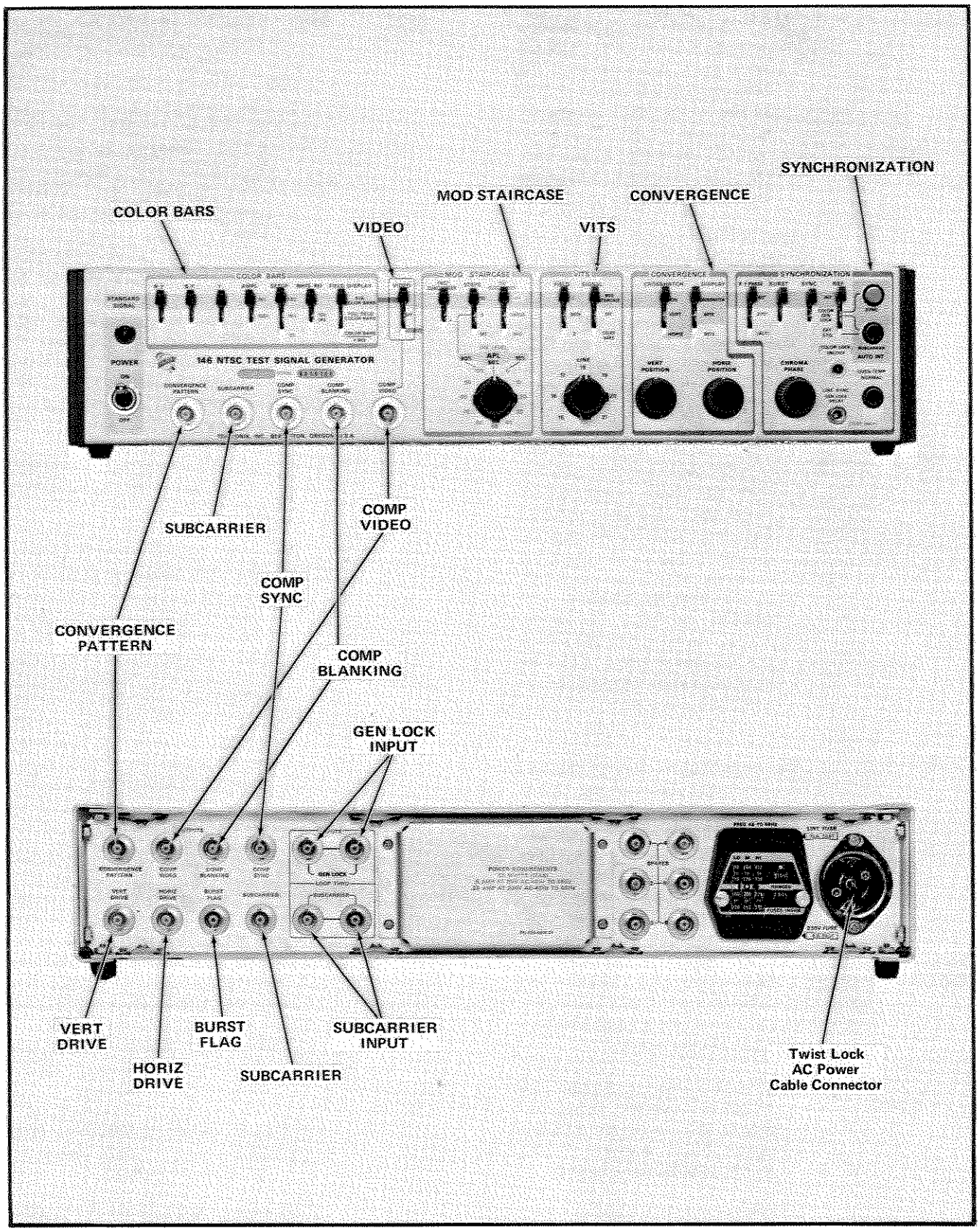

Fig. 2-5. Front- and rear-panel controls and connectors on the 146.

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COLOR BARS (cont)

SETUP Switch: The 7.5% position provides a setup of 7.5% of the 100% white reference level. The 10% position sets the black level at 10% of the 100% white reference level. The 0% position removes the setup. In this position (0%) the black level is the same as the blanking level.

WHITE REF Switch: Affects white bar of FULL FIELD COLOR BARS and COLOR BARS/Y REF only. Up position allows white bar amplitude to be selected by the AMPL and SET-UP switches. The 100 IRE position sets the white reference at 100% amplitude.

FIELD DISPLAY Switch: The EIA COLOR BAR position puts the split field display signal on both fields (see Fig. 2-2A). In FULL FIELD COLOR BARS position the entire display consists of the color bar signal (see Fig. 2-2B). In the COLOR BARS/Y REF position the upper 3/4 of the display contains the color bars and the lower 1/4 contains the luminance levels of the color bar signal (see Fig. 2-2C).

VIDEO

Up position of the selector provides a color bar signal at the COMP VIDEO connector. Center (OFF) position removes the video component from all the active video lines (Sync, Burst, and VITS remain). Down position of the selector provides a staircase signal at the COMP VIDEO connectors.

MOD STAIRCASE

Consists of three lever switches and a twelve-position rotary switch that select the individual components of the staircase test signal.

180° SUBCARRIER Switch: Up position applies subcarrier phased 180° to the staircase test signal. Down position of the switch removes the subcarrier.

STEPS Switch: Up position provides 10 step staircase at the COMP VIDEO output. Center position provides 5 step staircase. Down position removes the staircase.

90° SUBCARRIER Switch: The 90° subcarrier applies to 4 out of 5 lines when the APL/IRE LEVEL rotary switch is in the 0 to 100 positions or to every line when the 180° SUBCARRIER and STEPS switches are both down.

The OFF position provides no subcarrier. The UNMOD position provides a 30 mV, 90° subcarrier with no amplitude or phase modulation. The MOD position provides a 30 mV, 90° subcarrier for the first and last 13.2 μs of each active line, a 305 mV, 90° subcarrier for the second 13.2 μs, and a 610 mV, 90° subcarrier for the third 13.2 μs.

APL/IRE LEVEL Rotary Switch: The 50% position provides a staircase signal on each active video line. The 0 to 100 positions provide a staircase signal to one out of every five active video lines and a selectable luminance level on the remaining four. The 90° subcarrier can be applied to four of five lines (with both the 180° SUBCARRIER and STEPS switches down, the APL is applied to every line including VITS STAIRCASE).

VITS

Two three-position lever switches and a seven-position rotary switch that select the line and field to which the vertical interval test signal is applied. Either color bar, APL, or staircase signal is available.

LINE Rotary Switch: Selects any line from line 15 through line 21 to which VITS is applied.

FIELD Switch: Selects field one, field two, or both fields to which the VITS is applied.

SIGNAL Switch: MOD STAIRCASE position provides a VITS consisting of either a 10 step (11

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VITS (cont)

level) or a five step (six level) modulated staircase which can be modified by the settings of the 180° SUBCARRIER and STEPS lever switches. When the 180° SUBCARRIER and the STEPS switches are down, an APL signal is applied to the VITS, the VITS can be modified with the 90° SUBCARRIER switch and APL/IRE LEVEL rotary switch.

The OFF position removes the VITS. The COLOR BAR position provides VITS consisting of a standard NTSC color bar signal which can be modified by the COLOR BARS lever switches (except the FIELD DISPLAY switch).

CONVERGENCE

Two lever switches and two potentiometers that control and position the display. The convergence signal is available at the CONVERGENCE PATTERN connectors.

CROSSHATCH Switch: ON position provides a crosshatch display. (DISPLAY switch must be in CROSSHATCH or BOTH positions.) VERT position provides vertical white bars only. HORIZ position provides horizontal white bars only.

DISPLAY Switch: The CROSSHATCH position provides a crosshatch display which can be modified by the CROSSHATCH switch selections. The BOTH position provides white dots centered in the rectangles formed by crosshatch. The DOT position provides white dots only.

VERT POSITION Control: Positions the display vertically.

HORIZ POSITION Control: Positions the display horizontally.

SYNCHRONIZATION

Consists of four lever switches, a goniometer to control synchronization of signals, screwdriver adjustment for internal-external timing, and a pushbutton switch to free run the generator.

R–Y PHASE Switch: 90° position, R–Y axis is locked to 90°. (Normal NTSC operation). 270° position, R–Y axis is locked to 270°. (For tests only). ALT position, R–Y axis alternates between 90° and 270° at H rate. (For testing quadrature phasing only).

BURST Switch: Applies (up position) or removes (down position) burst to COMP VIDEO outputs.

SYNC Switch: Applies or removes horizontal and vertical sync pulses to composite video output.

REF Switch: Up position (INT) selects internal sync generator and color standard. The center position (COLOR GEN LOCK) selects externally applied composite video or "Black Burst" to synchronize all signals. The down position (EXT STD) selects an externally applied color standard for the color standard.

(COLOR LOCK UNLOCK) Switch: Momentary type pushbutton switch, that produces loss of locking of horizontal sync to color subcarrier, when depressed, for test purposes.

CHROMA PHASE Control: Goniometer that varies burst phase of composite video output 360° in relation to subcarrier (either internal or external).

LINE SYNC GEN LOCK DELAY Control: Screwdriver adjustment to allow timing between 146 and external timing source.

POWER

Switches power ON and OFF.

Light: Indicates when POWER switch is on and the instrument is connected to a line voltage source.

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OVEN TEMP NORMAL LIGHT — Indicates when lighted, that the Master Oscillator crystal oven is at normal operating temperature.

AUTO INT SYNC LIGHT — An amber light that indicates when lit that external Sync is absent and Sync is generated by the internal Generator.

NOTE

Burst loss light also lights. See Operating Options, this section, for exceptions.

AUTO INT SUB-CARRIER LIGHT — A red light that indicates, when lit, that external subcarrier standard has been lost.

NOTE

See Operating Options, this section, for exceptions.

Output Connectors

All output signals are via BNC type connectors and have a 75 ohm source impedance. For proper operation, each output, when in use must drive a 75 ohm load.

CONVERGENCE PATTERN (Front and rear panel) — Provides a 835.5 mV P-P composite video signal, consisting of composite sync and convergence pattern signals as selected by front-panel controls.

SUBCARRIER (Front and rear panel) — Provides a 2 V P-P sine wave output at subcarrier frequency (3.579545 MHz).

COMP SYNC (Front and rear panel) — Provides a 4 V negative-going composite sync pulse per EIA specifications.

COMP BLANKING (Front and rear panel) — Provides a 4 V negative-going composite blanking pulse per EIA specifications.

COMP VIDEO (Front and rear panel) — Provides 1 V P-P composite video signal consisting of composite sync and video test signals as selected by front-panel controls (except CONVERGENCE controls).

BURST FLAG (Rear panel) — Provides 4 V negative-going pulses with leading edge 400 ns prior to burst. (Measured at 10% from quiescent on flag to 50% point on burst envelope.)

HORIZ DRIVE (Rear panel) — Provides a 4 V negative-going pulse. Its leading edge is coincident with the start of line blanking.

VERT DRIVE (Rear panel) — Provides a 4 V negative-going pulse. Its leading edge is coincident with the start of vertical blanking.

Input Connectors

All input signals are via BNC type connectors and are Loop-Thru. For proper operation each input, when in use, must be terminated into 75 ohms.

SUBCARRIER (Rear panel) — Accepts a 3.579545 MHz signal, 1 to 4 volts in amplitude.

GEN-LOCK (Rear panel) — Accepts composite video or "Black Burst" 0.5 volt to 2 volts in amplitude.

FIRST-TIME OPERATION

The following procedure demonstrates the use of the controls and connectors in the 146. Operation with three different display instruments is outlined for the convenience of the user. It is assumed that a video waveform monitor is available. A Vectorscope is essential if phase characteristics of the composite video output are to be observed. An oscilloscope is useful for observing sync, drive, and other output signals. It may be used to display all outputs except for phase characteristics.

To provide external composite video and color standard signals, a generator meeting all the input specifications of the 146 must be used.

Procedure 1

A Type R529 Waveform Monitor is used to display the following:

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1. Check the position of the line voltage selector plugs. (See Installation, this section.) Connect the 146 to the power source and turn on the POWER switch.

2. From the 146 COMP VIDEO connector, connect a 75 ohm coaxial cable to the Type R529 Video Input A connector. Connect a 75 ohm end-line termination to the other A Input connector.

3. While the instrument is warming up (OVEN TEMP NORMAL Light on when ready), set the front-panel controls as follows:

146

Set all switches to the STANDARD SIGNAL POSITION (all up).

Type R529

Vertical:	
Input	A
DC Restorer	On
Response	Flat
Volts Full Scale	1.0 (calib)
Position	Centered
Calibrator	Full Scale
Focus	Sharp Trace
Intensity	As desired
Scale Illum	Fully CW
Horizontal:	
Position	Centered
Display	2 line
Mag	X1
Line Selector	18
Field	One
Sync	Int

4. The display should consist of two lines of composite video, each containing the EIA Color Bar test signal similar to that shown in Fig. 2-2A.

5. With the Type R529 Vertical Position control, set the blanking level on the 0 IRE graticule line. The sync tips should be at −40 IRE, the white level should be at 77 IRE, the white level of the −I, W, Q, B signal should be at 100 IRE, and the black level of the −I, W, Q, B signal should be at the 7.5 IRE level.

6. Set the COLOR BARS R−Y and B−Y switches down. Note the display now shows only the luminance component of the color bar signal (the luminance levels should correspond to these given in Fig. 2-2A) and the entire −I, W, Q, B signal. Return the R−Y and B−Y switches to the up position.

7. Set the COLOR BARS Y switch down. Note: the display now consists of the complete −I, W, Q, B signal but only the chrominance portion of the color bar signal is present. Return the Y switch to the up position.

8. Set the COLOR BARS AMPL switch to 100%. Note the change in amplitude of the color bar white reference and chrominance amplitudes. Also, note there is no change in the −I, W, Q, B signal. Return the AMPL switch to 75%.

9. Set the COLOR BARS SETUP switch to 10%. Note: the entire composite video signal has shifted upward. The black level of the −I, W, Q, B signal should be at 10 IRE. Now, set the SETUP switch to 0%. Note: the entire composite video signal has shifted down. The black level of the −I, W, Q, B signal should be at 0 IRE. Return the SETUP switch to 7.5%.

10. Set the COLOR BARS WHITE REF switch to 100 IRE. Note the display does not change. Return the WHITE REF switch to the up position.

11. Set the COLOR BARS FIELD DISPLAY switch to FULL FIELD COLOR BARS. Note: the display now contains a composite video signal without the −I, W, Q, B signal. Also, note that the width of the chrominance bars have decreased. This signal should be similar to that shown in Fig. 2-2B.

12. Set the COLOR BARS WHITE REF switch to 100 IRE. Note the white pulse is now at 100 IRE. Return the WHITE REF switch to the up position.

NOTE

The COLOR BARS R−Y, B−Y, Y, AMPL, and SET-UP switches operate in a manner identical to their operation with EIA COLOR BARS.

13. Set the COLOR BARS FIELD DISPLAY switch to COLOR BARS/Y REF. Note: the display now contains a composite video signal without the −I, W, Q, B signal but has a luminance display. This signal should be similar to that shown in Fig. 2-2C. Return the FIELD DISPLAY switch to EIA COLOR BARS.

14. Set the Type R529 Display switch to 2 Field. Note: the field is split to include a color bar signal for the first

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11.5 ms and a —I, W, Q, B signal for the next 3.8 ms. Set the 146 COLOR BARS FIELD DISPLAY switch to FULL FIELD COLOR BARS and note that the entire field is color bars. Set the FIELD DISPLAY switch to COLOR BARS/Y REF and note that the field is split to include a color bar signal for the first 11.5 ms and a color bar luminance signal for the next 3.8 ms. Return the FIELD DISPLAY switch to FULL FIELD COLOR BARS position, and the Type R529 Display switch to 2 line.

15. Set the 146 VIDEO switch to OFF. The display should consist of only sync and burst ("Black Burst"). Set the VIDEO switch to the down position. The signal can now be altered with the controls in the MOD STAIRCASE section. The display should consist of a modulated staircase signal similar to that shown in Fig. 2-4A.

16. Set the MOD STAIRCASE 180° SUBCARRIER switch to the down position. Notice that the modulation on each of the steps has been removed, leaving only a luminance level for each step. Return the 180° SUBCARRIER switch to the up position.

17. Set the STEPS switch to 5. This display should consist of a modulated staircase signal similar to Fig. 2-4B. Set the STEPS switch to OFF. This removes the steps leaving only the modulation. The modulation may be removed with the 180° SUBCARRIER switch.

18. Set the MOD STAIRCASE 180° SUBCARRIER switch to its down position, 90° SUBCARRIER switch to UNMOD and the APL/IRE LEVEL switch to 0. Note the APL offset chroma on each line.

19. Set the 90° SUBCARRIER switch to MOD. This applies modulation to the APL offset chroma. The APL level may be changed from 0 to 100 with the APL/IRE LEVEL switch. Return the APL/IRE LEVEL switch to 0.

20. Set the Type R529 Display switch to 2 Field and the Mag switch to X25. Set the 146 MOD STAIRCASE STEPS switch to 5 and note that a staircase signal now appears on one out of every five lines in the active video region including VITS. Modulation can be applied to the steps with the 180° SUBCARRIER switch (see Fig. 2-6). Return the 180° and 90° SUBCARRIER switches to the Standard Signal position and the APL/IRE LEVEL switch to 50%.

21. Adjust the Type R529 Horizontal Position control to display the field blanking interval. Set the 146 VIDEO switch to the up position and note the VITS staircase signal on line 18 (see Fig. 2-7). The VITS signal may be put on

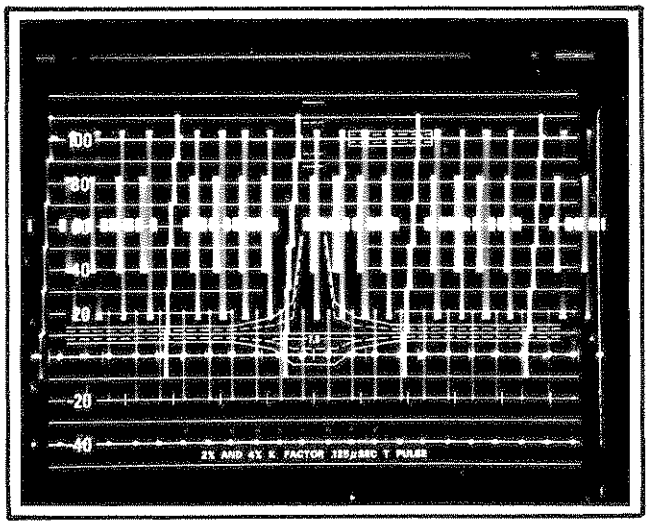

Fig. 2-6. Modulated 60 IRE level with modulated steps.

different lines with the VITS LINE selector. The staircase may be changed to an APL signal by changing the 180° SUBCARRIER and STEPS switches to the down position and rotating the APL/IRE LEVEL switch (modulation can be applied with the 90° SUBCARRIER switch) or to a color bar signal with the VITS SIGNAL switch. The signal may be removed completely with the same switch by placing it in the OFF position.

22. Set the Type R529 Mag switch to X1. Switch the VITS FIELD selector from 1 to BOTH and change the VITS SIGNAL selector to MOD STAIRCASE. Note the VITS staircase appears on both fields. Now change the VITS FIELD switch from BOTH to 2 and note that the staircase appears on only field 2.

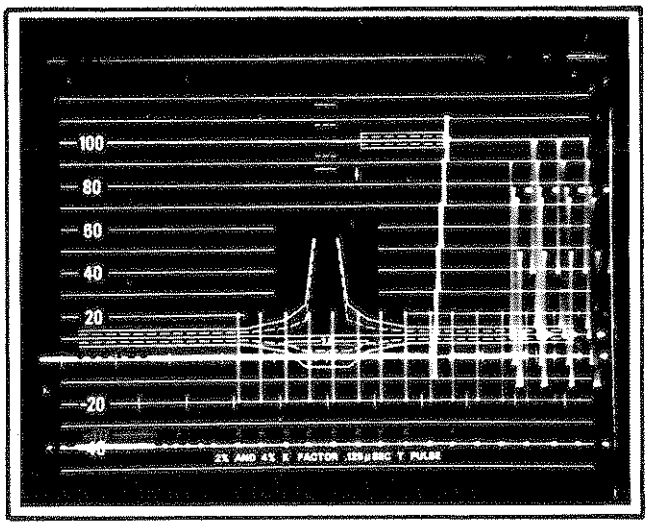

Fig. 2-7. Field blanking interval showing the VITS on line 18.

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23. Set the Type R529 Display selector to 2 Line and the DC Restorer switch to Off. Set the 146 SYNCHRONIZATION BURST switch to the down position and note that burst is removed from the composite video signal. Return the BURST switch to the up position.

24. Set the SYNCHRONIZATION SYNC switch to the down position and note that the sync has been removed from the display. Return the SYNC switch to the up position.

25. Observing the 146 front-panel, set the REF switch to COLOR GEN LOCK. Note both the amber (sync loss indicator) and red (subcarrier loss indicator) lights are on, and the display consists of Comp Sync only.

26. Set the REF switch to EXT STD. Note: only the red indicator is on and the display consists of Comp Sync and Luminance only. Return the REF switch to the INT position.

Procedure 2

A Type 547 Oscilloscope with a Type 1A1 Plug-In Unit is used as a display device for the following procedure. The oscilloscope must have a bandwidth from DC to approximately 5 MHz. An oscilloscope with a bandwidth of DC to 15 MHz or greater and a deflection factor of 0.1 V/Cm or better is recommended.

1. From the external signal source (A Type 140 was used for this procedure), connect composite video via a 75 ohm coaxial cable to the 146 rear-panel GEN LOCK Loop-Thru Input connector. Terminate the unused connector with a 75 ohm end-line termination. Connect subcarrier via a 75 ohm coaxial cable to the 146 rear-panel SUBCARRIER Loop-Thru Input connector. Terminate the unused connector with a 75 ohm end-line termination.

2. From the 146 COMP VIDEO connector, connect a 75 ohm coaxial cable and a 75 ohm termination to the Channel 1 Input connector of the Type 1A1. From the 146 rear-panel HORIZ DRIVE connector, connect a 75 ohm coaxial cable to the test oscilloscope Time Base A Trigger Input connector.

3. Set the 146 front-panel switches to the STANDARD SIGNAL position.

4. Set the test oscilloscope for minus external DC triggering at a sweep rate of 10 μs. Set the Type 1A1 for DC coupling at .2 V/Cm.

5. Perform steps 4 through 13 of Procedure 1.

NOTE

The displays obtained will be the same as those obtained with the Type R529, except there is no IRE scale on the graticule and the display will consist of approximately 1.5 TV lines.

6. Change the 75 ohm coaxial cable on the 146 rear-panel HORIZ DRIVE connector to the VERT DRIVE connector. Change the test oscilloscope Time/Cm to 5 ms, then do step 14 of procedure 1.

7. Change the 75 ohm coaxial cable on the 146 VERT DRIVE connector to the HORIZ DRIVE connector. Change the test oscilloscope Time/Cm to 10 μs, then do steps 15 thru 19 of procedure 1.

8. Set the 146 MOD STAIRCASE STEPS and 180° SUBCARRIER switches to the up positions. Change the test oscilloscope for internal triggering and the Time/Cm to .1 ms. Adjust the Trigger Level control to obtain a stable display. The display should now show one line out of every five with staircase signal and the other four with modulated 90° subcarrier.

9. Change the cable from the 146 rear-panel HORIZ DRIVE connector to the VERT DRIVE connector, then change the test oscilloscope for external triggering and the Time/Cm to .2 ms. The display should now show the vertical blanking interval. Set the 146 VIDEO switch to the up position. Note the VITS staircase on one of the lines. Rotate the VITS LINE selector on the 146 and note that the VITS signal appears on different lines as the selector is rotated.

10. Set the STEPS and 180° SUBCARRIER switches down. Rotate the APL/IRE LEVEL switch. Note the change in the IRE level of the VITS signal. Modulation can be added to the IRE level with the 90° SUBCARRIER switch. Set the VITS SIGNAL switch to OFF. Note that the VITS staircase has been removed. Set the SIGNAL switch to COLOR BAR. Note: the VITS signal is now a color bar.

11. Change the cable from the 146 COMP VIDEO connector to the CONVERGENCE PATTERN connector. Set the CONVERGENCE CROSSHATCH switch to HORIZ. Set the test oscilloscope Time/Cm to 2 ms with X5 magnification. Note the single line out of every 17 with a white luminance level (see Fig. 2-8A). Its position can be changed with the VERT POSITION control on the 146. These

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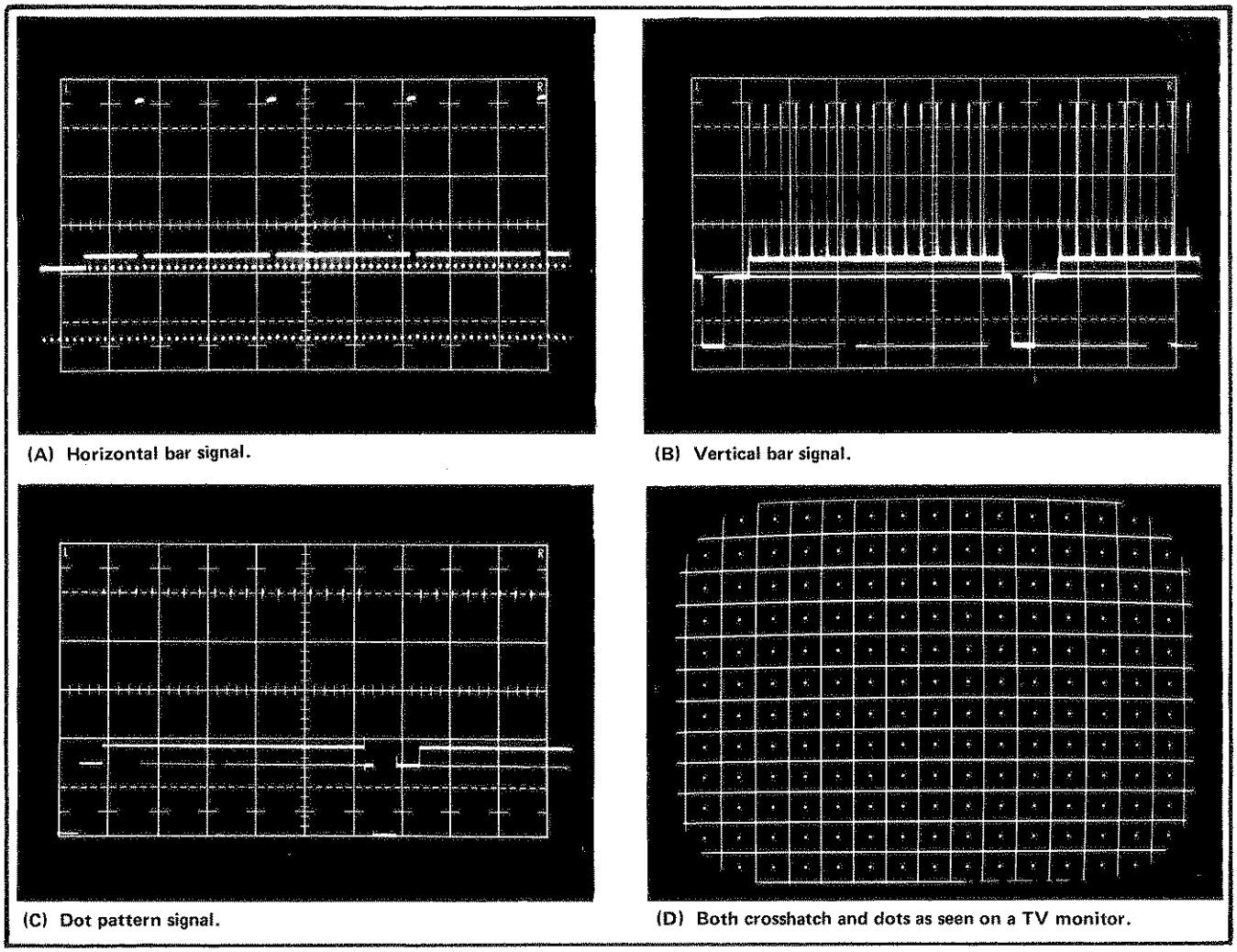

(A) Horizontal bar signal.

(B) Vertical bar signal.

(C) Dot pattern signal.

(D) Both crosshatch and dots as seen on a TV monitor.

Fig. 2-8. Convergence pattern outputs.

pulses correspond to the horizontal bars as seen on a monitor (see Fig. 2-8D.

12. Set the test oscilloscope Time/Cm to 10 μs with no magnification and internal triggering. Set the 146 CROSS-HATCH switch to VERT. The display should consist of a composite sync and blanking signal with 16 or 17 positive-going pulses along the line (see Fig. 2-8B). These pulses correspond to the vertical bars on a monitor (see Fig. 2-8D).

13. Set the 146 CONVERGENCE DISPLAY switch to DOTS. The display should be similar to that seen in the previous step, but should have dim positive-going pulses (see Fig. 2-8C). These correspond to the dots on a monitor (see Fig. 2-8D).

14. Set the 146 CONVERGENCE DISPLAY switch to BOTH. The display should consist of both vertical bars and dots. The dot pulses should be between each pair of the vertical bar pulses.

15. Change the cable from the 146 CONVERGENCE PATTERN connector to the COMP BLANKING connector. Set the Type 1A1 Volts/Cm to 1 V and the test oscilloscope Time/Cm to 50 μs. The display should be a series of negative-going pulses with an amplitude of 4 volts peak to peak. Pulse interval is 63.5 μs and pulse duration is approximately 12 μs.

16. Set the test oscilloscope Time/Cm to 5 ms with external triggering. The display should now be the composite blanking signal.

17. Change the cable from the COMP BLANKING connector to the COMP SYNC connector. The display should now be the composite sync signal.

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18. Set the test oscilloscope Time/Cm to 50 μs with internal triggering. The display should be a series of negative going-pulses with an amplitude of 4 volts peak to peak. Pulse interval is 63.5 μs and pulse duration is approximately 4.7 μs.

19. Change the cable from the COMP SYNC connector to the SUBCARRIER connector. Set the test oscilloscope Time/Cm to .2 μs. The display should consist of a sine wave, at the subcarrier frequency of 3.579545 MHz, with an amplitude of 2 volts peak to peak.

20. Change the cable from the SUBCARRIER connector to the rear-panel BURST FLAG connector. Set the test oscilloscope Time/Cm to 10 μs. The display should consist of 4 volt negative going pulses.

21. Change the cable from the rear-panel BURST FLAG connector to the HORIZ DRIVE connector. The display should consist of 4 volt negative-going pulses. They are coincident with the horizontal blanking interval.

22. Remove the cable from the rear-panel VERT DRIVE connector. Change the cable from the HORIZ DRIVE connector to the VERT DRIVE connector. Set the test oscilloscope Time/Cm to 10 ms. The display should consist of negative-going pulses with an amplitude of 4 volts peak to peak. They are coincident with the vertical blanking interval.

23. Disconnect the cable from the VERT DRIVE connector and connect it to the COMP VIDEO connector. Reconnect the cable from the test oscilloscope Trigger Input connector to the HORIZ DRIVE connector. Set the test oscilloscope Time/Cm to 10 μs with external triggering. Set the 146 VIDEO switch to OFF and the STEPS switch to OFF. The display should consist of sync and burst only.

24. Set the 146 REF switch to COLOR GEN LOCK. Note that both the amber and red lights are off, which indicates GEN LOCK.

25. Disable Burst of the external composite video signal. (Set the Type 140 Burst switch down.) Note: the 146 red light (loss of subcarrier) comes on and the test oscilloscope display consists of sync and luminance only. Return the "Burst" component of the external signal.

26. Disable the sync of the external composite video signal. (Set the Type 140 Sync switch down.) Note the 146 amber (loss of sync) and the red (loss of subcarrier) indicators light up. Note the display consists of sync only. (With these conditions, the 146 internal generator is providing the sync.) Return the sync to the external composite video signal.

27. Set the 146 REF switch to EXT STD. Note the red light is off, which indicates that the external standard is providing the subcarrier.

28. Disable the external signal standard. (Set the Type 140 Ref switch to Ext.) Note the red indicator light comes on and the display consists of sync and luminance only, which indicates that external standard has been lost. Return the external standard.

29. Set the 146 REF switch to COLOR GEN LOCK. Set the test oscilloscope for X10 magnification and adjust the Horizontal Position control to display the burst portion of the signal. Press the 146 (COLOR LOCK UNLOCK) switch. Note the subcarrier (burst) now free runs. Release the switch.

30. From the external signal source, connect composite video via a 75 ohm coaxial cable and a 75 ohm termination to the Type 1A1 Channel 2 Input connector. Set the external signal for sync and burst only. Set the Type 1A1 Mode switch to Alt and the Channel 2 Volts/Cm switch to the same setting as the Channel 1. Using the Type 1A5 Position and Variable (Volts/Cm) for 1 channel, overlay the two displays.

31. Using a small screwdriver, adjust the 146 LINE SYNC GEN LOCK DELAY control (a front-panel adjustment). Note the 146 signal can be made to lead or lag the external signal. Adjust the control for coincidence on the leading edge of sync.

Procedure 3

A Type R520 NTSC Vectorscope is used as a display device for the following. The Vectorscope provides a means of displaying phase characteristics as well as amplitude information, permitting graphic analysis of hue and saturation in the composite video signal. R, G, B, Y, I, and Q components can also be displayed on the line sweep graticule of the Type R520 NTSC. See the Type R520 instruction manual operating instructions for measurement details.

Differential phase and gain measurements can be made using the Modulated Staircase test signal. The procedure is described in the Type R520 NTSC instruction manual.

1. Connect the COMP VIDEO output on the 146 to the Ch A input on the Type R520 NTSC through a 75 Ω

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coaxial cable. Connect a 75 Ω terminating resistor to the unused connector.

2. Set the 146 controls as directed in Step 3 of Procedure 1 except, the COLOR BARS FIELD DISPLAY. Set this selector to FULL FIELD COLOR BARS.

3. Set the Type R520 NTSC controls as follows:

TYPE R520 NTSC

Signal Selector	Full Field, AΦ, Ch A
CH A 100%-75%-Max Gain	75%
Ch A Gain	Cal
A Phase	As is
Ch B 100%-75%-Max Gain	75%
Ch B Gain	Cal
B Phase	As is
Ref	Burst
Function Selector	Vector
Luminance Gain	Cal
Calibrated Phase	0°
Intensity	As desired
Focus	Well defined display
Scale Illum	As desired
Field	1
Sync	Int
Vert Position	Midrange
Horiz Position	Midrange

4. The display should be a vector presentation of the chrominance portion of the color bar test signal.

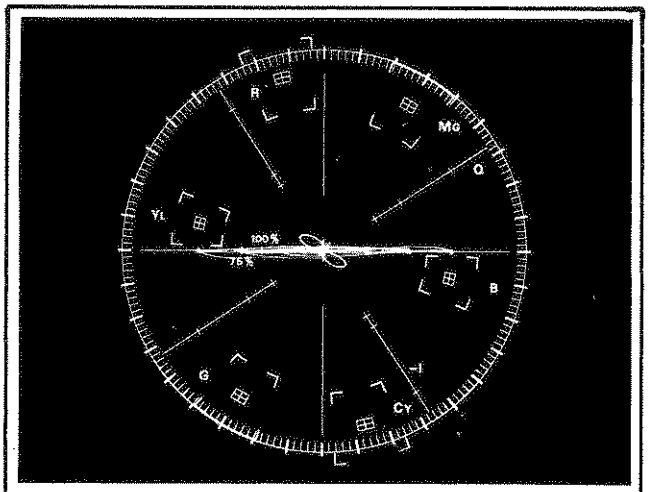
5. Adjust the A Phase control on the Type R520 NTSC to align the burst vector to the 180° position.

6. Switch the COLOR BAR R—Y selector (on the 146) to the down position. The display should consist of the burst vector and 6 dots on the B—Y (or 0°-180° axis). See Fig. 2-9. This display contains only the B—Y component of the color bar and is useful for setting up B—Y amplitudes of the color segments. Inscribed scale markings on the graticule facilitate the check.

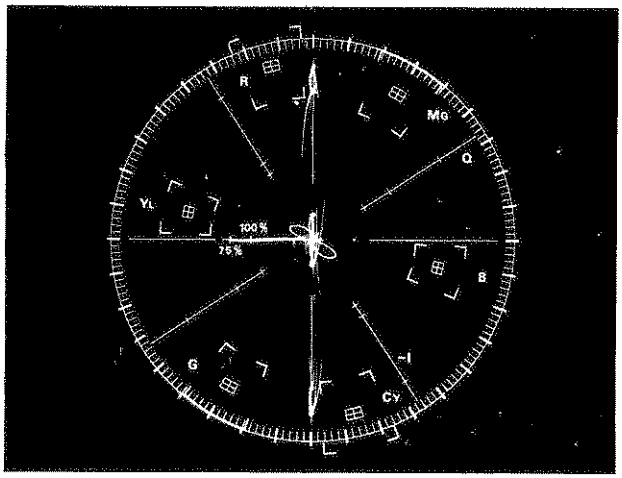
Return the R—Y lever switch to the up position.

7. Switch the COLOR BARS B—Y selector (on the 146) to the down position.

The display should consist of a vertical row of 6 dots plus the burst vector at 180°. See Fig. 2-9B. This display contains the R—Y component of the color bar, and is useful



(A) B-Y component of color bar test signal.



(B) R-Y component of color bar test signal.

Fig. 2-9. Vector display of color bar test signal containing only the B—Y or R—Y components.

for setting up the R—Y amplitude of the color segments. Inscribed scale markings on the graticule facilitate the check.

Return the B—Y lever switch to the up position.

8. In the previous two steps, if the R—Y and B—Y amplitude (dots) fell on or very near their corresponding scale markings, then all color vectors should fall within their respective inner boxes on the graticule (indicating that they are within ±2.5° phase and ±2.5 IRE amplitude error limits) when both R—Y and B—Y components are present in the color bar signal (see Fig. 2-10).

9. Switch the COLOR BARS FIELD DISPLAY selector on the 146 to EIA COLOR BARS. There should be two

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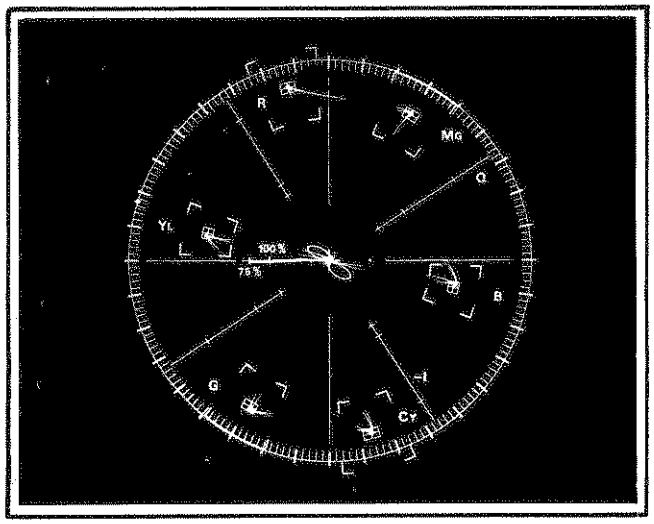


Fig. 2-10. Vector presentation of the color bar test signal. Position of the dots within the smaller boxes indicates that the displayed color vectors are within ±2.5°, and ±2.5 IRE in amplitude.

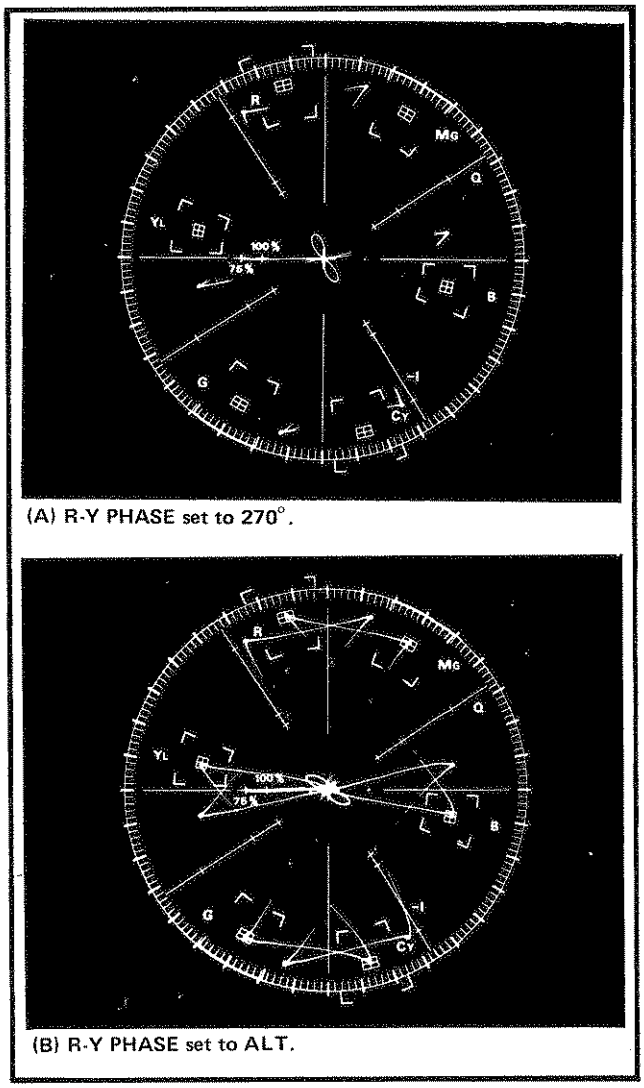
additional vectors on the display; one on the Q axis, and one on the –I axis. Return the FIELD DISPLAY switch to FULL FIELD COLOR BARS.

10. Switch the 146 SYNCHRONIZATION R–Y PHASE selector to the 270° position. The vectors should now be inverted, as shown in Fig. 2-11A.

11. Set the 146 SYNCHRONIZATION R–Y PHASE lever switch to the ALT position. This alternates the phase of the R–Y subcarrier between 90° and 270° at the H-rate (see Fig. 2-11B). Return the R–Y PHASE lever switch to the 90° position.

12. Set the 146 VIDEO switch to the down position. There should be a burst vector at 180° and a subcarrier vector at 180°.

13. Rotate the 146 APL/IRE LEVEL switch to 0, and set the MOD STAIRCASE 90° SUBCARRIER switch to MOD. The display should consist of a burst vector at 180°, a subcarrier vector at 180°, and three dots along the 90° axis corresponding to the modulated 90° subcarrier. See Fig. 2-12.



(A) R-Y PHASE set to 270°.

(B) R-Y PHASE set to ALT.

Fig. 2-11. Vector display of color bar signal with R–Y PHASE set to 270° and ALT.

OPERATING OPTIONS

General Information

In specific user applications the 146, as factory connected, may not provide certain components of a test signal(s) when desired. For example: if operating in the COLOR GEN LOCK mode, loss of the external 3.58 MHz component will automatically prevent any chroma information from being obtained from the 146. This loss of chroma may not be desirable. By changing a circuit board pin connection, the chroma information may be obtained. The following changes can be performed if desired.

A. Staircase Modulation Phasing

The 146 is factory connected to provide a modulated staircase test signal with the modulation phased at 180°. (Burst is also phased at 180°.) To produce the staircase test signal with the modulation phased at 0°, move the center conductor of the orange-on-white coaxial cable, located on the Modulator circuit board, from pin P to pin R (see Fig. 2-13 and diagram 1).

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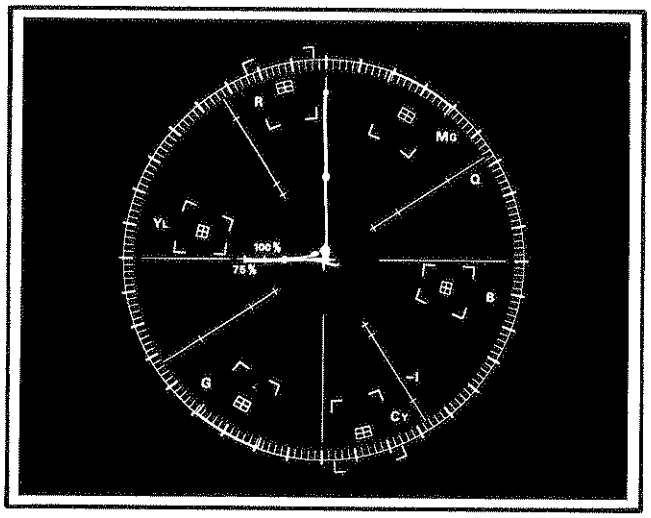

Fig. 2-12. Vector presentation of 180° and modulated 90° subcarriers.

B. Line Sync Lock Time

When operated in the COLOR GEN LOCK mode, the 146 will line lock to the external signal in approximately 50 ms. To obtain a slower lock with the external signal, change the black wire between pins X and Y on the Line Timing circuit board to pins Y and Z (see Fig. 2-14 and diagram 6b). In this mode, the 146 line lock rate is limited to about 1 line/sec.

C. Auto—Non Auto Chroma

When operated in COLOR GEN LOCK or EXT STD modes, the 146 is factory connected to disable the chrominance components of the COMP VIDEO outputs if the external 3.58 MHz component is lost. (Also, if external sync is lost in COLOR GEN LOCK mode only.) To provide chrominance information even with the external loss of subcarrier, move the black-brown on white wire, located on the Gen Lock circuit board, from pin R to pin S (see Fig. 2-15 on diagram 16).

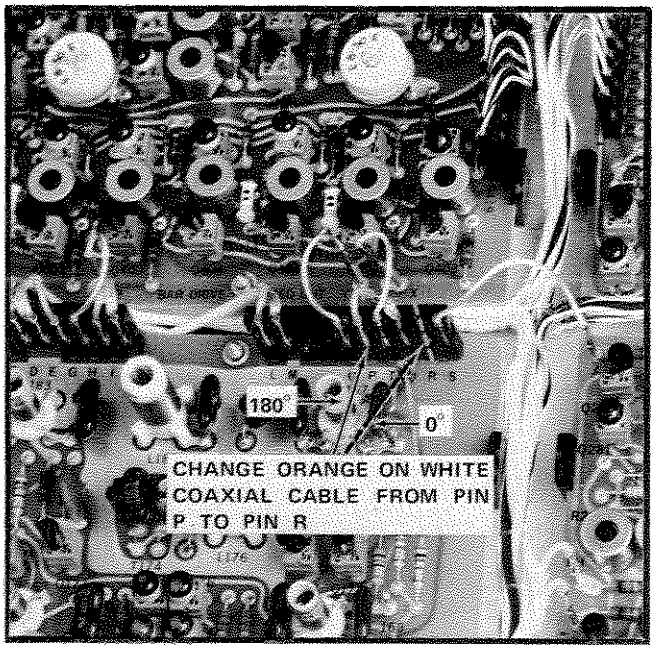

Fig. 2-13. Modulator circuit board showing location of coaxial cable used to change staircase modulation phasing.

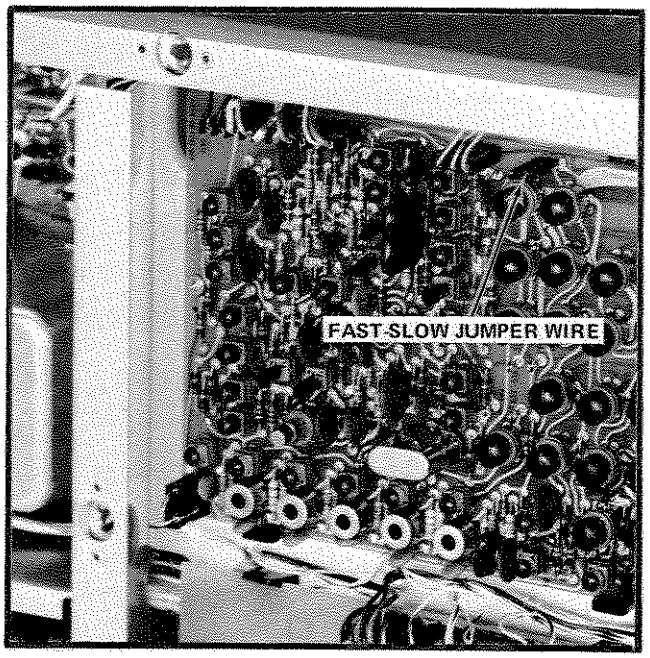

Fig. 2-14. Line Timing board showing location of FAST-SLOW line sync lock jumper.

NOTE

When the 146 is operated in the COLOR GEN LOCK mode and the externally applied Gen Lock signal is monochrome (no burst), the SUBCARRIER outputs revert to the internal subcarrier (within FFC frequency specifications), but the SYNC outputs are locked to the incoming signal. Thus, the SYNC and SUBCARRIER outputs are not 'color locked'. Color signals generated in this mode cannot be used with a Video Tape Recorder (VTR).

D. Auto-Non Auto Video

When operated in the COLOR GEN LOCK mode, the 146 is factory connected to eliminate the luminance portion of the output if the external sync signal is lost. To obtain luminance at all times, move the red-violet-on-white wire, located on the Gen Lock circuit board pin AA, to pin Z (see Fig. 2-15 and diagram 15).

E. CW Subcarrier Lock

If desired, the 146 can be Gen Locked to a composite sync signal with superimposed subcarrier. This is accomplished by changing the black jumper wire

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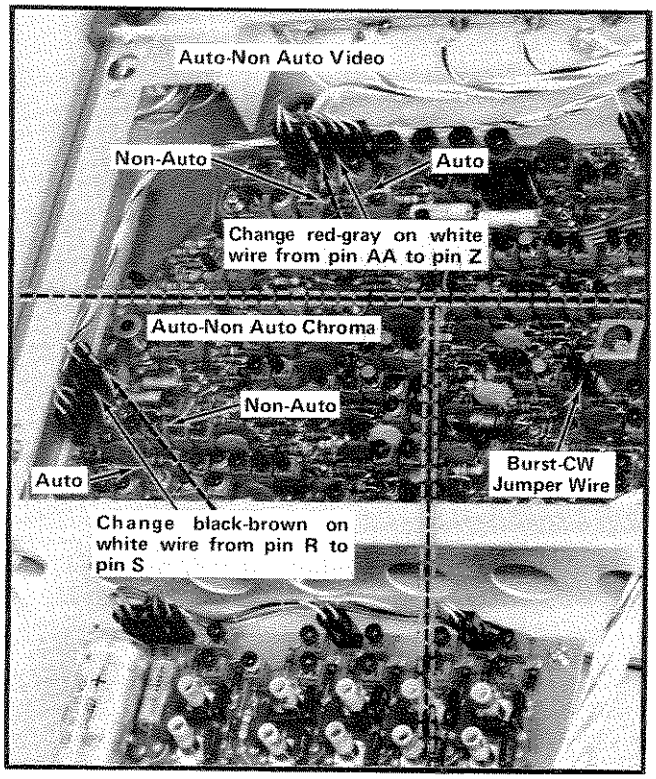

Fig. 2-15. Gen Lock circuit board showing location of pins to convert Auto—Non-Auto Chroma and Auto—Non-Auto Video; jumper wire for selecting Burst or CW operation.

on the Gen Lock circuit board from the BURST position to the CW position (see Fig. 2-15 and diagram 12).

GLOSSARY OF TERMS

ACTIVE VIDEO LINES: All video lines not occurring in the vertical blanking interval.

APL: Average picture level. The average luminance level of the unblanked portion of a television line measured in IRE units.

BACK PORCH: That portion of the composite video signal which lies between the trailing edge of the horizontal sync pulse and the trailing edge of the horizontal blanking pulse.

BLACK BURST: A signal consisting of composite sync and burst.

BLANKING LEVEL: The level of the front and back porches of the composite video signal.

BREEZEWAY: In NTSC color, the portion of the back porch between the trailing edge of the sync pulse and the start of the color burst.

BURST FLAG: Pulses used to key out a portion of the 3.579545 MHz sine wave subcarrier for use as a reference for the color signal.

B—Y: A color signal corresponding to the 0° axis of a vector diagram. It is formed from a combination of red, green, and blue chrominance signals (B—Y=—0.30R—0.59G+0.89B).

CHROMINANCE: That property of light which produces a sensation of color in the human eye apart from any variation in luminance that may be present.

COLOR BAR: A test signal, typically containing six basic colors: yellow, cyan, green, magenta, red, and blue, which is used to check the chrominance functions of color TV systems.

COLOR BURST: In NTSC color systems, this normally refers to a burst of approximately 8 to 10 cycles of 3.579545 MHz subcarrier frequency on the back porch of the composite video signal. This serves as a color synchronizing signal to establish a frequency and phase reference for the chrominance signal.

COLOR SUBCARRIER: In color systems, this is the carrier signal whose modulation sidebands are added to the monochrome signals to convey color information; in NTSC, it is a 3.579545 MHz sine wave.

COMPOSITE BLANKING: This signal is composed of pulses at line and field frequencies used to make the return traces of a picture tube invisible.

COMPOSITE SYNC: The line and field rate synchronizing pulses (including the field equalizing pulses) when combined together form the composite sync signal.

COMPOSITE VIDEO: For color, this consists of blanking, field and line synchronizing signals, color synchronizing signals, chrominance and luminance picture information. These are all combined to form the complete color video signal.

CONVERGENCE: In color television, the meeting or crossing of the three electron beams at the shadow mask.

CROSSHATCH: A grid of vertical and horizontal white bars over a black background.

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DIFFERENTIAL GAIN: The amplitude change, usually of the 3.579545 MHz color subcarrier, introduced by the overall circuit, measured in dB or per cent, as the picture signal on which it rides in varied from blanking to white level.

DIFFERENTIAL PHASE: The phase change of the 3.579545 MHz color subcarrier introduced by the overall circuit, measured in degrees, as the picture signal on which it rides is varied from blanking to white level.

EIA: An abbreviation for Electronic Industries Association.

EQUALIZING PULSES: Pulses of one half the width of the horizontal sync pulses which are transmitted at twice the rate of the horizontal sync pulses during the portions of the vertical blanking interval immediately preceding and following the vertical sync pulses. The purpose of these pulses is to cause the vertical deflection to start at the same time in each interval, and also serves to keep the horizontal sweep circuits in step during the portions of the vertical blanking interval immediately preceding and following the vertical sync pulse.

FIELD: One half of a complete picture (or frame) interval, containing all of the odd, or all of the even, lines of the picture.

FIELD BLANKING: Refers to the blanking signals which occur at the end of each field. Also called vertical blanking.

FIELD FREQUENCY: The rate at which one complete field is scanned, normally 59.94 times a second.

FRAME: One complete picture consisting of two fields of interlaced scanning lines.

FRONT PORCH: That portion of the composite picture signal which lies between the leading edge of the horizontal blanking pulse and the leading edge of the corresponding sync pulse.

GEN LOCK: Synchronization of signals in both frequency and phase.

H RATE: The time for scanning one complete line, including trace and retrace. NTSC equals 1/15734 second (color) or 63.56 μs.

HORIZONTAL DRIVE: A pulse at H-rate used in TV cameras. Its leading edge is coincident with the leading edge of the horizontal sync pulse and the trailing edge is coincident with the leading edge of the burst flag pulse.

HUE: The attribute of color perception that determines whether the color is red, yellow, green, blue, or the like. White, black, and gray are not considered hues.

IRE: An abbreviation for Institute of Radio Engineers.

IRE SCALE: An oscilloscope scale that applies to composite video levels. There are 140 IRE units in 1 volt.

—I, W, Q, B: An NTSC test signal used to check television broadcase equipment. It consists of a —I signal followed by a white bar then a Q signal and a black level on each line.

LINE BLANKING: The blanking signal at the end of each scanning line. Used to make the horizontal retrace invisible. Also called horizontal blanking.

LINE FREQUENCY: The number of horizontal scans per second, normally 15,734.26 times per second.

LUMINANCE: The amount of light intensity, which is perceived by the eye as brightness (referred to as "Y").

NTSC: National Television Systems Committee. An industry-wide engineering group which, during 1950-1953, developed the color television specifications now established in the United States.

REFERENCE WHITE LEVEL: The level corresponding to the specified maximum excursion of the luminance signal in the white direction.

R—Y: A color signal corresponding to the 90° position of a vector diagram. It is formed from a combination of red, green, and blue chrominance signals (R—Y=0.70R—0.59G—0.11B). Any color on the vector diagram can be made from a combination of R-Y and B-Y signals.

SATURATION: This indicates how little a color is diluted by white light, distinguishing between vivid and weak shades of the same hue. The more a color differs from white, the greater is its saturation. Saturation is also indi-

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cated by the terms purity and chroma. High purity and chroma correspond to high saturation and vivid color.

SETUP: The separation in level between blanking and reference black levels.

STAIRCASE: A video test signal containing several steps at increasing luminance levels. The staircase signal is usually amplitude modulated by the subcarrier frequency and is useful for checking amplitude and phase linearities in video systems.

SYNC: An abbreviation for the words "synchronization", "synchronizing", etc. Applies to the synchronization signals, or timing pulses, which lock the electron beam of the picture monitors in step, both horizontally and vertically, with the electron beam of the pickup tube. The color sync signal (NTSC) is known as the color burst.

VERTICAL BLANKING INTERVAL: The blanking portion at the beginning of each field. It contains the equalizing pulse, the vertical sync pulses, and VITS (if desired).

VERTICAL DRIVE: A pulse at field rate used in TV cameras. Its leading edge is coincident with the leading edge of the vertical blanking pulse and its duration is 10.5 lines.

VITS: Vertical interval test signal. A signal which may be included during the vertical blanking interval to permit on-the-air testing of video circuitry functions and adjustments.

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NOTES

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