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

1420 NTSC
1421 PAL
1422 PAL-M
VECTORSCOPE
(SN B050000 AND UP)

INSTRUCTION MANUAL

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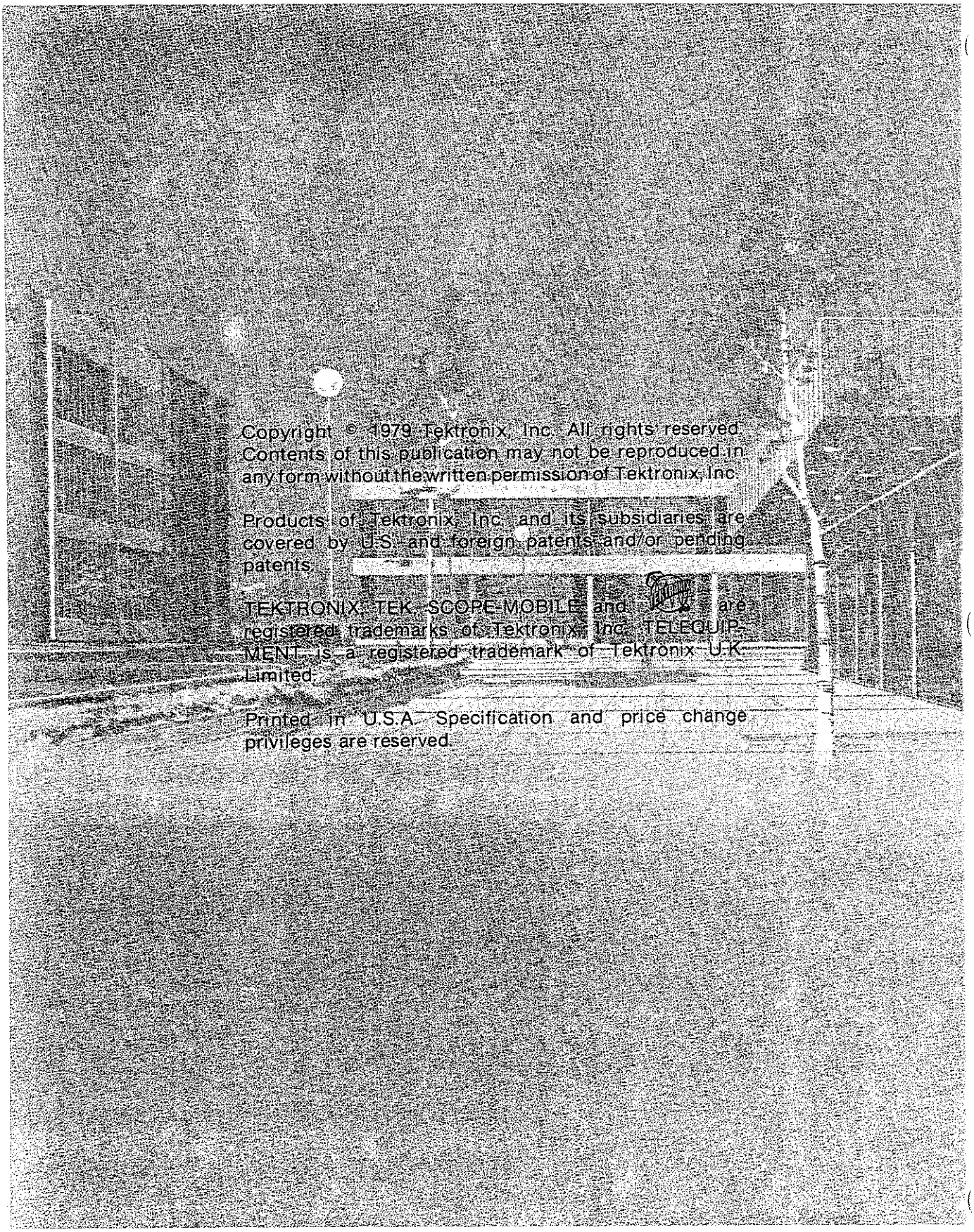

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PREFACE

This Preface describes the contents of the manual, with a brief description of each section within the manual. The Operators and Servicing Safety Summaries are also included here.

The Table of Contents is a detailed list of all important pieces of information and their location in the manual.

The manual is split into two parts, Operator's Information and Service Information. All pertinent information regarding the operation of the instrument is located in the Operator's part. This will be of use to both the operator and the service technician. The Service part contains information necessary to effectively service the instrument. This information should be used only by qualified service technicians.

The Operators part includes Sections 1 and 2:

Section 1, Introduction and Specification, includes a general description of the instrument, and the specification.

Section 2, Operating Instructions, includes information on controls, connectors, and operator familiarization.

The Service part contains Sections 3 through 10:

Section 3, Installation, covers the operating power information required for the instrument. Also the mechanical installation of the instrument is discussed.

Section 4, Theory of Operation, begins with a general overview of the instrument, followed by a detailed circuit description.

Section 5, Calibration, includes a Performance Check, Adjustment Procedure, and an equipment list.

Section 6, Maintenance, covers the standard electrical and mechanical maintenance, plus any special tools, unusual components, and special handling.

Section 7, Options, documents any options available with the instrument.

Section 8, Replaceable Electrical Parts list, includes ordering information and part numbers for all replaceable electrical parts.

Section 9, Diagrams, includes a Block Diagram, Schematics, Circuit Board illustrations, component basing diagrams, waveforms, and adjustment location illustrations.

Section 10, Replaceable Mechanical Parts list, refers to an exploded-view drawing of the instrument, and lists ordering information for all replaceable mechanical parts.

Change and correction information after the manual has been printed is located behind a tabbed page at the rear of the manual.

The text and diagrams are in accord with, and based on, the following standards of the American National Standards Institute, Inc. (ANSI):

ANSI Y1.1—1972, Abbreviations

ANSI Y32.2—1975, Graphic Symbols

ANSI Y32.14—1973, Graphic Symbols (Logic)

ANSI Y32.16—1975, Reference Designators

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PART 1—OPERATOR'S INFORMATION

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED SERVICE 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.

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PART II—SERVICE INFORMATION (cont)

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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

As Marked on Equipment

DANGER — High voltage.

Protective ground (earth) terminal.

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.

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.

Danger Arising From Loss of Ground

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

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 Table 3-1 in the Installation section.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type, voltage rating and current rating as specified in the parts list for your product.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

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

Do Not Remove Covers or Panels

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

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

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

Use Care When Servicing With Power On

Dangerous voltages 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.

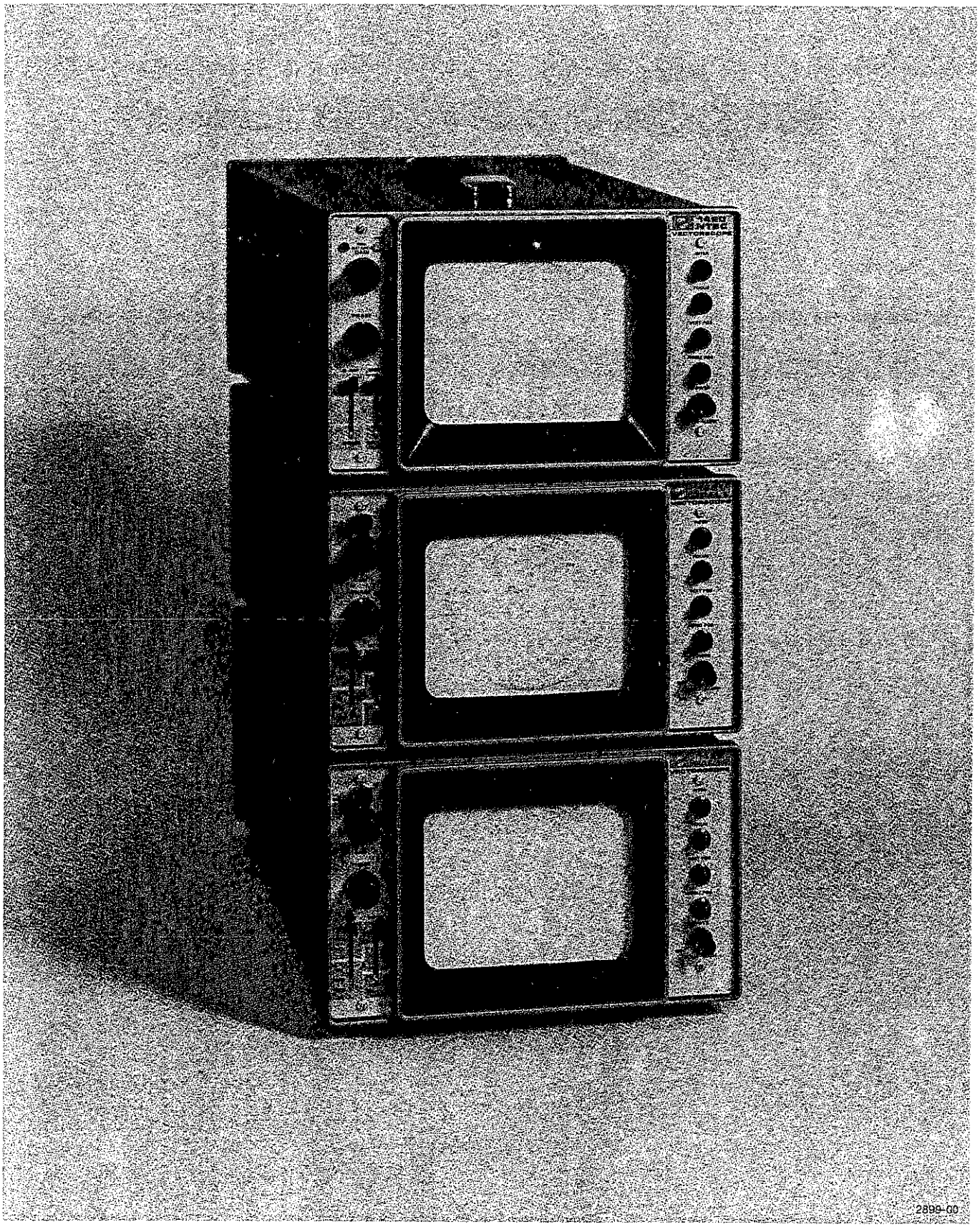

Fig. 1-1. The 1420 NTSC, 1421 PAL, and 1422 PAL-M Vectorscopes.

PART 1

OPERATOR'S INFORMATION

INTRODUCTION AND SPECIFICATION

INTRODUCTION

The TEKTRONIX 1420 NTSC, 1421 PAL, and 1422 PAL-M Vectorscopes are compact (one-half rack width, 5-1/4 inches vertical height) television instruments designed to display and measure chrominance information from a composite color video signal. The chrominance information, saturation, and hue are displayed on the crt in a polar plot fashion. The radius of the polar plot is a function of saturation, the peak-to-peak amplitude of the chrominance signal; the angular (phase) displacement is relative to the hue information, phase difference between the chrominance information and the reference vector (burst).

A front-panel lever switch (INPUT) allows selection of display from either of the two channel inputs, A or B. The lever switch also allows the selection of Channel A INPUT with attenuation to allow viewing of large signals.

The 1420 is designed to be used with NTSC, 525/60 scan television systems. The 1421 is designed to be used with PAL, 625/50 scan television systems. The 1422 is designed to be used with PAL-M, 525/60 scan television systems. The vector display may be referenced to either an internal or external subcarrier source.

The graticule markings provide references for butst and the primary and complementary color vectors and allow measurement of differential phase and differential gain.

The graticule illumination lights allow taking waveform display photographs in which the graticule is clearly visible.

SPECIFICATION

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

Items listed in the Performance Requirements column of Table 1-1 are verified by completing the Performance Check in this manual unless specifically stated otherwise. Items listed in the Supplemental Information column may not be verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

Table 1-1

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information	Perf. Ch. Step No.
Chrominance Processing Characteristics			
Chrominance Bandwidth			
Subcarrier Frequency (F_{sc})			

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information	Perf. Ch. Step No.
Chrominance Processing Characteristics (cont)			
Chrominance Bandwidth (cont)			
Subcarrier Frequency (F_{SC}) (cont)			
1420 NTSC		3.579545 MHz	
1421 PAL		4.43361875 MHz	
1422 PAL-M		3.575611 MHz	
Upper −3 dB point	F_{sc} +500 kHz ±100 kHz		23
Lower −3 dB point	F_{sc} −500 kHz ±100 kHz		23
Vector Phase Accuracy	Within 1°		5
Quadrature Phasing	Within 0.25°		18
Subcarrier Regenerator			
1420		Phase-locked to in-coming subcarrier or burst when present at A INPUT or B INPUT with ϕ REF set to either Channel A or B. Otherwise, free-running. Disabled when ϕ REF is set to EXT.	
1421 and 1422		With EXT SUB set to INT, the Subcarrier Regenerator is phase-locked to the incoming subcarrier or burst when present at A INPUT or B INPUT with ϕ REF set to either Channel A or B. Otherwise, free-running. Subcarrier Regenerator is disabled when EXT SUB is set to EXT.	
Pull-In Range	Within 50 Hz of F_{sc}		No Performance Check provided[a]
Pull-In Time	Within 1 second with subcarrier frequency within 50 Hz of F_{sc}		
Phase Shift with Subcarrier Frequency Change	Within 0.5° from F_{sc} to F_{sc} +50 Hz, or F_{sc} to F_{sc} −50 Hz		
Phase Shift with Burst Amplitude Change	Within 2° from nominal burst amplitude to +6 dB, or from nominal burst amplitude to −6 dB		21
Phase Shift with Subcarrier Source Change	Within 0.5°	ϕ REF switched between A and B	11d
Phase Shift with Input Channel Change	Within 0.5°	Video INPUT switched	11b

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information	Perf. Ch. Step No.
Chrominance Processing Characteristics (cont)			
Phase Shift with Front Panel GAIN Control	Within 1°	From unity to 2X unity, or from unity to 0.5X unity	11f
Phase Control Range		360° continuous rotation with goniometer	
Burst Jitter	0.5° or less		15
EXT SUB REF Input			
Amplitude Range	1 V to 4 V p-p		17
Input DC Voltage		±20 V (max.)	
Frequency (F_{sc})			
1420		3.579545 MHz ±50 Hz	
1421		4.4361875 MHz ±50 Hz	
1422		3.575611 MHz ±50 Hz	
EXT PAL PULSE Input (1421 and 1422 only)			
Amplitude Range	1 V to 5 V p-p		16
Input DC Voltage		±20 V (max.)	
Polarity		Negative going	
Pulse Timing		4 μs to H/2	
Phasing		Negative transition coincident with leading edge of line sync on either +V or −V lines. Internally selectable. Factory set to +V.	
Amplifier Characteristics			
INPUT Amplitude Range		1 V ±6 dB	
INPUT DC Voltage (max)		+20 V, −20 V	
Front Panel GAIN	Unity to +15.12 dB, Unity to −6 dB	Unity to 5.7X unity, and unity to 0.5X unity	12
Gain Stability			
With Temperature Change	0.5% or less from 0° C to 50° C		No Performance Check provided[b]
With Mains Voltage Change	2% or less as main voltage changes ±10% from center of range	Range selectable by internal plug-jumpers	No Performance Check provided[c]

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information	Perf. Ch. Step No.
Amplifier Characteristics (cont)			
Position Control Range			
HORIZ	At least 1/4" from center		19d
VERT	At least 1/4" from center		19b
Clamp Stability			
Center spot movement with rotation of PHASE control	1/64" or less		20
INPUT Isolation	At least −80 dB between channels	At F_{sc}	24
Return Loss			
A INPUT and B INPUT	At least 46 dB down	Loop-through terminated in 75 Ω. Input in use or not in use, instrument on or off.	25e
EXT SUBCARRIER REFERENCE Input	At least 34 dB down		25h
EXT PAL PULSE	At least 34 dB down	50 Hz to 5 MHz	25i
Diff Phase	1° or less		14
Diff Gain	1% or less		13
Power Supply Characteristics			
Power Supplies			
Accuracy			
+15 V		±2% (±0.3 V); +14.7 V to +15.3 V	
−15 V		±1% (±0.15 V); −14.85 V to −15.15 V	
+210 V		±10% (±21.0 V); 189.0 V to +231.0 V	
−3500 V		Approximate	
Ripple			
+15 V		10 mV or less	
−15 V		10 mV or less	
+210 V		1 V or less	
Mains Voltage Range		Mains Voltage and Range are selectable by internal plug-jumpers	
110 Vac			
Low	90 Vac to 110 Vac (100 Vac Nominal)		
Med	99 Vac to 121 Vac (110 Vac Nominal)		

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information	Perf. Ch. Step No.
Power Supply Characteristics (cont)			
Mains Voltage Range (cont)			
High	108 Vac to 132 Vac (120 Vac Nominal)		
220 Vac			
Low	180 Vac to 220 Vac (200 Vac Nominal)		
Med	198 Vac to 242 Vac (220 Vac Nominal)		
High	216 Vac to 264 Vac (240 Vac Nominal)		
Crest Factor		At least 1.35	

[a]Performance Check may be made using a video signal generator with a variable subcarrier oscillator of + and −50 Hz from F_{SC}.

[b]Performance Check may be made using an environmental chamber that the instrument would fit into.

[c]Performance Check may be made using a variable mains voltage source.

Table 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Information
Temperature	
Non-operating	−40° C to +65° C
Operating	0° C to +50° C
Altitude	
Non-operating	To 50,000'
Operating	To 15,000'

Table 1-3

PHYSICAL CHARACTERISTICS

Characteristics	Information
Length	18.5" (46.99 cm)
Width	8.5" (21.59 cm)
Weight	5.25" (13.34 cm)
Weight	Less cabinet, 13 lb (6.0 kg)

OPERATING INSTRUCTIONS

INTRODUCTION

This section of the manual will help familiarize the user with the 1420 NTSC, 1421 PAL, and 1422 PAL-M Vectorscopes. Common features and functions are covered, while pertinent model differences are described at appropriate intervals. The term "Vectorscope" in the manual text indicates your particular instrument model. Included in this section are:

1. An explanation of the functions of the controls, connectors, and indicators.

2. A check-out procedure that provides "hands-on" familiarization.

3. An operator familiarization section that provides basic color television principles as it relates to the vectorscope.

4. An explanation of how to use the vectorscope graticule.

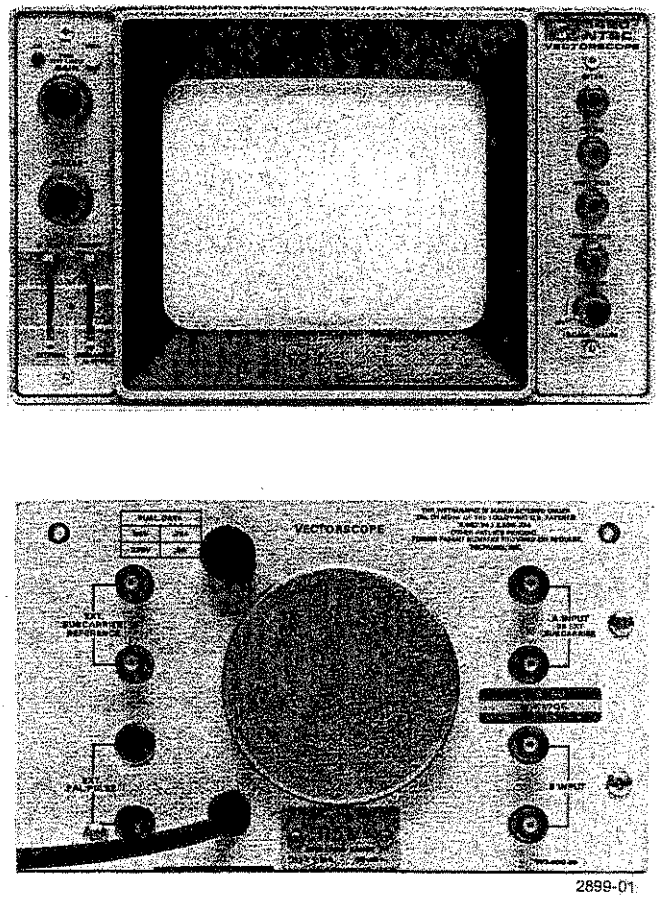

Fig. 2-1. 1420 Front and Rear Panels.

CONTROLS, CONNECTORS, and INDICATORS

Introduction

The following describes the functions or operations of the various controls and connectors found on the front- and rear-panel of the 1420, 1421, and 1422 Vectorscope. The front- and rear-panel controls, connectors, and indicators are shown in Fig. 2-1 and Fig. 2-2.

Front Panel (Left Side)

PUSH—TEST CIRCLE. By pressing the center portion of the knob marked GAIN, the subcarrier regenerator is unlocked from the reference and the 180° phase switcher is operating. This feature is useful in checking horizontal and vertical gain match and quadrature phasing.

GAIN. The outer part of the knob rotates to provide a variable gain control to vary the amplitude of the input composite video signal. The control has a calibrated detent position in the extreme ccw position.

CAL (Indicator). Incandescent lamp indicates that the GAIN control is in the calibrated detent position.

UNCAL (Indicator on 1420 only). Incandescent lamp indicates that the GAIN control is not in the calibrated detent position.

PHASE. Provides a continuously uncalibrated control of the display's phase position through a range of 360°.

INPUT. Three-position lever switch that allows the user to select signal information to be displayed from the rear panel A INPUT or B INPUT connectors. The SUB-

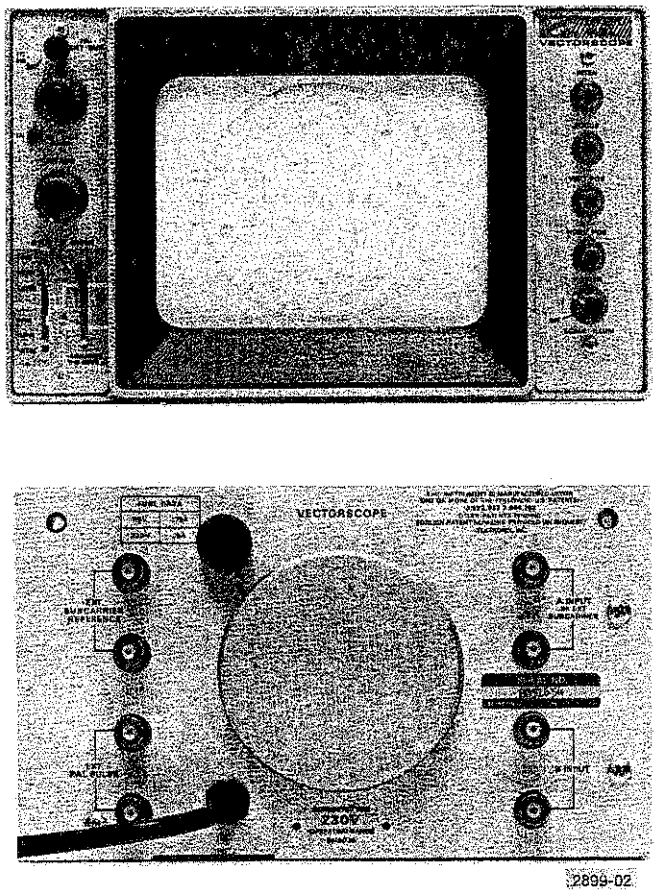

Fig. 2-2. 1421, 1422 Front and Rear Panels.

CARRIER (A INPUT) position displays the signal from the A INPUT connector with an attenuation loss of about 2 1/4 times or 6.9 dB.

ϕ REF (1420). Three-position lever switch used to select the subcarrier reference phase for the Vectorscope display. In the first two positions, A or B, the subcarrier reference phase is derived from the internal subcarrier regenerator, which is phase-locked to the subcarrier reference at the input connector selected. In the third position, EXTERNAL, the subcarrier reference phase is obtained from a continuous 3.58 MHz subcarrier reference signal applied to the EXT SUBCARRIER REFERENCE INPUT.

ϕ REF (1421, 1422). Four-position lever switch that selects two functions of operations. The first operation to consider is the subcarrier reference source to phase-lock the internal subcarrier regenerator. The subcarrier regenerator provides the subcarrier reference phase for the Vectorscope's display. The subcarrier reference used to phase-lock the subcarrier regenerator is either obtained from the A INPUT or B INPUT as indicated on the right side of the switch.

The other function this switch provides is either a PAL VECTOR or NTSC VECTOR display. The PAL VECTOR position displays a normal PAL signal with alternating burst and chrominance phase (see Fig. 2-3). The NTSC VECTOR position enables the 180° phase switcher. This allows the overlaying of the −V phase on the +V phase display (see Fig. 2-4).

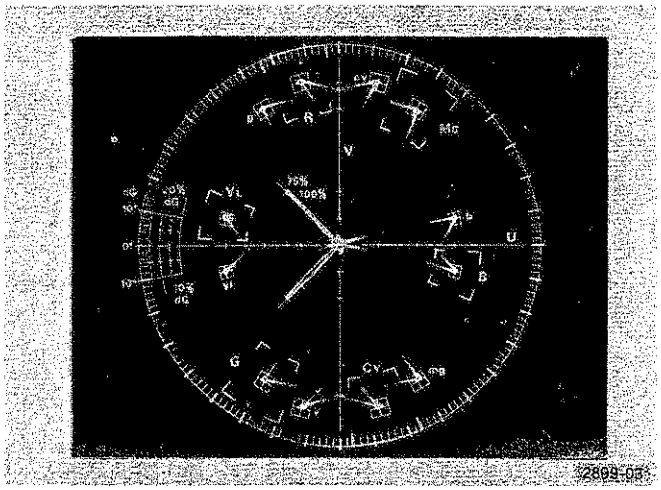

Fig. 2-3. 1421, 1422 PAL color bar vector display.

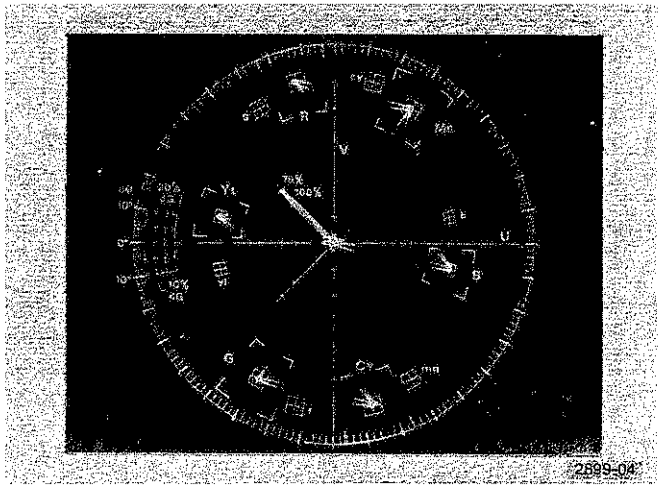

Fig. 2-4. 1421, 1422 PAL color bar NTSC vector display.

EXT SUB (1421, 1422). Push/pull switch to allow the subcarrier reference phase to be selected from either the internal subcarrier regenerator or a continuous subcarrier signal applied to the EXT SUBCARRIER REFERENCE input and a PAL Pulse signal applied to the EXT PAL PULSE input. The external reference circuitry is activated by pulling the knob out. The ϕ REF switch still allows the

user to select either PAL or NTSC VECTOR display while still referenced to the external subcarrier and external PAL Pulse.

EXT SUB (Indicator for 1421, 1422). Incandescent lamp that indicates if the Vectorscope is in the External Subcarrier Reference mode of operation.

Front Panel (Right Side)

INTEN. Controls the display brightness.

FOCUS. Controls the display resolution.

VERT POS. Moves the display on the R-Y (V) axis.

HORIZ POS. Moves the display on the B-Y (U) axis.

POWER. Turning the knob clockwise out of the detent position turns the instrument on.

SCALE ILLUM. Turning the knob clockwise increases the scale illumination.

Rear Panel

A INPUT. Dual-input bnc connectors permit loop-through or terminates in 75 Ω. Accepts composite video or subcarrier signals to be displayed on Channel B and/or for locking the subcarrier regenerator.

B INPUT. Dual-input bnc connectors permit loop-through or terminate in 75 Ω. Accepts external, continuous subcarrier to be used as an external subcarrier reference phase.

EXT SUBCARRIER REFERENCE. Dual-input bnc connectors permit loop-through or terminates in 75 Ω. Accepts external, continuous subcarrier to be used as an external subcarrier reference phase.

EXT PAL PULSE (1421, 1422). Dual-input bnc connectors permit loop-through or terminates in 75 Ω. Accepts external PAL Pulse to be used with the encoder in the Vectorscope to maintain correct phase of the V axis signals. The phasing requirements of the PAL Pulse for the Vectorscope may be reversed by internal selection.

FUSE. Fuse holder that contains the mains input voltage fuse.

OPERATOR'S CHECKOUT PROCEDURE

The Checkout Procedure is divided into two sections, one for checking the 1420 Vectorscope and the other for checking the 1421 and 1422 Vectorscopes. The procedures are provided to aid in obtaining a display on the Vectorscope, and may be used for operator familiarization and as a check of basic instrument operation. Only instrument functions, not measurement quantities or specifications, are checked in this procedure. Therefore, a minimum amount of test equipment is required. If performing the Operator's Checkout Procedure reveals improper operation or instrument malfunction, first check the operation of associated equipment, then refer to qualified service personnel for repair or adjustment of the instrument.

1420 CHECKOUT PROCEDURE

This procedure requires a video signal generator capable of providing composite video and color bars signals. A TEKTRONIX 1410 video test generator equipped with Sync Generator, Color Bar, and Linearity modules was used in preparing this procedure.

1. Setup

Video Signal Generator

Test Signal	Standard NTSC Color Bar
Amplitude	75%
Setup	7.5%

1420

GAIN	CAL
PHASE	Anywhere
ϕ REF	B
INPUT	B
INTEN	ccw
FOCUS	midrange
VERT POS	midrange
HORIZ POS	midrange
POWER	off

a. Connect composite video from the video signal generator to the 1420 B INPUT. Terminate the B INPUT loop-through in 75 Ω.

b. Connect subcarrier from the video signal generator to the 1420 A INPUT. Terminate the A INPUT loop-through in 75 Ω.

NOTE

Check the line voltage information indicated on the rear panel. If the power source voltage is not within

the factory-set range, have a qualified service person change the voltage operating range of the 1420. The necessary information is in the Service Information of this instruction manual.

c. Connect the 1420 to a suitable power source.

d. Set the 1420 POWER switch ON. Check that the front-panel CAL lamp is lit. Check that the SCALE ILLUM control (concentric with POWER switch) varies brightness of the graticule. Allow 10 minutes warm-up before proceeding.

2. Vector Presentation of Color Bars

a. Rotate the 1420 INTEN and FOCUS controls for a bright, well-defined display.

b. Rotate the 1420 VERT POS and HORIZ POS controls to center the display origin at graticule center.

c. Rotate PHASE to place the burst vectors on their graticule marks (see Fig. 2-5).

3. Vector Presentation of Color Bars with Phase Lock from the Opposite Channel

a. Set the 1420 ϕ REF switch to A. Chrominance information in Channel B is now demodulated with reference to the subcarrier phase in Channel A. The display on the Vectorscope should be the same as illustrated in Fig. 2-5. Some phase jitter will be noticed in this mode of operation, because the Sync Stripper circuit does not receive or regenerate composite sync. Therefore, the H Regenerator free-runs at about 15 kHz, but not at exact line sync time. As a result, timing signals generated with reference to the H Regenerator are not exact.

4. Display of Subcarrier Signal

a. Set the 1420 INPUT switch to SUBCARRIER (A INPUT). Adjust the 1420 GAIN control to set the termination of the subcarrier signal on the graticule edge. Push the TEST CIRCLE button. This feature can be used to check vertical to horizontal gain match (see Fig. 2-6) and quadrature phase (see Fig. 2-7).

b. Set the 1420 ϕ REF switch to B. The subcarrier phase is now demodulated with respect to burst phase in the Channel B signal.

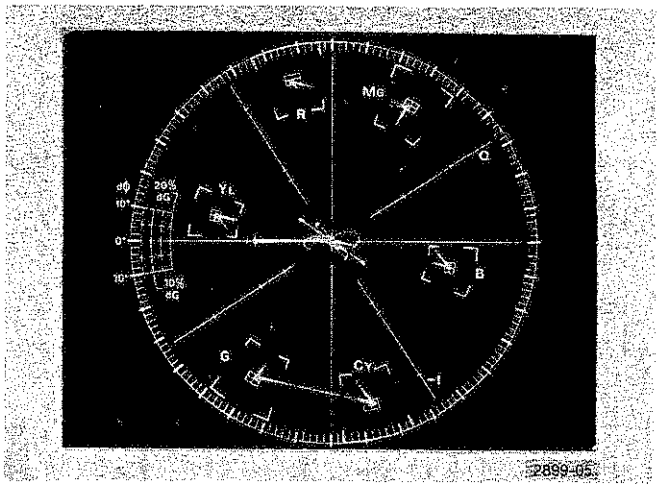

Fig. 2-5. 1420 NTSC color bars, 75% amplitude, 7.5% setup.

5. GAIN Control

a. Set the 1420 INPUT switch to B. Change the composite video input signal to a 5-step staircase, modulated with 140 mV of subcarrier. Rotate the 1420 GAIN control just out of the detent. The display is now about one-half original size and the UNCAL indicator is lit. Rotate the GAIN control to the counter-clockwise detent. The display is now back to original size and the CAL indicator is lit.

6. External Subcarrier Reference

a. Set up the equipment the same as in Steps 1 and 2, except set the ϕ REF switch to EXT. Note that there is no display except a dot in the center of the graticule.

b. Disconnect the subcarrier signal from the A INPUT and connect it to the EXT SUB INPUT. Note that the display is now phase-locked to the external subcarrier signal.

1421, 1422 CHECKOUT PROCEDURE

This procedure requires a video signal generator capable of providing composite video and subcarrier signals. In preparing this procedure, a TEKTRONIX 1411 Signal Generator with appropriate modules was used with the 1421 PAL Vectorscope and a TEKTRONIX 145-M was used with the 1422 PAL-M Vectorscope.

1. Setup

a. Set the PAL Video Signal Generator for standard PAL Colour Bars test signal; 75% amplitude, 0% setup.

b. Set the PAL-M Video Signal for standard PAL-M

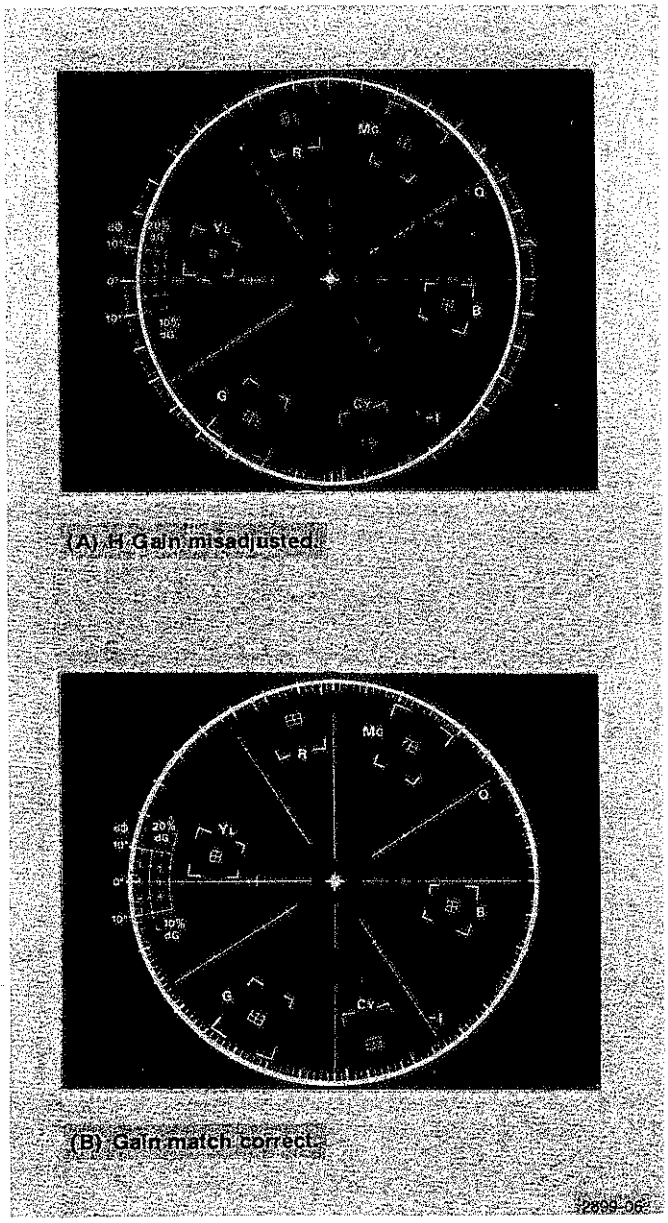

Fig. 2-6. 1420 — Checking the horizontal to vertical gain match.

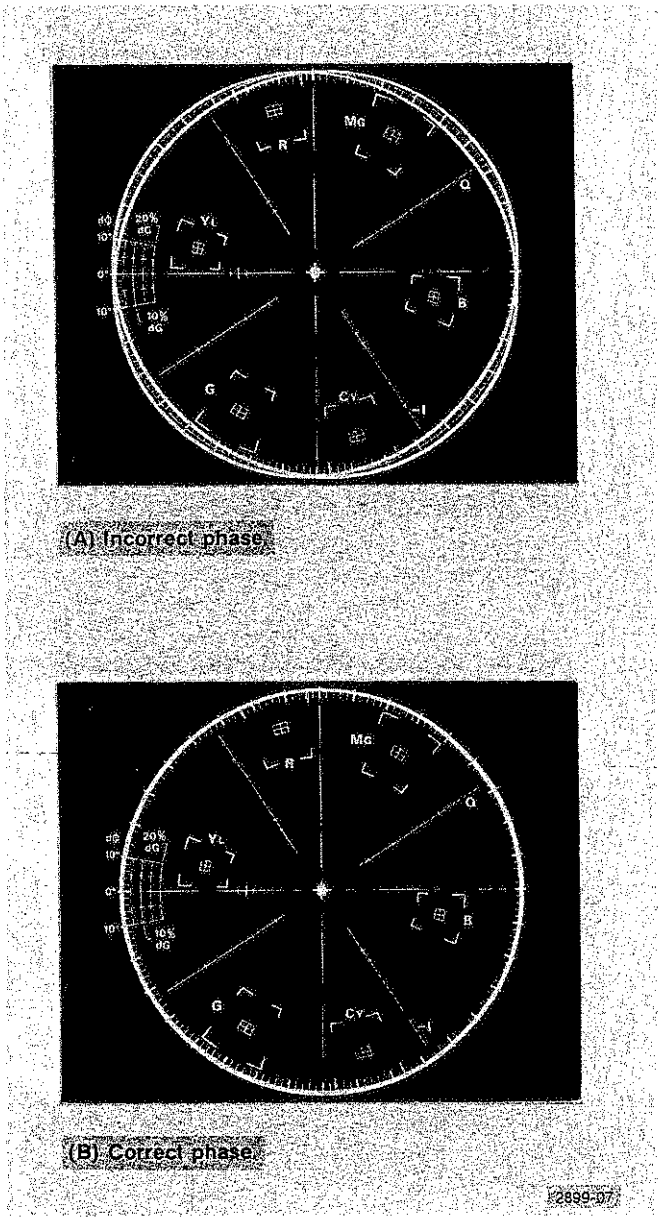

Fig. 2-7. 1420 — Checking quadrature phase.

Colour Bars test signal; 75% amplitude, 50 mV setup, 100% white reference.

c. Set the Vectorscope controls as follows:

GAIN	CAL
PHASE	Anywhere
ϕ REF	B VECTOR PAL
INPUT	B
INTEN	ccw
EXT SUB	INT
FOCUS	midrange
VERT POS	midrange
HORIZ POS	midrange
POWER	off

d. Connect the composite video from the video signal generator to the Vectorscope B INPUT. Terminate the B INPUT loop-through in 75 Ω.

e. Connect the subcarrier from the video signal generator to the Vectorscope A INPUT. Terminate the A INPUT loop-through in 75 Ω.

NOTE

Check the line voltage information indicated on the rear panel. If the power source voltage is not within the factory-set range, have a qualified service per-

son change the voltage operating range of the instrument. The necessary information is in the Service Information section of this manual.

f. Connect the Vectorscope to a suitable power source.

g. Set the Vectorscope POWER switch ON. Check that the front-panel CAL lamp is lit. Check that the SCALE ILLUM control (concentric with POWER switch) varies brightness of the graticule. Allow 10 minutes warm-up before proceeding.

2. Vector Presentation of Colour Bars

a. Rotate the Vectorscope INTEN and FOCUS controls for a bright, well-defined display.

b. Rotate the VERT POS and HORIZ POS controls to center the display origin at graticule center.

c. Rotate PHASE to place the burst vectors on their graticule marks (see Fig. 2-3).

d. Set the Vectorscope ϕ REF switch to B VECTOR NTSC. The 180° switcher in the demodulator is now running, causing the −V burst and the chrominance vectors associated with it to be switched in phase and overlaid with the +V burst and chrominance. See Fig. 2-4. This feature is particularly useful in studio source phasing, where all input signals to the studio switcher can be displayed in turn, and phase errors removed by adjusting source phasing for overlay of the Vectorscope display. Source phasing, using this feature, also assumes accurate burst quadrature.

3. Vector Presentation of Colour Bars with Phase Lock from the Opposite Channel

a. Set the Vectorscope ϕ REF switch to A VECTOR PAL. Chrominance information in Channel B is now demodulated with reference to the subcarrier phase in Channel A. The display on the Vectorscope should be the same as illustrated in Fig. 2-3. Some phase jitter will be noticed in this mode of operation, because the Sync Stripper circuit does not receive or regenerate composite sync. The H Regenerator free-runs at about 15 kHz, but not at exact line sync time. As a result, timing signals generated with reference to the H Regenerator are not exact.

4. Display of Subcarrier Signal

a. Set the Vectorscope INPUT switch to SUBCARRIER (A INPUT). Adjust the Vectorscope GAIN control to set the termination of the subcarrier signal on the graticule edge. Push the TEST CIRCLE button. This feature can be used to check vertical to horizontal gain match (see Fig. 2-8) and quadrature phasing (see Fig. 2-9).

b. Set the Vectorscope ϕ REF switch to B VECTOR PAL. The subcarrier phase is now demodulated with respect to burst phase in the Channel B signal.

5. GAIN Control

a. Set the Vectorscope INPUT switch to B. Change the composite video input signal to a 5-step staircase, modulated with 140 mV of subcarrier. Rotate the Vectorscope GAIN control just out of the detent. The display is now about one-half original size and the CAL light is not lit. Rotate the GAIN control to the clockwise stop. The display is now about five times original size. Rotate the GAIN control to the counterclockwise detent. The display is now back to original size and the CAL indicator is lit.

6. External Subcarrier and PAL Pulse Reference

a. Set up the equipment the same as in Steps 1 and 2, except set the Vectorscope EXT SUB switch to EXT. The EXT SUB lamp should light. Note that there is no display except a dot in the center of the graticule.

b. Disconnect the subcarrier signal from the Vectorscope A INPUT, and connect it to the EXT SUBCARRIER REFERENCE input. Connect an External PAL Pulse (1 to 5 V p-p negative-going pulse) to the EXT PAL PULSE input. Terminate the other two loop-through inputs in 75 Ω. Note that there is a display, and it is now phase-locked. Setting the EXT SUB switch back to INT returns the Vectorscope to the normal operating modes and also extinguishes the EXT SUB light.

OPERATOR'S FAMILIARIZATION

BASIC INFORMATION

In color television the visual sensation of color is described in terms of three qualities: luminance, hue, and saturation. Figure 2-10 shows a conical representation of these concepts.

Luminance. Luminance is brightness as perceived by the eye. As the eye is most sensitive to green and least to blue light of equal energy, green is a bright color and blue is a dark color as conveyed by the luminance signal to monochrome TV receivers.

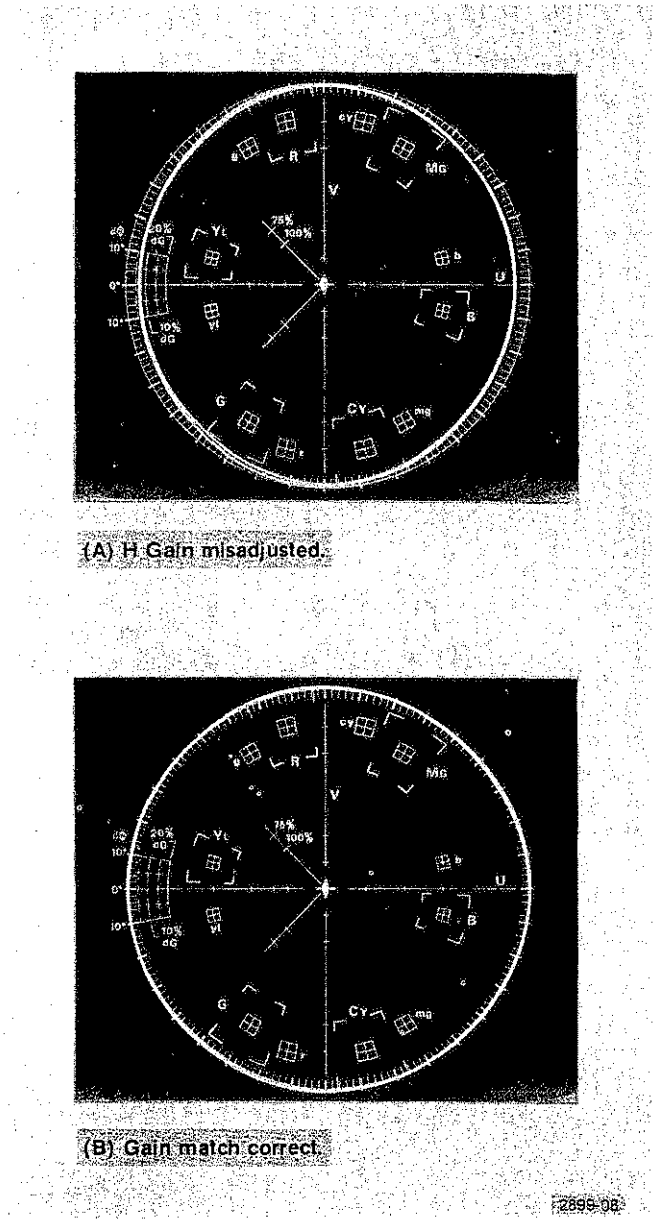

Fig. 2-8. 1421, 1422 — Checking vertical to horizontal gain match.

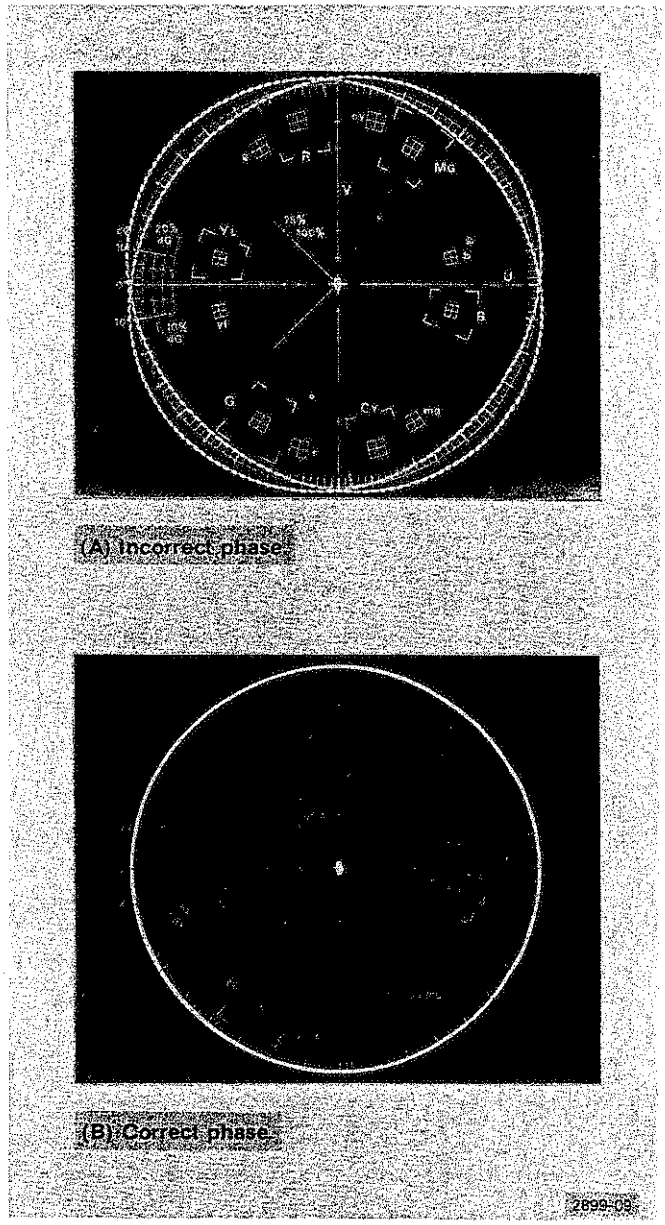

Fig. 2-9. 1421, 1422 — Checking quadrature phase.

Chrominance. 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 the like. White, black, and gray are not considered hues. Hue is presented on the Vectorscope CRT as a phase angle and not in terms of wavelength. For example, red, having a wavelength of 610 millimicrons, is indicated as 104° on the standard color phase vector diagram when the burst is at 180° for NTSC and 135° for PAL and PAL-M. The standard color-phase vector diagram is shown in Fig. 2-11 for NTSC, and Fig. 2-12 for PAL and PAL-M.

Saturation is the degree to which a color (or hue) is diluted by white light in order to distinguish between vivid and weak shades of the same hue. For example, vivid red is highly saturated and pastel red has little saturation. Using the Vectorscope, saturation is the radial distance from the center (where zero saturation exists) to the end of the color vector where 75% or 100% saturation exists for a particular color. If burst vector amplitude corresponds to the 75% saturated marking (see Fig. 2-13 for NTSC and Fig. 2-14 for PAL and PAL-M), the colors are 75% saturated. If burst vector amplitude corresponds to the 100% marking, the colors are 100% saturated. The 100% markings are shown only on the 1421 and 1422.

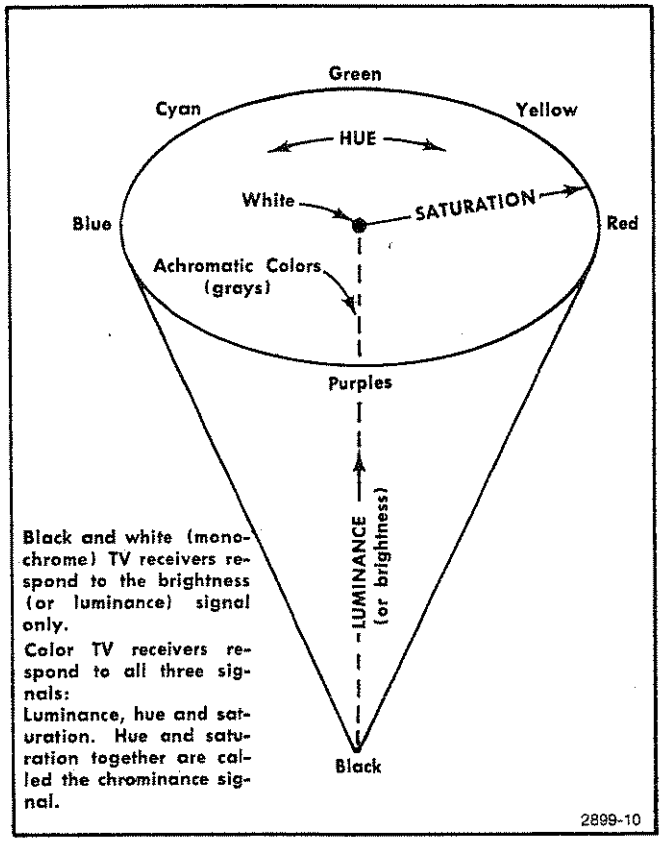

Fig. 2-10. Conical three-dimensional representation of color concepts.

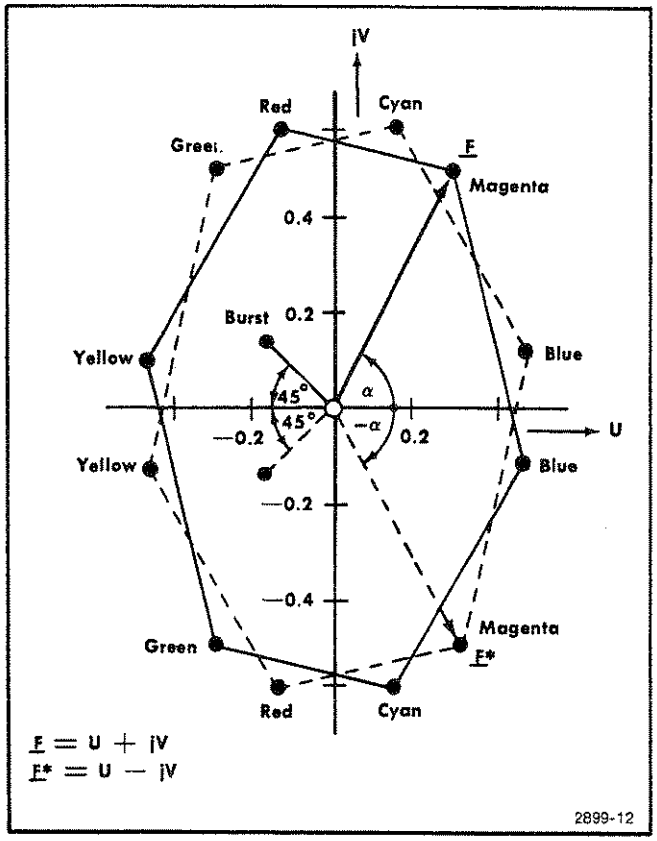

Fig. 2-12. PAL, PAL-M standard color-phase vector diagram.

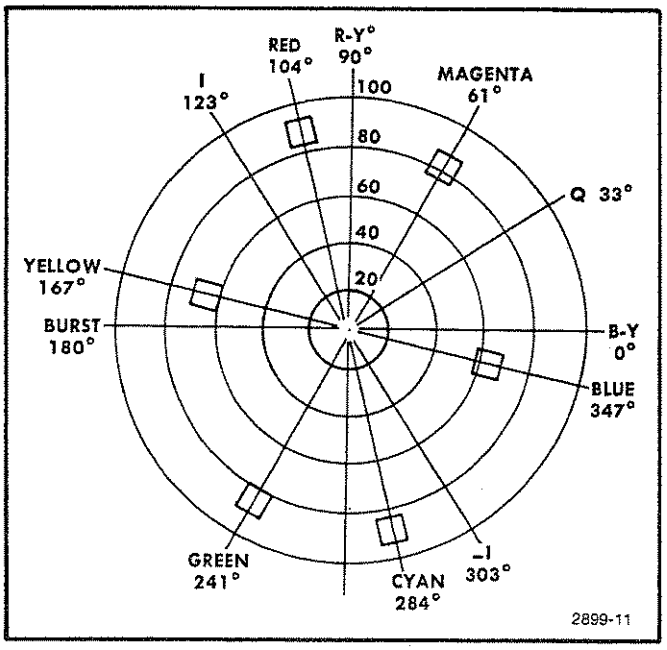

Fig. 2-11. NTSC standard color-phase vector diagram.

Encoding. The hue and saturation information in the color television system is carried on a single subcarrier frequency: 3.579545 MHz for NTSC, 4.43361875 MHz for PAL, and 3.575611 MHz for PAL-M. These signals, in modulated subcarrier form, are called chrominance. The hue information is carried by the subcarrier phase; the saturation information is carried by means of amplitude modulation with the subcarrier suppressed. A subcarrier which supplies phase information is required for demodulation. No chrominance signals are present during the horizontal blanking interval, and a sample of the subcarrier is provided within this interval and is called burst.

Decoding. To recover the hue information, phase demodulators are employed in the Vectorscope. The phase reference is the color subcarrier which is regenerated by an oscillator in the instrument. The oscillator is locked in both phase and frequency to the incoming color burst signal. The Vectorscope displays the relative phase and amplitude of chrominance signal on polar coordinates. To identify these coordinates, the vector graticule (see Fig. 2-13 for NTSC and Fig. 2-14 for PAL and PAL-M) has points which correspond to proper

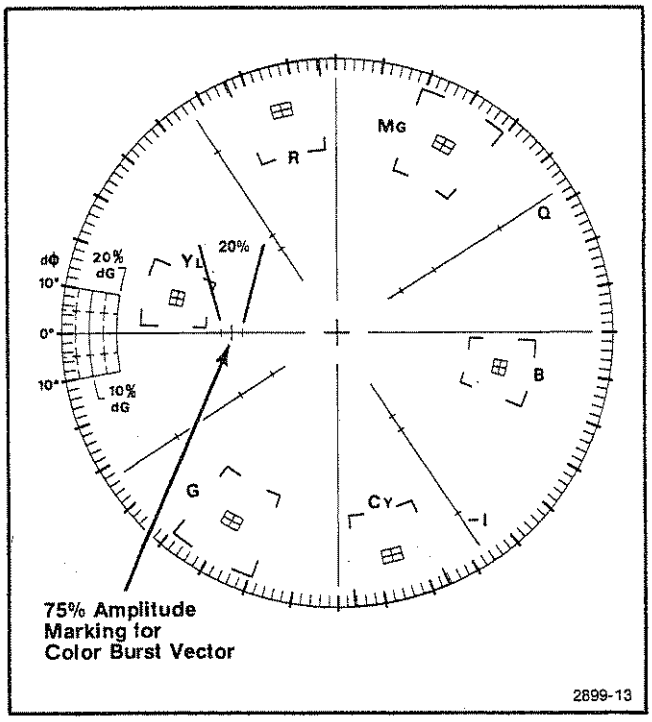

Fig. 2-13. 1420 burst markings.

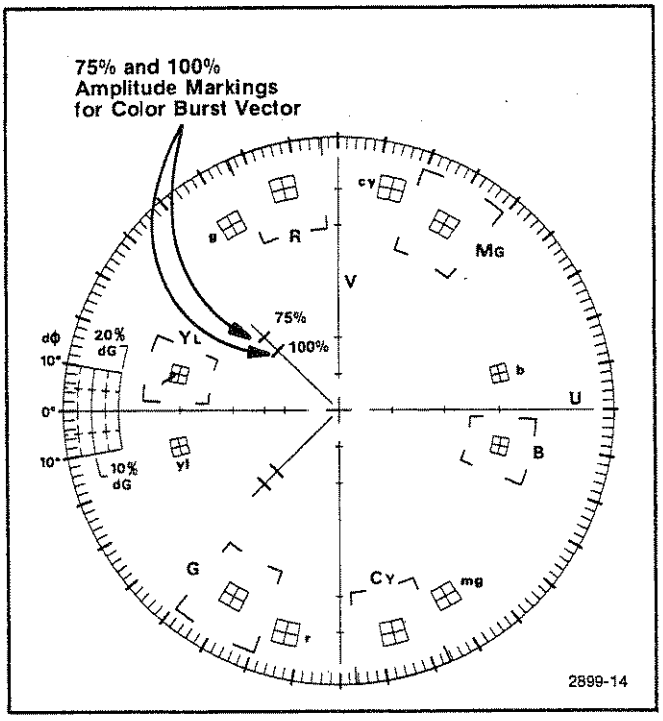

Fig. 2-14. 1421, 1422 burst markings.

phase and amplitude of the three primary colors related to the 180° burst vector for NTSC and the 135° burst vector for PAL and PAL-M: R (Red), B (Blue), and G (Green). The complements of the primary colors are indicated as follows: Cy (Cyan), Yl (Yellow), and Mg (Magenta). When the burst vector is at 225° for PAL and PAL-M, the conjugate color points are identified as follows: r (red), b (blue), g (green), cy (cyan), yl (yellow), and mg (magenta).

Any errors in the color encoding, video tape recording, or transmission processes which change these phase or amplitude relationships causes color errors on the television receiver picture. The polar-coordinate type of display such as that obtained on the 1420, 1421, or 1422 has proven to be the best method for portraying these errors.

FUNCTIONAL USE OF GRATICULE

Measurement of Color Bars

The polar display permits measurements of hue in terms of relative phase of the chrominance signal with respect to the color burst. Relative amplitude of chrominance to burst is expressed in terms of the displacement from center (radial dimension of amplitude) towards the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

On the graticule for the 1420, each chrominance vector terminates in a system of graticule markings in the shape of two boxes (a small box inside a large box). (See Fig. 2-15.) The dimensions of the large boxes represent ±10° centered on the exact chrominance phase, and ±20% of chrominance amplitude centered around 100% of standard amplitude (75% amplitude, 7.5% setup), while the dimensions of the smaller boxes represent ±2.5° and ±2.5 IRE.

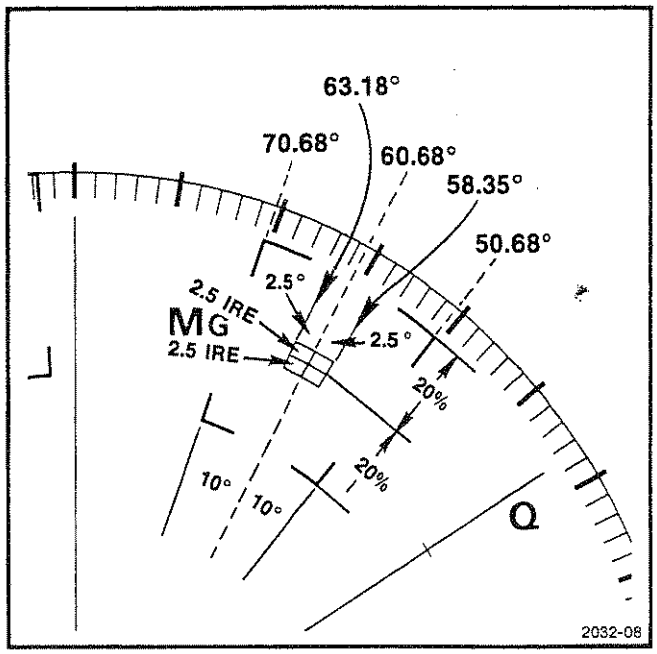

Fig. 2-15. 1420 graticule details, Magenta box.

On the graticule of the 1421 or 1422, each chrominance vector related to the +V burst terminates in a system of graticule markings in the shape of two boxes (a small box inside a large box). (See Fig. 2-16.) The dimensions of the large boxes represent ±10° centered on the exact chrominance phase and ±20% of chrominance amplitude centered around 100% standard amplitude (75% amplitude, 0% setup), while the dimensions of the smaller boxes represent ±3° and ±5% of chrominance amplitude. Note that the chrominance vectors associated with the −V burst are not terminated in boxes.

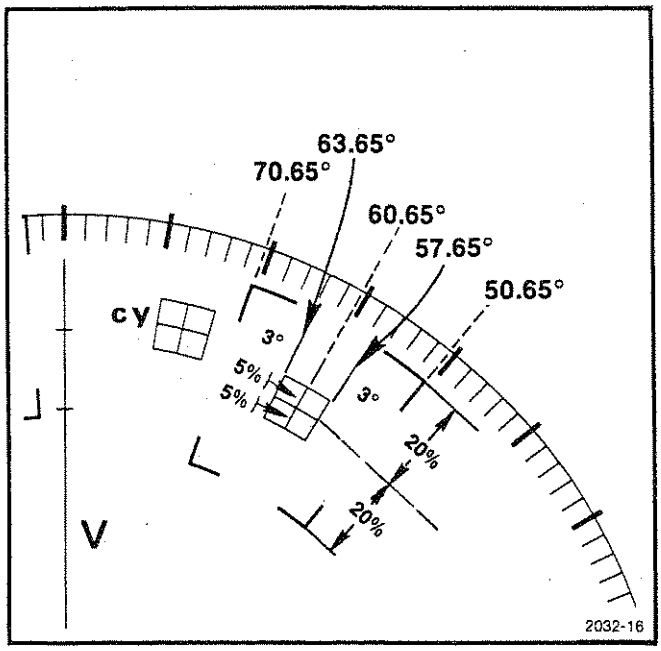

Fig. 2-16. 1421, 1422 graticule details, Magenta box.

Other graticule markings may be noted at this time. On the 1420, the small marks at intervals along the I and Q axes denote the amplitudes of the chrominance components as demodulated from a signal referenced to I and Q (see Fig. 2-17). On the 1421 and 1422, the small marks at intervals along the U and V axes denote the amplitudes of the U and V chrominance components (see Fig. 2-18).

Differential Gain and Phase Measurements

The two major distortions which the chrominance signal suffers are differential gain and differential phase. These distortions are chrominance non-linearities caused by luminance amplitude variations. Both can be measured

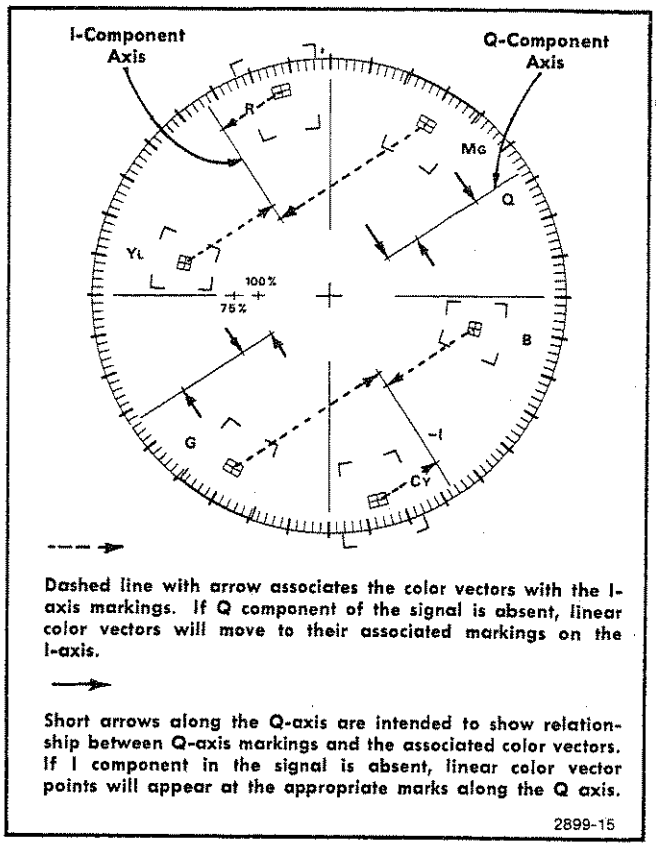

Fig. 2-17. Illustrating the purpose of the I and Q axis markings on the vector graticule.

on the Vectorscope. Differential gain is a change in color subcarrier amplitude due to a change in the luminance signal while hue and saturation of the original signal are held constant. In the reproduced picture, the saturation will be distorted in the areas between the light and dark portions of the scene. Differential phase is a phase change of the chrominance signal by the luminance signal while the original chrominance signal is held constant. In the reproduced picture, the hue will vary with scene brightness. Differential gain and differential phase may occur separately or together.

Differential gain (dG) and differential phase (dϕ) measurements can be made using the graticule markings located around the outer edge of the graticule at the termination of the B-Y axis for the 1420 and −U axis on the 1421 and 1422. See Fig. 2-19 for a differential gain measurement illustration and Fig. 2-20 for a differential phase measurement illustration.

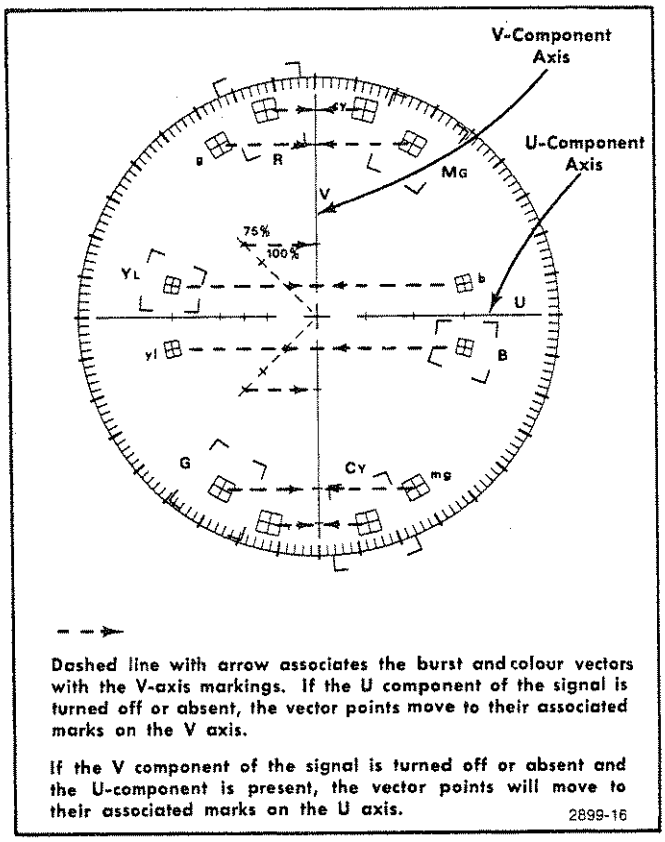

Fig. 2-18. Illustrating the purpose of the U and V axis marks on the vector graticule.

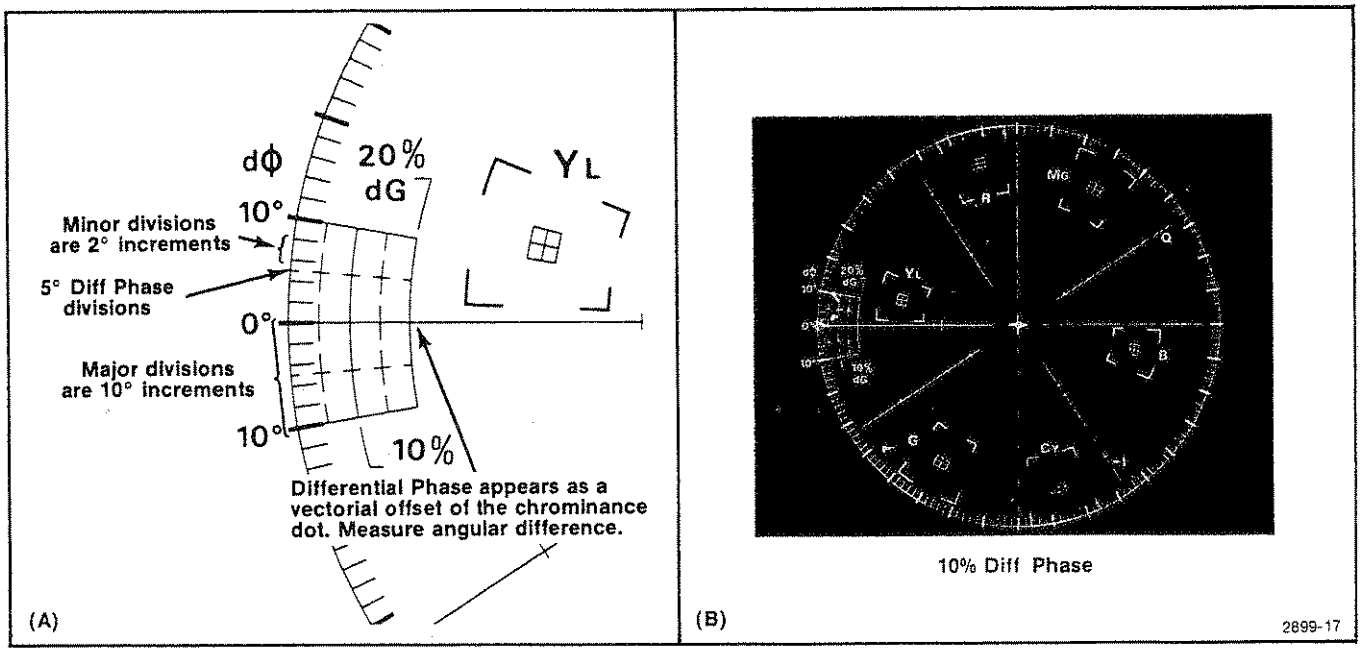

Fig. 2-19. (A) Differential Phase graticule markings; (B) Example of Differential Phase.

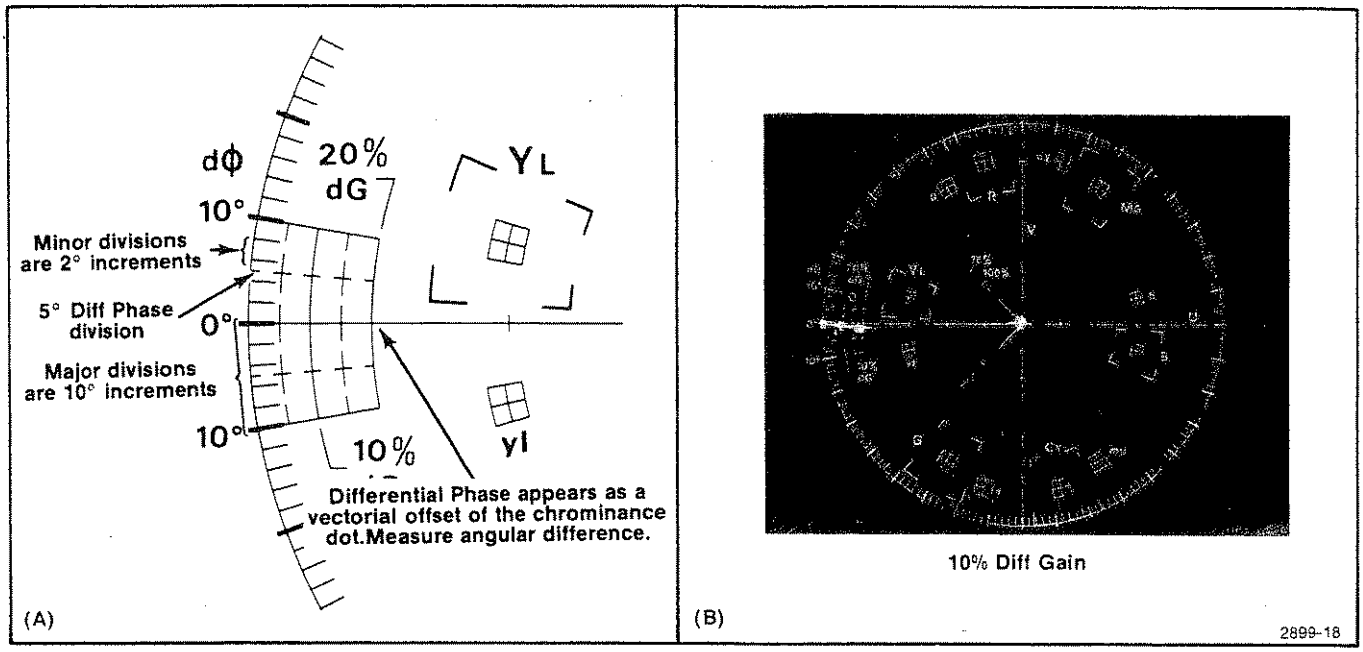

Fig. 2-20. (A) Differential Gain graticule markings; (B) Example of Differential Gain.