Range Commanders Council

TELECOMMUNICATIONS
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# TEST METHODS FOR TELEVISION SYSTEMS AND SUBSYSTEMS

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DOCUMENT 453-77

# TEST METHODS FOR TELEVISION SYSTEMS AND SUBSYSTEMS

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RANGE COMMANDERS COUNCIL

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# FOREWORD

The purpose of this technical report is to provide definitions, standards, and test procedures which can be directly, or in concept, applied to the testing of television systems and subsystems used with range instrumentation. This report is intended to clarify and/or augment existing government and industry standards and procedures where instrumentation applications are unique or where test ranges would benefit from a commomality of of test procedures. Those procedures which can be defined, as they apply to specific instrumentation systems, will be extracted and published as IRIG standards when such standards are deemed desirable.

The Telecommunications Group (TCG) members were assisted in the preparation of this document by many nonmembers, some serving for as long as two years on the Television Committee of the TCG. Most notable for the quantity of effort expended are: Mike Skinner, YPG; Henry Newton, WSMR; and Jim Rieger, NWC.

## 1.0 TELEVISION SYSTEM SIGNAL STANDARDS

A television system is defined as any interconnection of television equipment operating in synchronism which provides a means for generation, transmission, and reproduction of an input. Such a system uses optical, electronic, magnetic or mechanical methods for converting information from a visual state to an electrical state and, after signal transmission, back to a visual state. The basic components which comprise all television systems regardless of the degree of complexity are:

a. A source generating synchronizing signals

b. One or more sources generating electrical signals which represent picture information

c. A transmission medium

d. One or more output display devices

A functional block diagram showing the interrelation of television equipments employed in a television system is shown in Figure 1 to illustrate general areas of television equipment usage. The basic standards for the electrical signal to be processed by the television system shall be as given in the following paragraphs. These standards are defined for monochrome television signals.

Although this document is concerned with black-and-white (monochrome) television systems, the specifications and test procedures herein can be used for National Television Systems Committee (NTSC) color television systems as well. Demands of a color system on a distribution and switching system are no more taxing than a high-quality black-and-white system, except where noted. Generally, the vertical sync rate for color is slightly different (lower) than in monochrome, being derived from the color reference frequency. The color sync rates are well within the

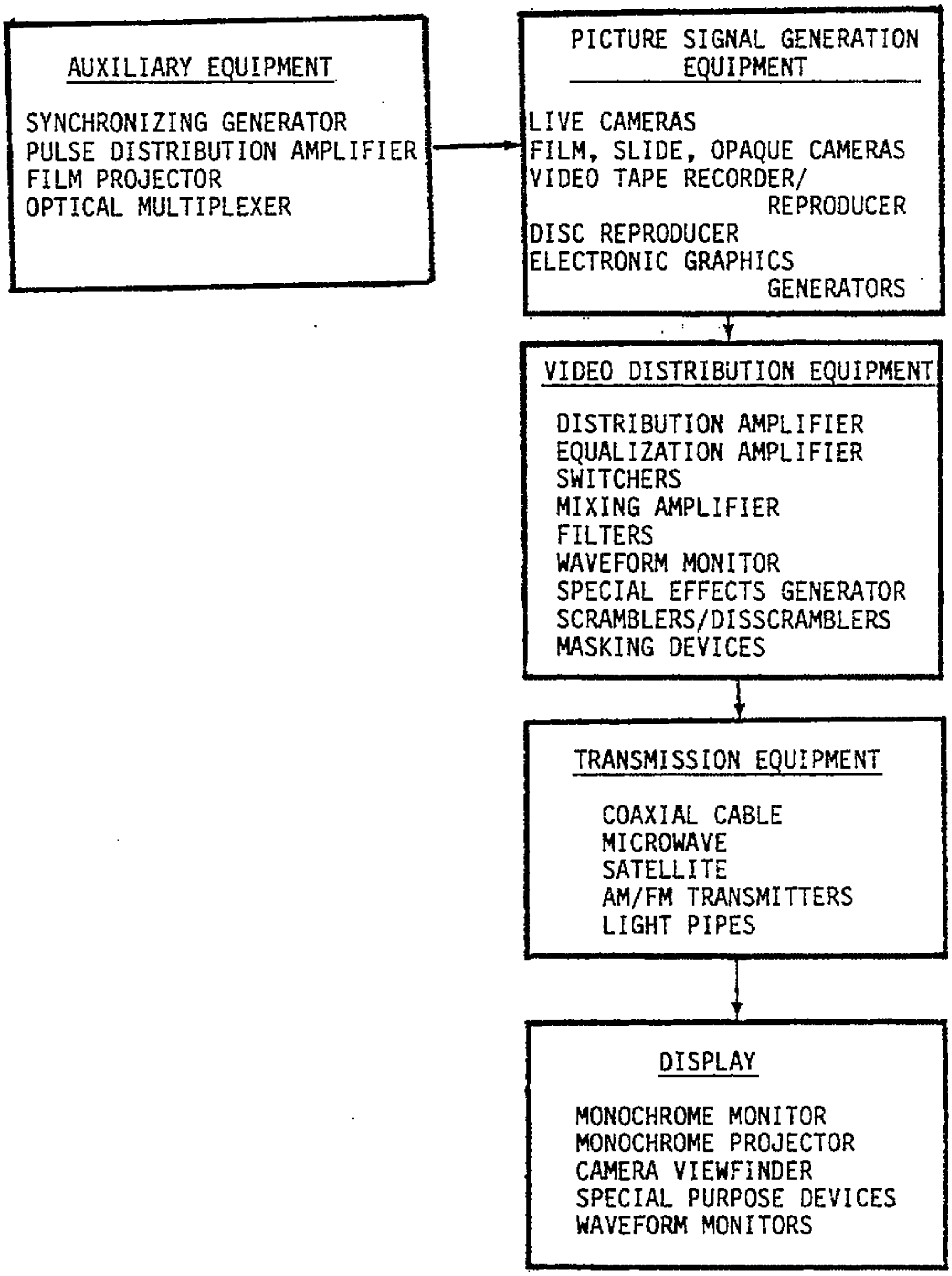



Figure 1. Functional Block Diagram of Television System.

allowable monochrome tolerances, except that a vertical 60 Hz line-lock is an impossibility. Any color signal consists of three or more color separation signals (usually red, green, blue, and orthochromatic black and white) and are combined in a "colorplexer" to form the color signal, which is then processed like any composite signal. Numerous literature references which are beyond the scope of this document may be cited for testing of these additional color circuits.

## 1.1 MONOCHROME VIDEO SIGNALS

The monochrome video signals employed in the television system shall be based upon a scanning raster of 525 lines per frame in two fields interlaced 2:1 and shall conform to the specifications illustrated in Figure 1-1 and detailed or defined in the following paragraphs:

1.1.1 HORIZONTAL SCANNING LINE FREQUENCY. The number of scanning lines per second shall be 15,750 ± 15 Hz. Deviation in the time position of the leading edge of any horizontal drive pulse shall not exceed 0.06% of the average interval between the leading edges of a stream of at least 20 immediately preceding pulses.

1.1.2 FIELDS. The nominal number of fields per second shall be 60. Actual field rate shall be the horizontal frequency divided by 262.5.

1.1.3 FRAMES. The nominal number of frames per second shall be 30. Actual field rate shall be the horizontal frequency divided by 525.

1.1.4 PICTURE SIGNAL LEVEL. The picture signal as measured from blanking level to maximum white level shall be 0.714 ± 0.035 V. This point is defined as 100 units.

1.1.5 SYNCHRONIZING SIGNAL LEVEL. The synchronizing signal level as measured from blanking level to sync level shall be 0.4 ± 0.05 of the peak picture signal level and defined as -40 units.

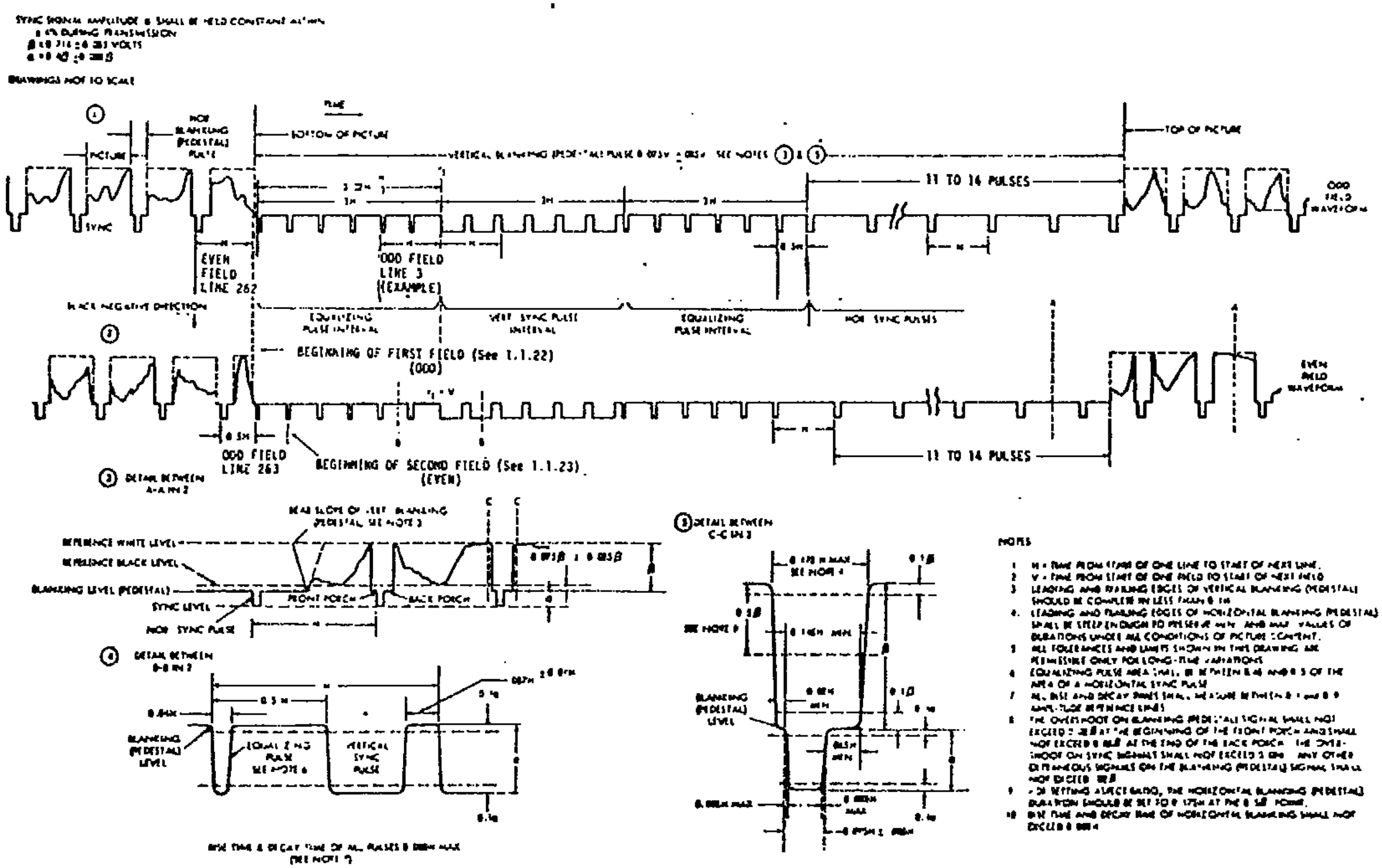



Figure 1-1. Standard Monochrome Video Signal Characteristics.

1.1.6 SYNCHRONIZING SIGNAL LEVEL STABILITY. The synchronizing signal level shall be maintained constant within ± 4% throughout a given transmission even though picture level variations, due to scene characteristics, ranging from 0.075 to 1.00 of peak white level occur. The time between recurrence of sync level variations approaching the maximum permissible shall not be less than one-third of a second.

1.1.7 BLANKING LEVEL AMPLITUDE. The amplitude of the blanking level referred to the ac axis of the signal shall not vary greater than ± 5% of the sync signal amplitude during one field. The ac axis of the signal shall be determined by averaging the signals over one field.

1.1.8 SETUP LEVEL AMPLITUDE. The reference black level shall be separated from the blanking level by the setup interval which shall be 5 to 10 units. Setup is also called "pedestal."

1.1.9 SYNCHRONIZING SIGNAL WAVEFORM. The synchronizing signal waveform shall conform with the specifications detailed in Figure 1-1.

1.1.10 SYNCHRONIZING SIGNAL TIMING STABILITY. The synchronizing signal timing stability of all video signal transmissions, including those video signals generated from video tape, shall be the same as that given in subparagraph 1.1.1.

1.1.11 ASPECT RATIO. The video signal shall provide a picture display which has the aspect ratio of four units horizontally to three units vertically.

1.1.12 SCANNING. During active scanning intervals, the scene shall be scanned from left to right horizontally and from top to bottom vertically, at uniform velocities.

1.1.13 ACTIVE LINES. The number of active scanning (unblanked) lines for the purpose of transmission of visual information shall be within 485 lines maximum and 480 lines minimum per frame.

1.1.14 VERTICAL BLANKING. The number of scanning lines which occur during vertical blanking shall be within 20 lines minimum and 23 lines maximum (0.076 V to 0.088 V; where V is the time interval from the beginning of one field to the beginning of the next field). See also subparagraph 1.1.21.

1.1.15 HORIZONTAL BLANKING. The time of horizontal blanking shall be within the limits of 0.16 H minimum and 0.18 H maximum; where H is the time interval from the beginning of one line to the beginning of the next line, nominally 63.5 μsec.

1.1.16 INTERLACE RATIO. The scanning lines of two fields shall be interlaced to form one frame and thus provide an interlace ratio of 2:1. (This is a natural consequence of the use of an odd number of lines in a frame.)

1.1.17 POLARITY. The polarity of the composite video signal shall be white positive and sync negative and other video signal parameters shall be as specified in ⑤ of Figure 1-1.

1.1.18 COMPOSITE VIDEO SIGNAL LEVEL. Composite video is the video signal mixed with the synchronization signal. The composite video signal voltage level as measured from maximum white to sync level shall be within the limits of 0.98 V minimum to 1.02 V maximum.

1.1.19 PULSE RISE AND DECAY TIMES. The rise and decay times of the leading and trailing edges of the horizontal and vertical sync and of the equalizing pulses shall not exceed 0.003 H or 190 nanoseconds (ns). (For the purpose of this document, rise time is the time taken to get from 10% to 90% of a step input.)

1.1.20 TEST SIGNAL TRANSMISSIONS. The interval beginning with the last 12 msec of line 17 and continuing through line 21 of the vertical blanking interval of each field may be used for the transmission of test signals. Test signals may include: signals used to supply reference modulation levels so that variations in light intensity of the scene viewed by the camera will be faithfully transmitted; signals designed to check the performance of the overall transmission system or its individual components; cue and control signals related to systems operations and analog, digital or test telemetry signals. All test signals transmitted shall be subject to the following conditions as set forth below in addition to those describing the video signal characteristics:

a. Test signals may not be transmitted during that portion of each line devoted to horizontal blanking.

b. A guard interval of no less than one-half line shall be maintained at all times between the last signal and the beginning of the first picture scanning line.

1.1.21 ODD FIELD. The field containing 263 lines and starting the active (unblanked) period with a full line and having its final active line blanked at the midpoint. (See Fig. 1-1.)

1.1.22 EVEN FIELD. The field containing 262 lines commencing at the end of the partially blanked line of the first field and ending after the last complete unblanked line. (See Fig. 1-1.)

1.1.23 UNDERSCAN. A decrease in sweep voltage for the horizontal and vertical deflection of a kinescope or pickup tube, such that only a fraction of the screen is actually scanned. This is done with kinescopes, for example, so that images near the edge of the picture normally masked by the kinescope mounting frame will be visible. Decreasing sweeps in this manner reduce resolution of kinescopes and of pickup tubes. Underscanning can happen accidentally if power supply voltage is low.

1.1.24 APERTURE CORRECTION. Electronic "peaking" or overequalization (or boosting) of the high frequency content of the picture. This makes up in part for the scanning beam not being a point of light, but rather a small circle of finite dimensions.

1.1.25 BRIDGE. Sampling of a voltage on a circuit without drawing appreciable current. For example, a video circuit, whose source, load, and cable characteristic impedance is 75 ohms, can be loaded with an oscilloscope whose input impedance is 10,000 ohms resistive without any visible change in the picture on the load end.

1.1.26 RASTER. The picture display on the face of a kinescope. If the kinescope is illuminated but contains no actual picture, that would be called a "blank raster."

1.1.27 PARABOLA. A pedestal or brightness signal added to the output of a pickup tube which brightens the middle of the picture with respect to the sides or brightens the sides with respect to the middle. This effect can be in the vertical direction, the horizontal direction, or both. Parabola circuits are used to correct for uneven lighting on the original scene or to correct for defects in the pickup tube.

1.1.28 SAW. A pedestal or brightness signal which brightens one side of the picture with respect to the other (in either the vertical or horizontal direction or both) to correct for incorrect lighting in the original scene or for defects in the pickup tube. The name "saw" is used to indicate that, when saw is used with an otherwise evenly illuminated picture, the wave form monitor exhibits sawteeth.

1.1.29 GAMMA. A brightness nonlinearity introduced to compensate for the nonlinearity of kinescope phosphors. Gamma is defined by the expression:

$$\partial = \frac{\Delta \log S_o}{\Delta \log S_i}$$

where $S_o$ is video output in volts and $S_i$ is video input in volts. As gamma decreases from unity, scene details near black are "stretched" at the expense of some highlight detail.

1.1.30 KINESCOPE. The "picture tube" on which the video information is displayed, either for direct viewing or for projection onto a suitable surface. Kinescopes are also referred to as cathode ray tubes (CRTs).

1.1.31 LAP SWITCHING. Since two events cannot possibly take place simultaneously, a switch between two cameras or other video sources must either overlap slightly or have a short "off" interval between them. If there is an overlap, the result is called lap switching. If an input is switched off before the next is switched on, the result is called gap switching. These definitions are similar to those of shorting and nonshorting switches.

1.1.32 GAP SWITCHING. See lap switching (subparagraph 1.1.31).

## 2.0 SYSTEM AND EQUIPMENT TESTS

## 2.1 GENERAL MEASUREMENT TECHNIQUES

### 2.1.1 ANALOG TRANSMISSION TYPES OF SYSTEMS

2.1.1.1 GENERAL. The purpose of this chapter is to provide standard methods for measuring and individual test techniques associated with television systems and equipment parameters.

When using these test techniques some precautions must be observed so that satisfactory results may be obtained and, in some cases, to ensure the safety of the personnel and equipment involved. These are outlined below.

a. Read the pertinent test technique thoroughly before starting any test or obtaining the necessary test equipment so that the test method is understood and there is an awareness of any special precautionary measures.

b. In addition to understanding the test technique, the equipment instruction book should be read and understood by any individual who lacks experience with that type of test equipment.

c. Obtain specific permission from the proper authority before preparing a given circuit for test.

d. When systems or parts of systems are to be tested under working conditions, but not while carrying traffic, they should be adjusted as closely as possible prior to the test.

e. Correct grounding of the system and the test equipment is essential. Where the test equipment and the system under test both require ground connections, these should be made to the same ground point to avoid creating ground return loops which can pick up interfering currents.

f. In many cases, the cooperation of personnel at the distant end of a circuit is necessary. Whenever possible a positive objective check should be made to ensure that instructions have been properly executed (e.g., if a circuit should be terminated in a specific impedance, the operator on the far end must provide and verify that termination).

g. For some of the tests involving back-to-back measurements over a channel or system, an order wire for communication between ends of the system will be required. Special mention of this in the individual test techniques has not been made in cases where the need is obvious.

h. Test equipments must be treated with great care since they are precision scientific instruments. Do not let unskilled personnel operate the equipment. Check all connections and switch positions thoroughly before applying power. Test equipment must be properly calibrated at sufficiently close intervals to assure accurate readings.

## 2.2 TV SYSTEM TESTS

### 2.2.1 VIDEO SIGNAL LEVEL, POLARITY, SYNC COMPRESSION (TV SYSTEMS)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of level, polarity and synchronizing signal compression of a composite video signal in a television system.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Composite Video Level, Polarity and Synchronizing Signal Compression in a Television System. | 2 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Procedure |
|---|---|---|---|
| Oscilloscope, Wideband | A | 3 | 1, 2, 3 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF LEVEL IN A TELEVISION SYSTEM (Figure 2)

(a) Calibrate Wideband Oscilloscope (A) to ensure that the voltage measurement accuracy is within a known tolerance for a full-screen display of 1.0 V over frequency ranges from 30 Hz to 10 MHz.

(b) Ascertain that the system to be tested is correctly terminated (75 ohms) at both input and output locations.

(c) Bridge the oscilloscope across the system terminal to be tested and record the peak-to-peak voltage observed when a signal containing a maximum white level is present. The brightest white on a given picture may be less than maximum; if this is suspected note the peak-to-peak level of sync, it should be 0.286 V.

(d) INPUT AND OUTPUT SIGNAL LEVELS. Video inputs and outputs are composite video signals. The nominal input and output level of a composite video signal across the standard impedance (75 ohms) is 1.0 V peak-to-peak. The nominal amplitude of the picture signal, measured from the blanking level to the reference white level, shall be 0.714 V. Variations in the composite input or output level shall be limited to a range extending from a minimum of 0.7 V to a maximum of 1.4 V peak-to-peak.

(2) MEASUREMENT OF SIGNAL POLARITY IN A TELEVISION SYSTEM (Figure 2)

(a) Determine the deflection polarity of Oscilloscope (A) by testing it with a dc supply or a source of known polarity.

(b) Bridge the oscilloscope across the system terminal under test, adjust the oscilloscope sweep to line or field rate and observe the direction of deflection relative to the synchronizing pulse peaks. The polarity of the signal should be such that sync pulses represent the most negative voltage present.

(3) MEASUREMENT OF SYNCHRONIZING SIGNAL COMPRESSION IN A TELEVISION SYSTEM (Figure 2)

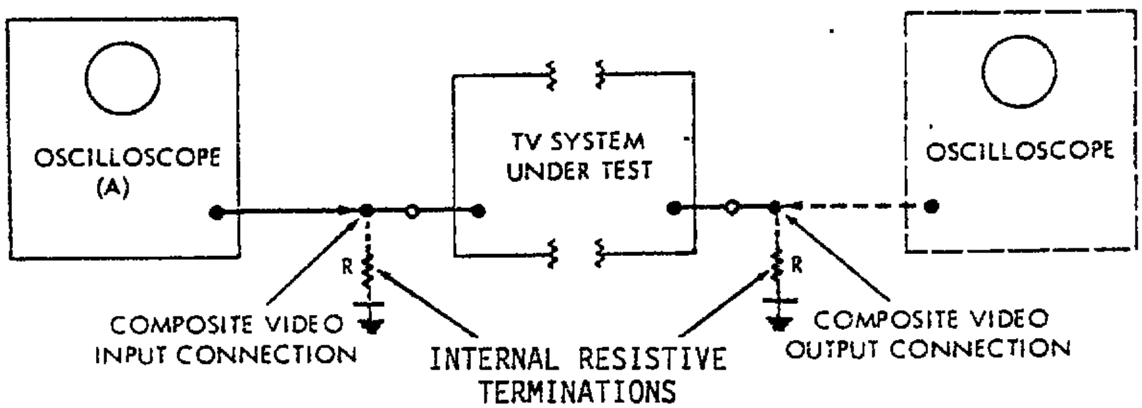
(a) Perform steps (a) and (b) of Procedure (1) above (where the system input and output points are widely separated, it will be necessary to provide calibrated equipment at each location).

(b) Bridge Oscilloscope (A) across the composite video input terminal of the system under test. Adjust the sweep frequency to field rate. Measure the peak-to-peak amplitude of the picture signal (blanking level to reference white level) and the amplitude of the synchronizing pulses (blanking level to synchronizing pulse peak). Verify that the synchronizing pulse amplitude is 40% ± 5% of the picture signal amplitude; a reading in this range is correct within the accuracy of the oscilloscope. If necessary, adjust the signal source to fulfill this requirement. Calculate the input synchronizing signal amplitude as a percentage of the input picture signal amplitude.

(c) Move the oscilloscope to the composite video output terminals of the system under test and adjust the composite signal level to a value between 0.7 V and 1.4 V peak-to-peak. Measure the peak-to-peak picture signal amplitude and the synchronizing signal amplitude as a percentage of the video signal amplitude.

(d) Calculate the change in synchronizing signal amplitude introduced by the system under test. This measurement shall be within four percentage units of the input synchronizing signal amplitude, expressed as a percentage of the input picture signal.

NOTE: Measurements (b) and (c) should be performed simultaneously if possible; as a minimum the interval between measurements shall be as short as possible to reduce the effect of parameter drift.




NOTES: 1. R = TERMINATING RESISTORS (WHERE REQUIRED)
2. CONNECTIONS ARE COAXIAL TYPE

Figure 2. Measurement of Video Signal Level, Polarity, Synchronizing Pulse Compression in a Television System.

2.2.2 VIDEO FREQUENCY RESPONSE (TV SYSTEMS)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of video channel amplitude versus frequency response of a television system.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevent Figure |
|---|---|---|
| 1 | Measurement of Video Channel Amplitude Frequency Response of a Television System | 2-1 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Procedure |
|---|---|---|---|
| Sine Wave Oscillator | A | 2 | 1 |
| Oscilloscope, Wideband | B | 3 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF FREQUENCY RESPONSE OF A TELEVISION SIGNAL CHANNEL (Figure 2-1)

(1) Connect Sine Wave Oscillator (A) to the terminated video input of the television system under test. The generator provides a sine wave in lieu of picture content. With the sine wave frequency adjusted to 100 kHz, set the input level at 1.0 V peak-to-peak.

(2) Connect Wideband Oscilloscope (B) across the terminated video output of the system under test.

(3) Measure the frequency response by observing on the oscilloscope the amplitude of the sine wave at the following frequencies:

(a) For a 4.5 MHz bandwidth system: 30, 60, 100, 200, and 500 Hz; 1, 2, 5, 10, 100 and 500 kHz; 1, 2, 3.58, 4, 4.2, 4.4, 4.5 and 5 MHz.

(b) For a 10 MHz bandwidth system: all the above frequencies, and additionally 6, 7, 8, 9, and 10 MHz.

(4) Convert the amplitude variations into decibel form and compare with specification limits.

(5) Reference Limits. Typical end-to-end video amplitude versus frequency limits for short- and long-haul circuits is shown in Figure 2-1a for 30 Hz to 4.5 MHz.

(6) Single Link. The end-to-end video amplitude versus frequency characteristic for circuits of 1000 nautical miles (nm) in length or less shall be within the limits specified by limits shown as dotted lines in Figure 2-1a from 30 Hz to 4.5 MHz (0 dB reference shall be taken at 160 kHz).

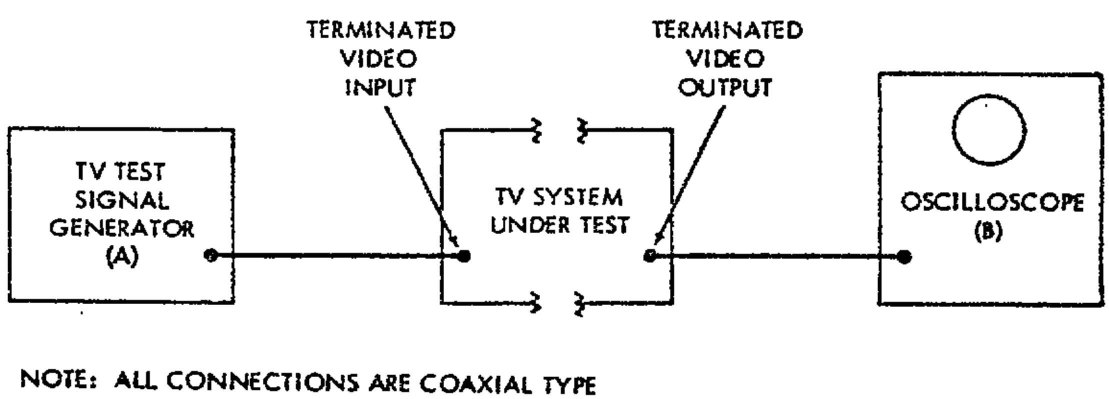



Figure 2-1. Measurement of Video Signal Amplitude Versus Frequency Response of a Television System.

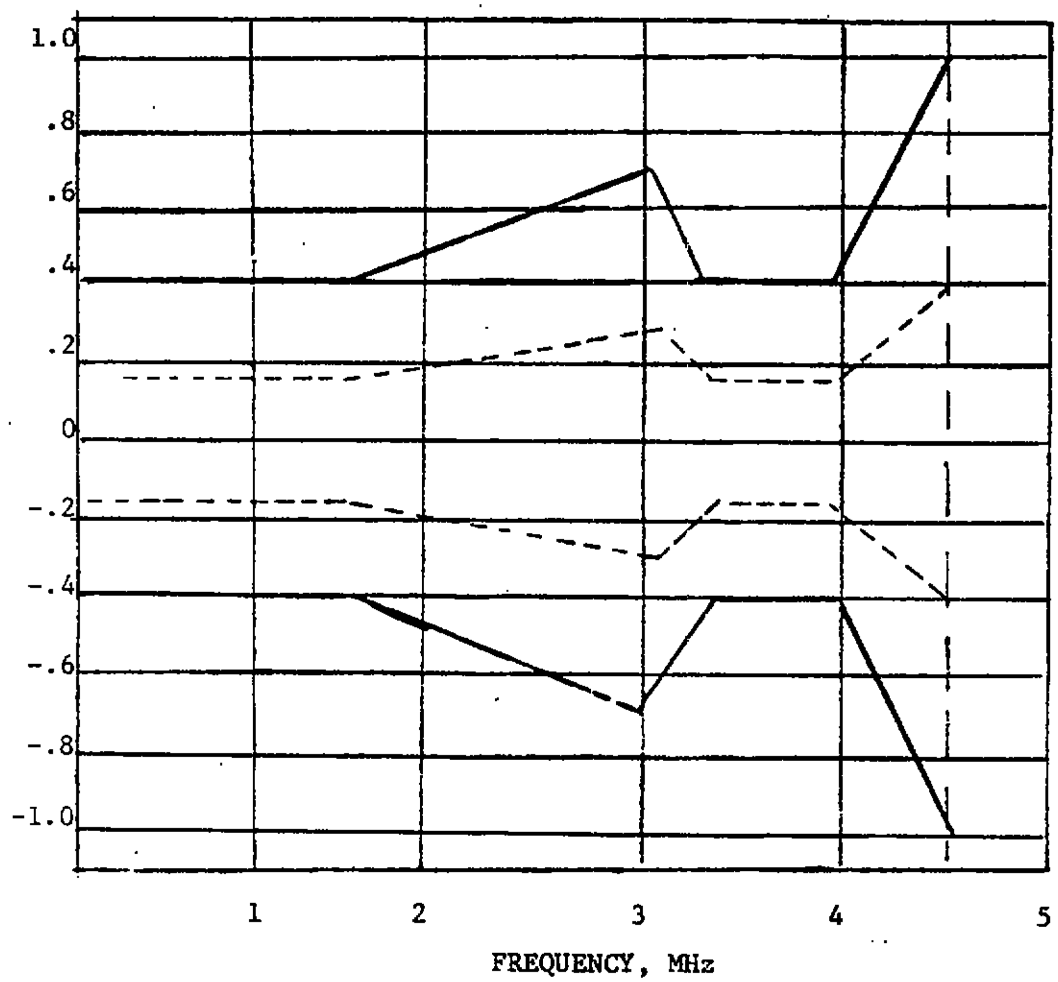



Figure 2-1a. Amplitude Versus Frequency Characteristic of the Video Channel.

2.2.3 WEIGHTED SIGNAL-TO-NOISE RATIO (TV SYSTEMS)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of the weighted signal-to-noise ratio of a television system as specified in the following paragraphs:

SIGNAL-TO-NOISE RATIO. The signal-to-noise ratio shall be defined as the ratio (in decibels) of the peak-to-peak amplitude of the picture signal (reference white to blanking level) to the root mean square (rms) amplitude of noise. Noise, by definition, shall include thermal, intermodulation, and termination equipment noise, but exclude low frequency hum, which is specified separately. Noise bandwidth shall be the same as picture bandwidth, falling 12 dB/octave or faster thereafter.

(1) Reference Circuit. The median signal-to-noise ratio of a long-haul circuit shall be at least 52 dB. Signal-to-noise ratio of 40 dB shall be exceeded 99.9% of any yearly period for systems subject to atmospheric fading.

(2) Single Link. The median weighted signal-to-noise ratio for a reference link (1000 nm) shall be at least 60 dB. A weighted signal-to-noise ratio of 40 dB shall be exceeded at least 99.983% of the time.

(3) Single Section. The median weighted signal-to-noise ratio for circuits of length 333 miles or less shall be at least 65 dB. A weighted signal-to-noise ratio of 40 dB shall be exceeded at least 99.995% of the time.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Weighted Signal-to-Noise Ratio of a Television System | 2-2 |

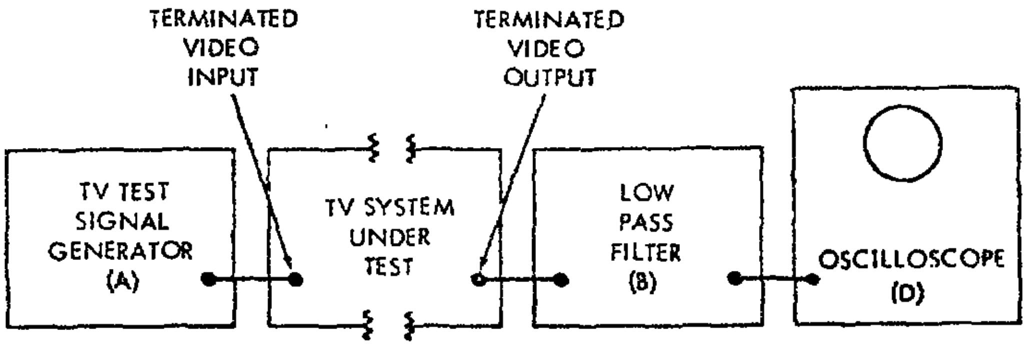
c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Procedure |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1 |
| Low-Pass Filter (Note Paragraph d (2) below) | B | --- | 1 |
| Oscilloscope, Line Selector | D | 3 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF WEIGHTED SIGNAL-TO-NOISE RATIO OF A TELEVISION SYSTEM (Figure 2-2)

(1) Connect TV Test Signal Generator (A) to the terminated input of the system under test. Set up the generator to supply a composite video waveform with a window signal as picture content. Adjust the window horizontal dimension to approximately 50% of raster width. Adjust setup level (see subparagraph 1.1.18) to an amplitude that is 10% of the reference white amplitude (10 units). Set the composite signal to a level of 1.0 V peak-to-peak.




NOTE: CONNECTIONS ARE COAXIAL TYPE

Figure 2-2. Measurement of Weighted Signal-to-Noise Ratio of a Television System.

(2) Connect the terminated system output via Low-Pass Filter (B). The cutoff frequency of the low-pass filter shall correspond to the nominal bandwidth of the system under test (see NOTE below). The output is then connected to the input of the wideband, Line Selector Oscilloscope (D). Noise voltage (rms) is related to 2σ (roughly 95% limits) by $V_{rms} = \frac{1}{4} V_{pp/2\sigma}$.

NOTE: Filters shall be of a passive, low-pass type designed to restrict the transmission of frequency components contained in a video signal which are above a desired upper frequency limit. Typical filters would have upper cutoff frequency ($f_c$) of 4.2 MHz or 10.0 MHz. The filters shall be designed for 75 ohm single input/single output operation.

2.2.4 LINEAR WAVEFORM DISTORTION (TV SYSTEMS)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of field time, line time and short time waveform distortion in television systems as specified in subparagraphs d. (1) (d), d. (2) (d) and d. (3) (d).

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Linear Waveform Distortion in a Television System | 2-3 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. In Appendix A | Used in Test Procedure |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1, 2, 3 |
| TV Waveform Monitor | B | 21 | 1, 2, 3 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF FIELD TIME WAVEFORM DISTORTION IN A TELEVISION SYSTEM (Figure 2-3a)

(a) Connect TV Test Signal Generator (A) to the terminated video input of the television system under test. Employ Waveform Monitor (B) to measure the waveforms appearing at the terminated output of the system.

(b) Adjust the signal generator to provide a 60 Hz square wave superimposed upon horizontal synchronizing pulses and blanking pulses (corresponding to the input signal delineated in Figure 2-3a.)

(c) With the waveform monitor set for field rate, measure any level variations of the output signal that occur within the "tolerance envelope" shown in Figure 2-3a and determine the percentage deviation from the input waveform. Check for compliance with the appropriate tolerance, depending upon whether the signal is clamped or unclamped. (Allowance should be made for the field time waveform distortion of the waveform monitor itself, which should be measured by preliminary calibration.)

(d) FIELD TIME LINEAR WAVEFORM DISTORTION. Field time linear waveform distortion is indicated by the extent to which a field frequency square wave, incorporated as picture content in the television signal input to a transmission circuit, is reproduced at the output with tilt or other variations in level occurring during its white interval. The time regions within 250 μsec of black/white or white/black square wave transitions are excluded from consideration, together with horizontal blanking intervals.

For a standard television distribution circuit, or any portion thereof, the variations within the white level portion of the square wave shall be no greater than ± 5%, if the signal is unclamped, of the amplitude difference between the level at the midpoint of the white interval and the level at the midpoint of the black interval. For a clamped signal the tolerance is ± 1% instead of ± 5%.

(2) MEASUREMENT OF LINE TIME WAVEFORM DISTORTION IN A TELEVISION SYSTEM (Figure 2-3b)

(a) Connect TV Test Signal Generator (A) to the terminated video input of the television system under test. Employ Waveform Monitor (B) to measure the waveforms appearing at the terminated output of the system.

(b) Arrange the signal generator to supply a test signal conforming to Figure 2-3b. This is a pulse signal at nominal line rate (approximately 15,750 pulses per second) with the pulse rise and decay portions following a sine-squared curve; the pulse signal is superimposed upon horizontal synchronizing and blanking pulses.

(c) Synchronize the waveform monitor to the test signal rate and examine the system output waveform. Measure the variation in level of the pulse within the tolerance envelope delineated in Figure 2-3b and determine whether the distortion is within the allowable limits.

(d) LINE TIME LINEAR WAVEFORM DISTORTION. Line time linear waveform distortion is indicated by the extent to which a line frequency square wave, incorporated as picture content in the television signal input to a transmission circuit, is reproduced at the output with tilt or other variations in level occurring during its white interval. The time regions with 1 μsec of the black/white or white/black square wave transitions are excluded from consideration.

For proper operation. the variations within the white portion of the square wave should be no greater than ± 1% of the amplitude difference between the levels at the midpoint of the black interval.

(3) MEASUREMENT OF SHORT TIME WAVEFORM DISTORTION IN A TELEVISION SYSTEM (Figure 2-3c)

(a) Connect TV Test Signal Generator (A) to the terminated video input of the television system under test. Utilize Waveform Monitor (B) to measure the waveforms appearing at the terminated output of the system.

(b) Set up the signal generator to supply a sine-squared pulse of 0.11 μsec half-amplitude duration, as depicted in Figure 2-3c, at a repetition rate of nominally 15,750 pulses per second. Adjust the input level to 1.0 peak-to-peak.

(c) Set the waveform monitor to sweep at nominal line rate and synchronize with the test signal. Using the monitor graticule, measure the amplitudes of the first negative lobes leading and trailing the output pulse. Determine the percentage amplitude of each negative lobe relative to the peak positive pulse amplitude and check for compliance with allowable limits.

(d) SHORT TIME LINEAR WAVEFORM DISTORTION. Short time linear waveform distortion is indicated by the extent to which a positive sine-squared pulse with a half amplitude duration of 0.11 μsec, introduced at the input to a television transmission circuit, is reproduced at the output with negative lobes preceding and/or following the pulse.

For proper operation, the amplitude of the first leading and/or trailing negative lobe should not exceed 13% of the peak positive amplitude of the output pulse.

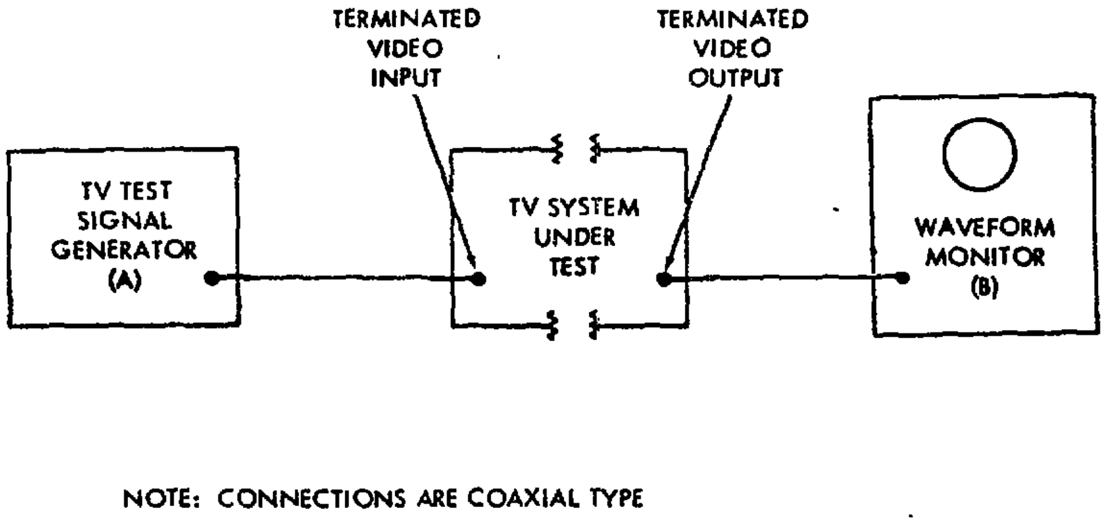
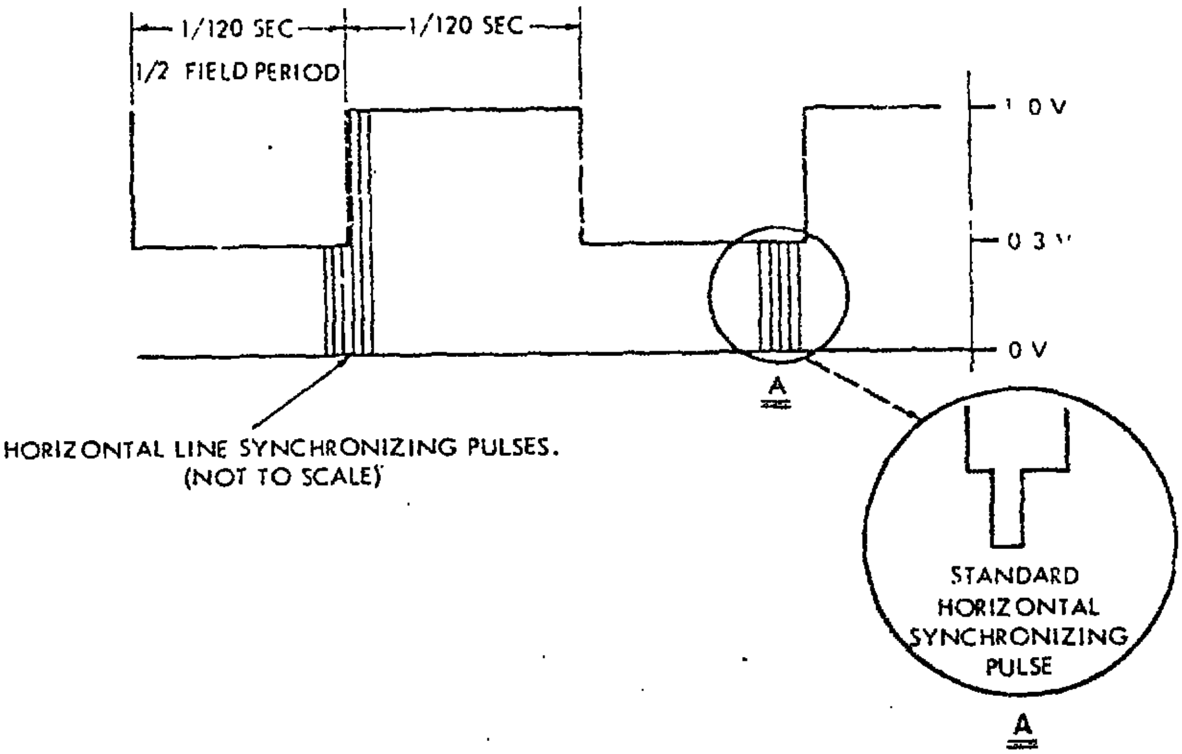



Figure 2-3. Measurement of Linear Waveform Distortion of a Television System.

INPUT SIGNAL




NOTES: 1. PEDESTAL (SETUP LEVEL) MAY BE OMITTED.
2. VERTICAL (FIELD) SYNC MAY BE INCLUDED.

AREA OF OUTPUT TOLERANCE APPLICABILITY

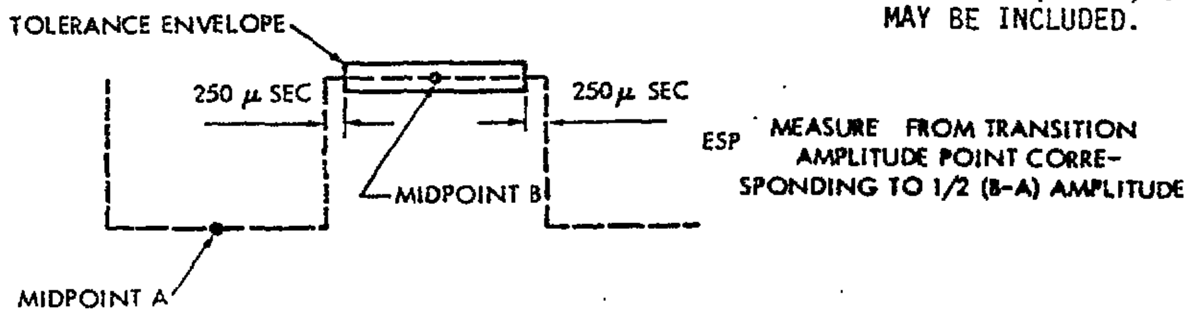
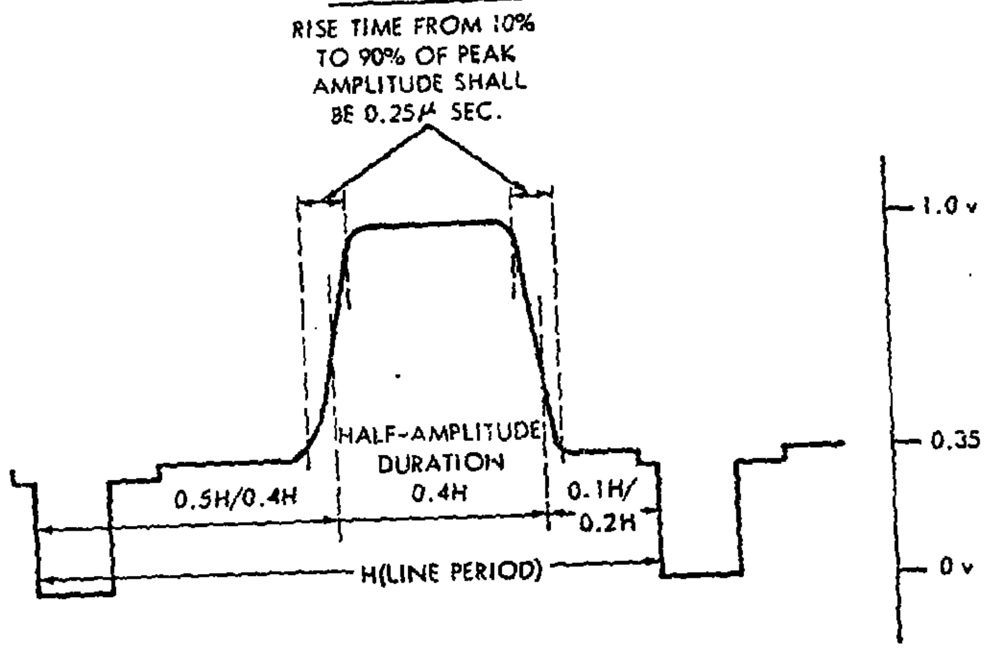



Figure 2-3a. Field Time Linear Waveform Distortion Test Signal.

INPUT SIGNAL




NOTES:
1. FIELD SYNC MAY BE INCLUDED.
2. RISE AND DECAY OF BAR SHALL FOLLOW $SIN^2$ CURVE.
3. SLOPES NOT TO SCALE.

AREA OF OUTPUT TOLERANCE APPLICABILITY

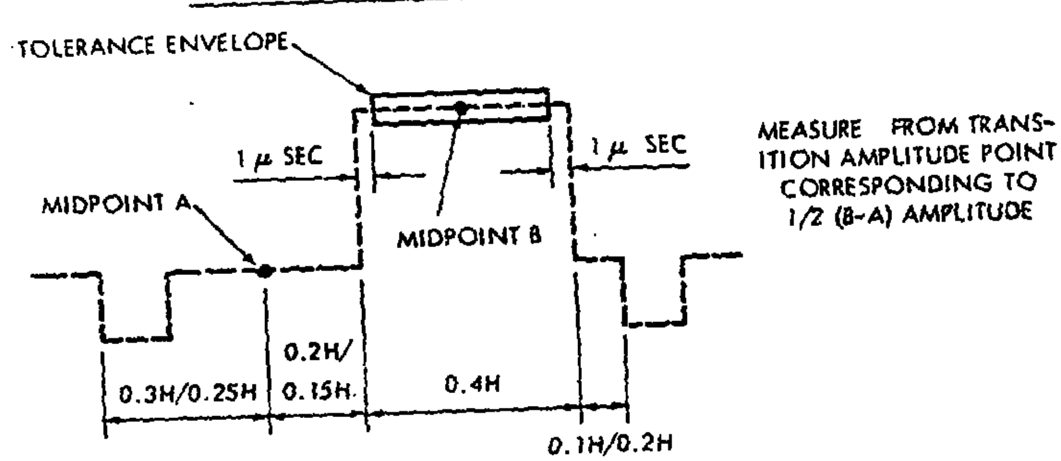



Figure 2-3b. Line Time Linear Waveform Distortion Test Signal.

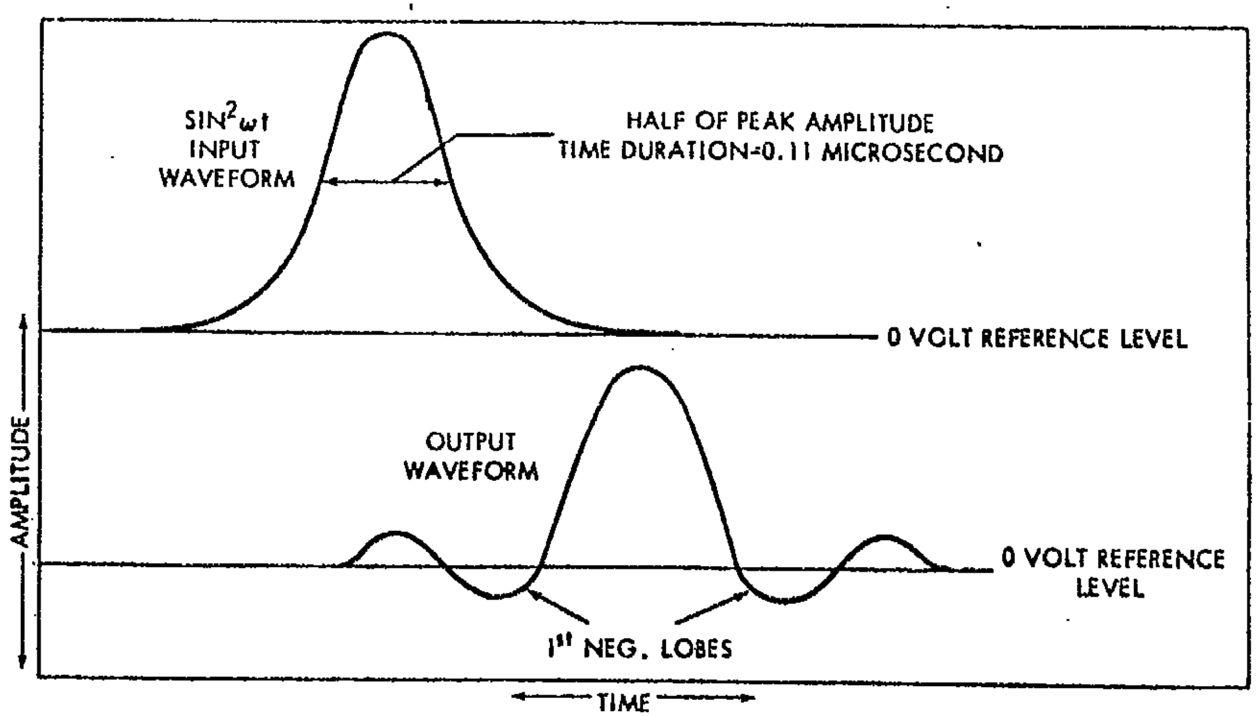



Figure 2-3c. Short Time·Linear Waveform Distortion Test Signal.

## 2.3 PICTURE SIGNAL GENERATION EQUIPMENT TESTS

### 2.3.1 TV CAMERA CHAINS

#### 2.3.1.1 HORIZONTAL RESOLUTION RESPONSE (TV CAMERA CHAINS)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of horizontal resolution response of monochrome camera chains and monochrome film and slide camera chains. The tests are applicable to the standards specified in the following paragraphs:

HORIZONTAL RESOLUTION RESPONSE

(1) IMAGE ORTHICON CAMERA. The minimum horizontal resolution response (depth of modulation as a percentage of peak-white-reference-black amplitude) for image orthicon camera chains shall be as specified in Table I. This performance shall be obtained when the camera lens is set at one f/stop above the knee of the image orthicon tube, with aperture correction* set at zero and the camera viewing a standard resolution chart that has 800-line resolution "wedges" in the center and corners.

**Aperture correction is high-frequency "peaking"; used to increase apparent horizontal resolution.*

TABLE I

IMAGE ORTHICON RESOLUTION RESPONSE

| Horizontal TV Lines | Resolution Response in % | | | |
|---|---|---|---|---|
| | 3" Image Orthicon | | 4½" Image Orthicon | |
| | Center | Corners | Center | Corners |
| 100 | 100 | 100 | 100 | 100 |
| 200 | 100 | 90 | 100 | 100 |
| 300 | 85 | 70 | 100 | 85 |
| 400 | 60 | 45 | 80 | 85 |
| 500 | 35 | 23 | 55 | 40 |
| 600 | 20 | 10 | 30 | 19 |
| 700 | 10 | 2 | 15 | 7 |
| 800 | 4 | -- | 7 | -- |

(2) VIDICON CAMERAS. The minimum horizontal resolution response of vidicon camera chains, when set for zero aperture correction*, and viewing a standard resolution chart that has 800-line resolution "wedges" in the center and corners, shall be as specified in Table II.

*Aperture correction is high-frequency "peaking"; used to increase apparent horizontal resolution.

TABLE II

VIDICON RESOLUTION RESPONSE

| Horizontal TV Lines | Resolution Response in % | | | |
|---|---|---|---|---|
| | 1" Vidicon | | 1.5" Vidicon | |
| | Center | Corners | Center | Corners |
| 100 | 93 | 78 | 100 | 85 |
| 200 | 70 | 59 | 90 | 76 |
| 300 | 45 | 38 | 75 | 64 |
| 400 | 30 | 25 | 60 | 50 |
| 500 | 20 | 17 | 47 | 40 |
| 600 | 10 | 8 | 35 | 29 |
| 700 | 3 | - | 25 | 21 |
| 800 | - | - | 17 | 14 |

(3) MONOCHROME FILM AND SLIDE CAMERA CHAIN. The center resolution response (depth of modulation as a percentage of peak-white-to-reference-black amplitude) with zero aperture correction shall equal resolution obtained in normal vidicon systems for tubes of the same size. If the system is a flying-spot scanner pickup, resolution shall equal or exceed resolution of a 1.5 in. vidicon. The corner resolution response shall be within 15% of the values specified for center resolution response.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Horizontal Resolution Response-TV Camera Chain | 2-4 |
| 2 | Horizontal Resolution Response TV Film and Slide Camera Chain | 2-4a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Oscilloscope (Wideband, Line Selector Type) | A | 3* | 1,2 |
| Monochrome Picture Monitor | B | 22 | 1,2 |
| Special Resolution Chart | D | 6 | 1 |
| TV Synchronizing Generator** | E | 15 | 1,2 |
| Special Resolution Chart | F | 6a | 2 |
| TV 35mm Slide Projector | G | 9 | 2 |

*Or use item 21.
**May be part of Unit under Test.

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

The following tests are performed to determine the amount of resolvable display detail available from the camera in the horizontal direction in the picture. The measurements are made by observation of the waveforms displayed on a line-selector oscilloscope as specific portions of a resolution chart are scanned by the camera. The figure to be recorded as the depth of modulation expressed as a percentage of the peak-white-reference-black amplitude. Tests are made at 100, 200, 300, 400, 500, 600, 700 and 800 lines at the center and the corners of the chart.

(1) MEASUREMENT OF HORIZONTAL RESOLUTION RESPONSE OF MONOCHROME CAMERA CHAIN (Figure 2-4).

For image orthicon cameras, the performance shall be measured when the camera tube is operating at one lens stop opening above the knee of the curve.

(a) Focus and align the camera upon Special Resolution Chart (D), which is designed for resolution measurements of at least 800 lines at both the center and the corners of the raster. Connect the terminated output of the camera chain to Monochrome Picture Monitor (B). Bridge the wideband, line-selection oscilloscope on Waveform Monitor (A) across the output of the camera chain. Connect TV Synchronizing Generator (E) to provide external synchronization if required. Set aperture correction to zero. Use underscanned monitor display to ensure precise alignment of test chart on the raster.

(b) Using line-selection techniques and the calibrated resolution lines at the center and the corners of the chart, measure the peak-to-peak signal amplitude at 100, 200, 300, 400, 500, 600, 700 and

800 line positions. Calculate for each position the percentage of peak-to-peak signal amplitude relative to the normal peak-white-to-reference-black amplitude. This resolution will probably not be apparent on the monitor (B) because the monitor may have limited frequency response and/or peaking circuits. The monitor is thus used for alignment only.

MEASUREMENT OF HORIZONTAL RESOLUTION RESPONSE OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-4a)

(a) Load 35mm TV Slide Projector (G) with Special Resolution Chart Slide (F), which is designed for resolution measurements of at least 800 lines at both the center and the corners of the raster. Position and adjust the projector to provide a properly dimensioned optical image of the chart on the photosensitive surface of the camera tube. Connect the terminated output of the camera chain to Monochrome Picture Monitor (B). Bridge the wideband, line-selection oscilloscope or have Waveform Monitor (A) across the output of the camera chain. Use underscanned monitor display to verify precise alignment of test chart on the raster. Set aperture correction of camera chain to zero. Connect TV Synchronizing Generator (E) to provide external synchronization, if required.

(b) Using line-selection techniques and the calibrated resolution lines at the center and the corners of the chart, measure the peak-to-peak signal amplitudes at the specified values of horizontal resolution. Calculate, in terms of percentage, the peak-to-peak signal amplitudes relative to the peak-white-to-reference-black amplitude.

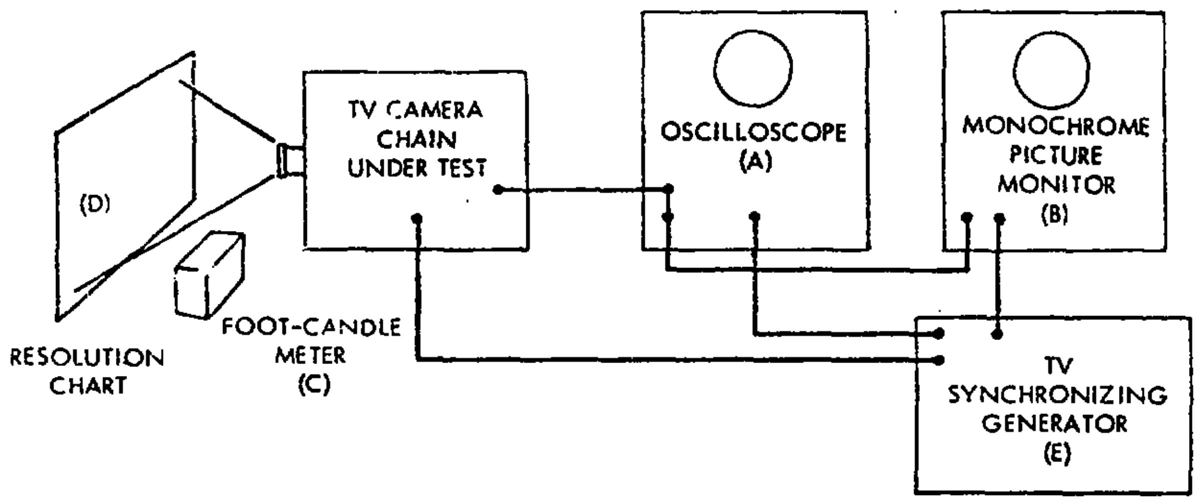
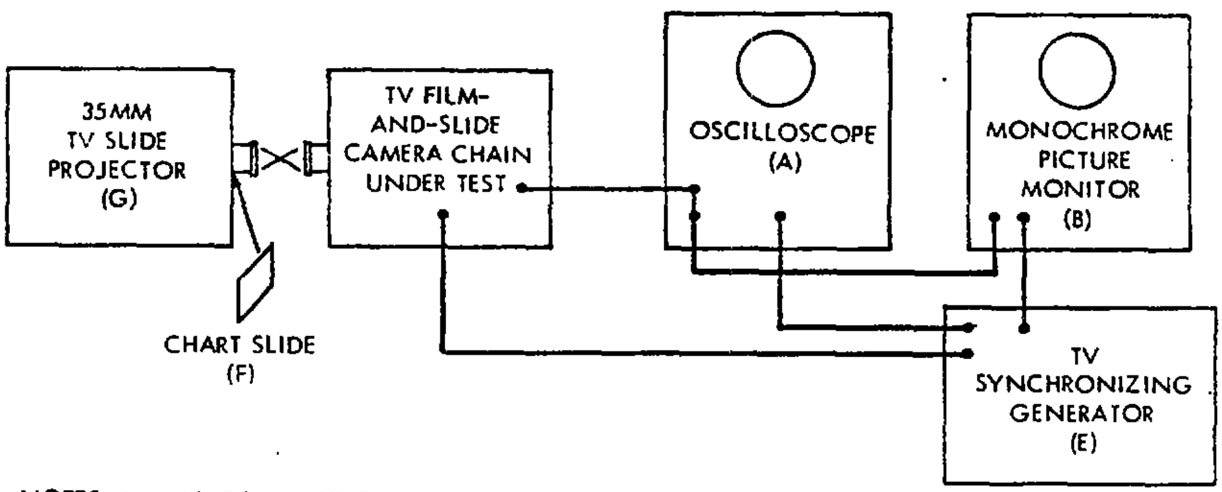



Figure 2-4. Measurement of Horizontal Resolution Response of TV Camera Chain.




NOTES: 1. ALL CONNECTIONS ARE COAXIAL TYPE
2. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-4a. Measurement of Horizontal Resolution Response of TV Film and Slide Camera Chain.

2.3.1.2 FREQUENCY AND PHASE RESPONSE AND APERTURE CORRECTION (TV CAMERA CHAINS)

a. APPLICABILITY. Frequency response measurements in this section include the characteristics of amplitude versus frequency, low frequency tilt and overshoot. The test arrangements in subparagraph b. below are applicable to the measurement of the frequency response characteristics and aperture correction of monochrome cameras and monochrome film and slide camera chains as specified in the following paragraphs:

(1) FREQUENCY RESPONSE. With zero aperture correction, the frequency response shall be flat $\pm$ 1.0 dB from 30 Hz to 10 MHz for the complete video channel from the camera preamplifier input to the camera output.

(2) APERTURE CORRECTION. Continuously variable aperture correction shall be provided for a monochrome signal which makes up to 12 dB of gain available at a frequency of 10 MHz.

(3) OVERSHOOT. With zero aperture correction, the overshoot to a square wave signal having a rise time of 0.1 µsec shall be less than 1% of the square wave amplitude.

(4) LOW-FREQUENCY TILT. The tilt imparted to a 60 Hz square wave passing through the complete video channel shall be less than 1% of the square wave amplitude.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Frequency Response and Aperture Correction - TV Cameras (Image Orthicon Sections) | 2-5 |
| 2 | Measurement of Frequency Response and Aperture Correction - TV Cameras (Vidicon Sections) | 2-5a |
| 3 | Measurement of Aperture Correction - TV Cameras | 2-5b |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1,2 |
| Oscilloscope, Wideband | B | 3 | 1,2 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF FREQUENCY RESPONSE - MONOCHROME CAMERA - IMAGE ORTHICON TYPE (Figure 2-5)

(a) Connect TV Test Signal Generator (A) to the input of the Camera Video Preamplifier (V) and set generator to provide a sine wave signal of 100 kHz that is blanked during horizontal and vertical blanking intervals. Cap camera lens.

(b) Adjust the amplitude of the test input signal to a value equivalent to the signal voltage produced when the normal current of the image orthicon final dynode is flowing through its load resistor.

(c) Connect Wideband Oscilloscope (B) to the Terminated Output (Y) of the camera video amplifier.

(d) Measure the output amplitudes on the oscilloscope at the following input frequencies: 30, 60, 100 and 500 Hz; 1, 10, 100, 250, 500 and 750 kHz; and 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 MHz.

(e) Convert the output voltage variations into decibel form, where $dB = 20 \log \frac{V\ test}{V\ ref}$

(2) MEASUREMENT OF APERTURE CORRECTION - MONOCHROME CAMERA - IMAGE ORTHICON TYPE (Figure 2-5)

(a) Repeat steps 1.(a), (b) and (c) of Procedure (1) with connections as in Figure 2-5.

(b) Set TV Test Generator (A) to a frequency of 10 MHz.

(c) Adjust input signal level to produce a video output level at (Y) of 0.7 V, peak-to-peak, with aperture correction set at maximum gain.

(d) Set aperture correction to zero and remeasure output amplitude. Convert the ratio of the two output amplitudes to decibel form.

(3) MEASUREMENT OF FREQUENCY RESPONSE - MONOCHROME CAMERA - VIDICON TYPE (Figure 2-5a)

(a) Set TV Test Signal Generator (A) to provide a sine wave signal that is keyed out during horizontal and vertical blanking intervals. Connect the generator to the camera video preamplifier input (point V) through a resistive impedance $R_p$ that is at least ten times greater than the camera tube target load resistor $R_L$. It is recommended that a string of lower value resistors be used; these should be soldered together with short leads and arranged to minimize shunt capacitance across the string. The connection to the preamplifier shall be made as short as possible to minimize capacitive coupling and loading while providing a current feed input. If the vidicon target is dc coupled to the preamplifier input stage, it may be necessary to employ capacitor $C_1$ at the generator output to provide ac coupling.

(b) The vidicon tube socket shall be disconnected and the vidicon pins grounded directly or through a large capacitor.

(c) Connect Wideband Oscilloscope (B) to the terminated video output of the camera.

(d) Set TV Test Signal Generator (A) to a level that provides preamplifier input at approximately the voltage that is produced when the normal operating vidicon target current is flowing through the load resistor $R_L$.

(e) Measure the output amplitudes on the oscilloscope at the following input frequencies: 30, 60, 100 and 500 Hz; 1, 10, 100 and 500 kHz; and 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 MHz.

(f) Convert output voltage variations into decibel form.

(4) MEASUREMENT OF APERTURE CORRECTION - MONOCHROME CAMERA - VIDICON TYPE (Figure 2-5a)

(a) Repeat steps (3) (a), (b), (c) and (d) of Procedure (3) with connections as in Figure 2-5a.

(b) Set TV Test Signal Generator (A) to a frequency of 10 MHz.

(c) Adjust input signal level to produce a video output level at (Y) of 0.7 V, peak-to-peak, with aperture correction set at maximum gain.

(d) Set aperture correction to zero and remeasure output amplitude. Convert the ratio of the two output amplitudes to decibel form.

(5) MEASUREMENT OF LOW-FREQUENCY RESPONSE (TILT) OF TV CAMERA - IMAGE ORTHICON TYPE (Figure 2-5)

Low-frequency response is evaluated in terms of the ability of the equipment to pass low-frequency square waves with minimum tilt. Tilt is a form of distortion of a rectangular pulse characterized by the introduction of slope on the horizontal components of the pulse. It is measured as the ratio, expressed as a percentage, between the amplitude of the slope component and the amplitude of the pulse.

(a) Follow steps (a), (b) and (c) of Procedure (1), except that the Signal Generator shall be set to supply a 60 Hz square wave instead of a sine wave. Synchronize square wave to field frequency.

(b) Measure the tilt by scaling the oscilloscope presentation of the 60 Hz square wave.*

(6) MEASUREMENT OF OVERSHOOT OF TV CAMERA - IMAGE ORTHICON TYPE (Figure 2-5)

Overshoot can be described as the amount by which a transient rise exceeds its final value. It is commonly tested by applying a square pulse signal to the equipment under test and measured as the percentage by which the first peak following the rise exceeds the flat top amplitude of the pulse.

(a) Follow steps (a), (b) and (c) of Procedure (1), except that the Signal Generator shall be set to supply a square wave of approximately 100 kHz frequency, synchronized to the television signal line frequency. The square wave shall have a rise time no greater than 0.1 μsec.

(b) Measure the percentage overshoot by scaling the oscilloscope display of the square wave output signal.

(7) MEASUREMENT OF LOW-FREQUENCY RESPONSE (TILT) OF TV CAMERA - VIDICON TYPE (Figure 2-5a)

Low-frequency response is evaluated in terms of the ability of the equipment to pass low-frequency square waves with minimum tilt. Tilt is a form of distortion of a rectangular pulse characterized

*Prior to the test, the Signal Generator-Oscilloscope combination shall have been checked for freedom from tilt at the test frequency; allowance shall be made for any tilt attributable to the test equipment.*

by the introduction of slope on the horizontal components of the pulse. It is measured as the ratio, expressed as a percentage, between the amplitude of the slope component and the amplitude of the pulse.

(a) Follow steps (a), (b), (c) and (d) of Procedure (3), except that the Signal Generator shall be set to supply a 60 Hz square wave instead of a sine wave. Synchronize square wave to field frequency.

(b) Measure the tilt by scaling the oscilloscope presentation of 60 Hz square wave.*

(8) MEASUREMENT OF OVERSHOOT OF TV CAMERA - VIDICON TYPE (Figure 2-5a)

Overshoot can be described as the amount by which a transient rise exceeds its final value. It is commonly tested by applying a square pulse signal to the equipment under test and measured as a percentage by which the first peak following the rise exceeds the flat top amplitude of the pulse.

(a) Follow steps (a), (b), (c) and (d) of Procedure (1), except that the Signal Generator shall be set to supply a square wave of approximately 100 kHz frequency, synchronized to the television signal line frequency. The square wave shall have a rise time no greater than 0.1 μsec.

(b) Measure the percentage overshoot by scaling the oscilloscope display of the square wave output signal.

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**Prior to the test, the Signal Generator-Oscilloscope combination shall have been checked for freedom from tilt at the test frequency; allowance shall be made for any tilt attributable to the test equipment.*

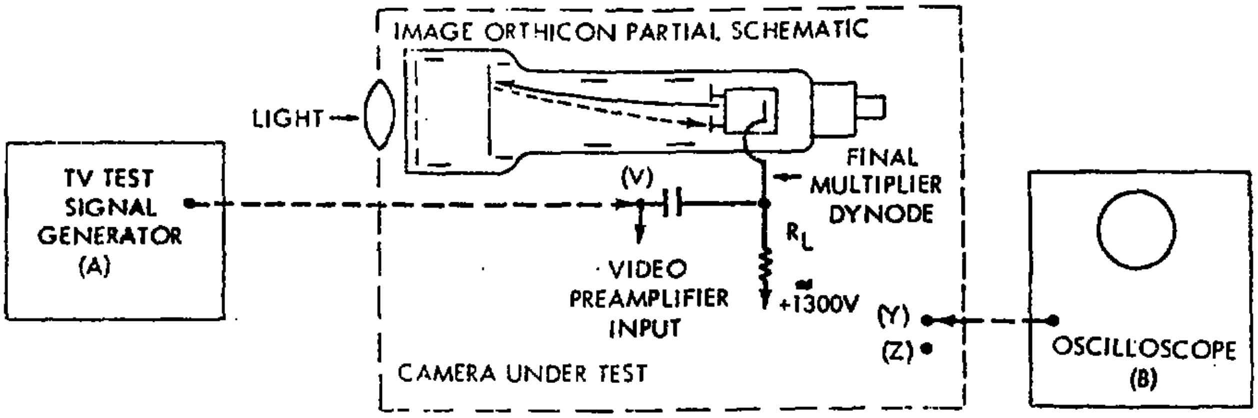
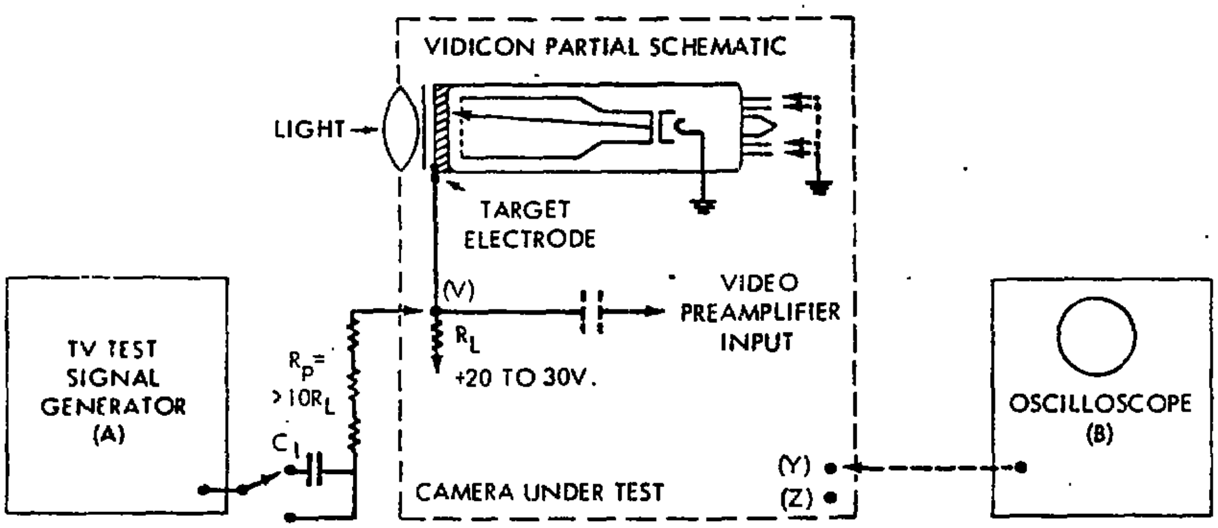



Figure 2-5. Measurement of Frequency Response and Aperture Correction of Television Cameras - Image Orthicon.




NOTES:
1. V = VIDEO PREAMPLIFIER INPUT
   Y = CAMERA VIDEO OUTPUT
   Z = COLOR CAMERA VIDEO CONNECTION AT INPUT TO COLOR ENCODER (WHERE ENCODER IS INTEGRAL WITH CAMERA)
2. $R_p$ IS A TEST SIGNAL INPUT RESISTOR COMPOSED OF SEVERAL RESISTORS ASSEMBLED WITH SHORT LEADS FOR MINIMUM CAPACITANCE. TOTAL RESISTANCE SHALL BE GREATER THAN TEN TIMES VIDICON TARGET LOAD RESISTOR ($R_L$)
3. $C_1$ IS A CAPACITOR THAT MAY BE REQUIRED TO ISOLATE DC VOLTAGES

Figure 2-5a. Measurement of Frequency Response and Aperture Correction of Television Cameras - Vidicon Type.

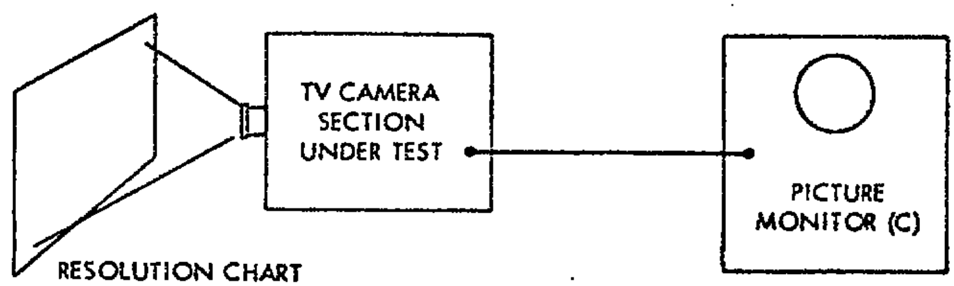



Figure 2-5b. Measurement of Aperture Correction - Television Cameras.

2.3.1.3 INTERLACE (TV CAMERA CHAINS).

Interlace measurements pertain to the accuracy with which the scanning lines of one field are centered between the scanning lines of the alternate field in a two-field-per-frame system.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of interlace of monochrome camera chains and monochrome film and slide camera chains as specified in the following paragraph:

INTERLACE. The displacement of any scanning line from a central position between lines of the alternate field shall not exceed ± 10% of the distance between lines of the alternate field.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Interlace of Monochrome Camera Chains | 2-6 |
| 2 | Measurement of Interlace of Monochrome Film and Slide Camera Chains | 2-6a |

C. TEST EQUIPMENT REQUIRED

| TEST Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Oscilloscope, Line Selector Type | A | 3 or 21 | 1,2 |
| Monochrome Picture Monitor | B | 22 | 1,2 |
| Resolution Chart | C | 5 | 1 |
| Resolution Chart Slide | D | 5a | 2 |
| Special Wedge Chart | E | -- | 1 |
| 5 Special Wedge Chart Slides | F | -- | 2 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF INTERLACE OF TV CAMERA CHAINS - MONOCHROME (Figure 2-6)

(a) Prepare a special wedge chart consisting of an 18" X 24" rectangle of low reflectance black cardboard and a small trapezoid of white cardboard or similar material having a reflectance coefficient approximating that of the white background of a Standard Resolution Chart. The trapezoid shall have a base of 4.0", a perpendicular left side of 0.75" and a perpendicular right side of 1.0".

(b) Focus the camera upon Standard Resolution Chart (C). Connect the camera video output on a bridged-through basis to line selector Oscilloscope (A) and terminate in Monochrome Picture Monitor (B). Adjust the camera to supply a composite video output signal level of 1.0 V, peak-to-peak. Observe the picture monitor display to verify focus and determine that the resolution chart image fully occupies the frame.

(c) Cover the Standard Resolution Chart with Special Wedge Chart (E) and locate the white trapezoid initially on the upper left area of the black cardboard, approximately 3" from the edges. The base of the trapezoid shall lie on a horizontal plane with respect to the raster.

(d) Set Oscilloscope (A) for repetitive scanning at line frequency and observe the traces that occur as the camera beam scans across the sloping top of the trapezoid. Approximately six faint (single sweep) black-to-white transition waveforms will be observable. The even-numbered transitions will be members of one scanning field and the odd-numbered transitions will be members of the alternate field.

(e) Adjust the oscilloscope to center the transitions on the display and expand the horizontal sweep to facilitate measurement of the time intervals between transitions. Measure the interval between the 1/2 pulse amplitude levels of three successive pulse traces, starting at the second trace. The interval between trace two and trace three shall be one-half of the interval between trace two and trace four (±10% of the interval between trace two and trace four).

(f) Repeat steps (c), (d) and (e) above, with the white trapezoid moved successively to the other three corners and to the center of the black background.

(2) MEASUREMENT OF INTERLACE OF TV FILM AND SLIDE CAMERA CHAINS - MONOCHROME (Figure 2-6a)

(a) Prepare five Special Wedge Chart Slides (F) by photographing the low reflectance black cardboard described in step (a) of Procedure (1) above, with the white trapezoid located successfully in the four corners and the center of the cardboard. Process the film to provide an opaque black background with a clear trapezoid pattern.

(b) Focus the camera upon Slide (D) of the Standard Resolution Chart. Connect the camera chain video output on a bridged-through basis to line selector Oscilloscope (A) and terminate in Monochrome Picture Monitor (B). Adjust the camera to supply a composite video output signal level of 1.0 V, peak-to-peak. Observe the picture monitor display to verify focus and assure that the resolution chart image fully occupies the frame.

(c) Replace the Standard Resolution Chart slide with one of the five Special Wedge Chart Slides (F).

(d) Perform steps (d) and (e) of Procedure (1) above, using each of the five Special Wedge Chart slides, in turn.

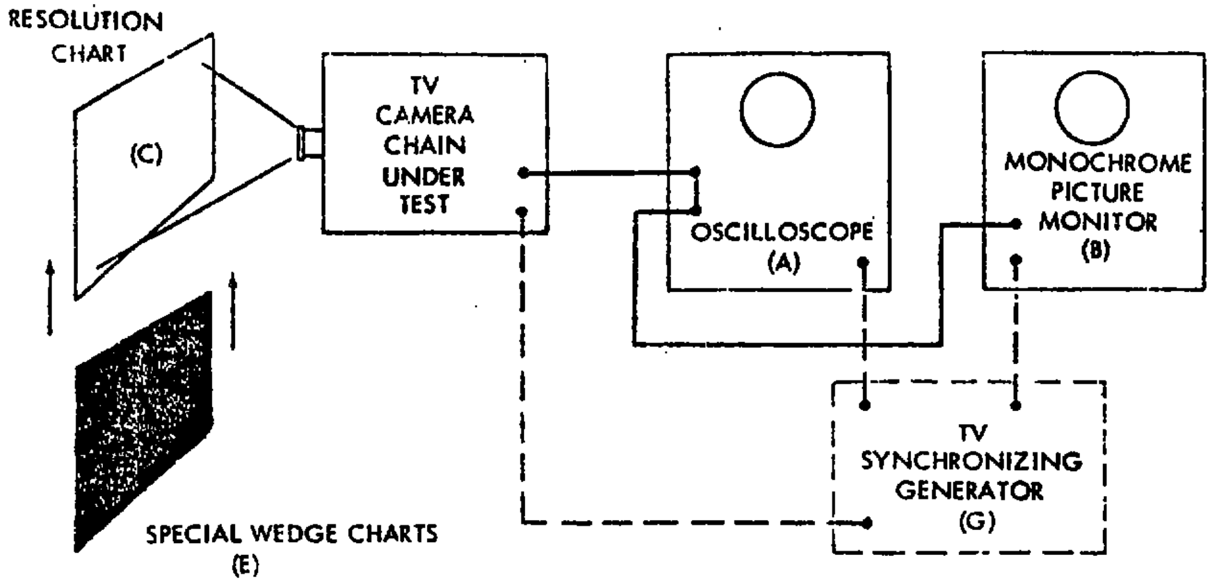
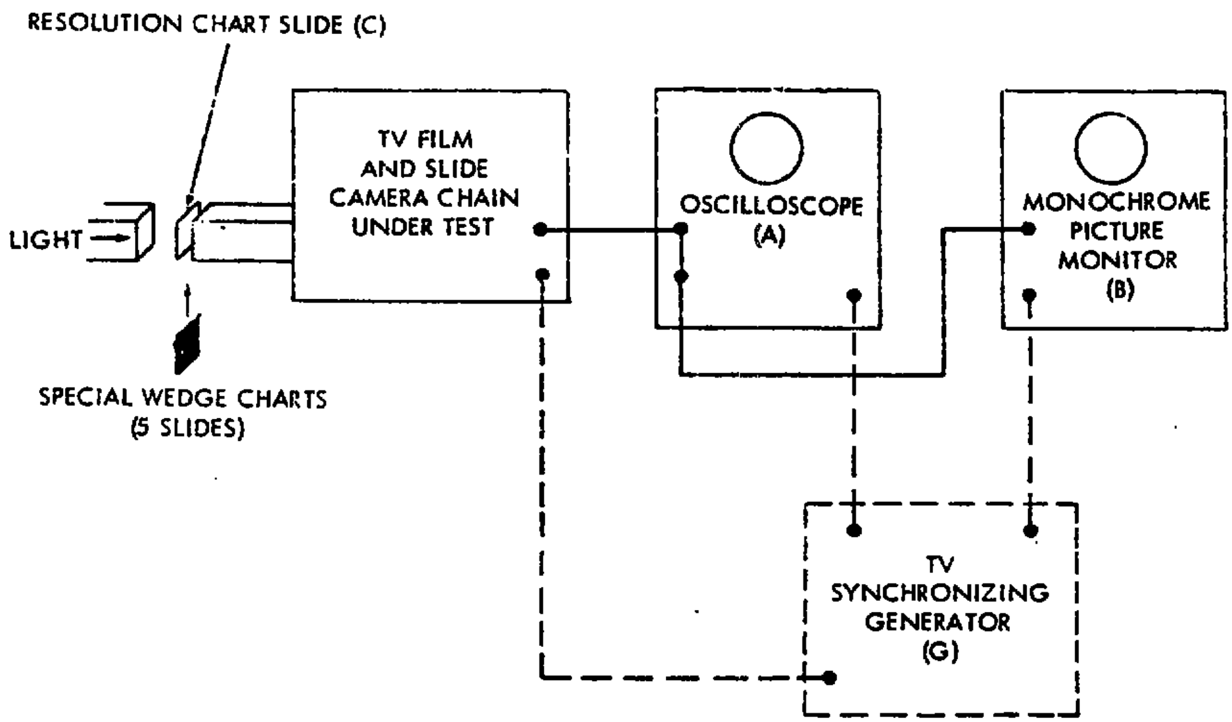



Figure 2-6. Measurement of Interlace of TV Camera Chain.




NOTES: 1. SYNCHRONIZING GENERATOR (G) SUPPLIES EXTERNAL SYNCHRONIZING SIGNALS TO OSCILLOSCOPE, CAMERA AND MONITOR WHEN TESTING COLOR CAMERA CHAINS

2. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-6a. Measurement of Interlace of Television Film and Slide Camera Chain.

2.3.1.4 NOISE AND HUM (TV CAMERA CHAINS)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of noise and hum of television camera chains as specified in the following paragraphs:

(1) SIGNAL-TO-NOISE RATIO. A noise bandwidth for measurement of signal-to-noise ratio is taken to be the same as the desired video bandwidth and includes the effects of aperture correction (if used). The ratio of the peak-white-to-reference-black video signal to rms noise shall be at least 46 dB weighted for image orthicon cameras and 55 dB weighted for vidicon cameras.

(2) HUM. The peak-to-peak level of hum appearing across any of the program or monitoring video outputs of the camera chain shall not exceed 0.3% of the blanking-to-maximum-white voltage.

b. TEST ARRANGEMENTS

| Arrangements | Description | Relevant Figure |
|---|---|---|
| 1 | Noise in Monochrome Camera Chain (Vidicon) | 2-7 |
| 2 | Noise in Monochrome Camera Chain (Image Orthicon) | 2-7 |
| 3 | Hum in Monochrome Camera Chain (Vidicon) | 2-7a |
| 4 | Hum in Monochrome Camera Chain (Image Orthicon) | 2-7a |
| 5 | Noise in Monochrome Film and Slide Camera Chain | 2-7B |
| 6 | Hum in Monochrome Film and Slide Camera Chain | 2-7c |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Waveform Monitor | A | 21 | 1,2 |
| Monochrome Picture Monitor | B | 22 | 1,2,5 |
| Standard Resolution Chart | C | 5 | 1,2,3,4 |
| Weighting Network | D | 14 | 1,2,5 |
| Foot-candle Meter | E | 19 | 1,2,3,4 |
| Synchronizing Generator | F | 15 | 1,2,5 |
| Low-pass Filter | G | 51 | 3,4,6 |
| Oscilloscope (line selector) | H | 3 (or 21) | 3,4,6 |
| 35mm Slide Projector | I | 9 | 5,6 |
| 35mm Resolution Chart Slide | J | 5a | 5,6,9,10 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF NOISE OF TV CAMERA CHAIN -MONOCHROME - VIDICON TYPE (Figure 2-7)

(a) Focus camera chain upon Standard Resolution Chart (C) and adjust camera for optimum operation. Use Foot-candle Meter (E) to adjust incident illumination on test chart to a uniform value of 200 foot-candles (fc). Connect the camera video output to the input of Weighting Network (D) and connect the network output to bridge through Waveform Monitor (A) and terminate in Monochrome Picture Monitor (B). Employ Synchronizing Generator (F) to externally synchronize the camera and the two monitors.

(b) Using line selector techniques, adjust the peak-to-peak amplitude of the video signal to approximately 0.7 V, measured by the waveform monitor. This measurement is obtained from the black-to-white video transitions generated from the trailing edge of one of the horizontal black bars appearing on the resolution chart.

(c) Measure by means of the waveform monitor the peak-to-peak noise amplitude within the area of one of the horizontal black bars on the chart. Convert the peak-to-peak amplitudes to rms values, using the approximation that the rms noise amplitude is equivalent to the 95% peak-to-peak noise amplitude divided by four.

(d) Calculate the weighted signal-to-noise ratio from the signal amplitude measured in step (b) and the rms noise amplitude approximation obtained in step (c) and express in decibel form.

(2) MEASUREMENT OF NOISE OF TV CAMERA CHAIN - MONOCHROME - IMAGE ORTHICON TYPE (Figure 2-7)

This test is identical to that described in (1) above, except that the incident illumination on the test chart shall be 100 fc.

(3) MEASUREMENT OF HUM OF TV CAMERA CHAIN - MONOCHROME - VIDICON TYPE (Figure 2-7a)

(a) Focus camera chain upon Standard Resolution Chart (C) and adjust camera for optimum operation. Use Foot-candle Meter (E) to adjust incident illumination on the test chart to a uniform value of 200 fc. Connect the terminated video output to the input of Low-Pass Filter (G) and Bridge Oscilloscope (H) initially across the input of the filter. Adjust the peak-to-peak amplitude of the video signal to 0.7 V noncomposite. Set automatic controls to off position. Cap the camera lens.

(b) Bridge Oscilloscope (H) across the output of the Filter (G). Set the oscilloscope sweep to field rate and measure the peak-to-peak amplitude of the hum.

(c) Convert to decibel form the ratio of the blanking-to-reference-white voltage level and the peak-to-peak hum voltage.

(4) MEASUREMENT OF HUM OF TV CAMERA CHAIN -MONOCHROME - IMAGE ORTHICON TYPE (Figure 2-7a)

This test is identical to that described in (3) above, except that the incident illumination on the test chart shall be 100 fc.

(5) MEASUREMENT OF NOISE OF TV CAMERA CHAIN -MONOCHROME - FILM AND SLIDE TYPE (Figure 2-7b)

(a) Load 35mm Slide Projector (I) with Standard Resolution Chart Slide (J), and focus and adjust TV camera for optimum scanning of the chart image. Connect the camera video output to the input of Noise-Weighting Network (D) and connect the network output to bridge through Oscilloscope (A) and terminate in Monochrome Picture Monitor (B). Externally synchronize the oscilloscope, monitor and camera by means of Synchronizing Generator (F).

(b) Measure on the oscilloscope the peak-to-peak amplitude of the video signal at line rate using the black-to-white video transitions generated from the black bar and the white background immediately below the lower gray scale on the resolution chart.

(c) Measure on the oscilloscope the peak-to-peak noise amplitude in the video signal within the area of one of the horizontal black bars appearing on the resolution chart. Calculate the rms noise amplitude by using the approximation that rms noise amplitude is equivalent to peak-to-peak noise amplitude divided by six.

(d) Calculate the weighted signal-to-noise ratio from the signal amplitude measured in step (b) above and the rms noise amplitude approximation obtained in step (c) above; convert to decibel form.

(6) MEASUREMENT OF HUM OF TV CAMERA CHAIN - MONOCHROME - FILM AND SLIDE TYPE (Figure 2-7c)

(a) Load 35mm Slide Projector (I) with Standard Resolution Chart Slide (J) and focus and adjust TV camera for optimum scanning of the chart image. Connect each of the terminated video outputs of the camera, in turn, to the input of Low-Pass Filter (G), and bridge Oscilloscope (H) initially across the filter input. Set the video output signal level to 0.7 V, peak-to-peak, noncomposite. Set camera automatic controls to the "off" position.

(b) Cap camera lens. Bridge Oscilloscope (H) across the filter output. Set oscilloscope sweep to field rate and measure the peak-to-peak amplitude of the hum.

(c) Convert to decibel form the ratio of the signal voltage established in step (a) to the peak-to-peak hum voltage measured in step (b).

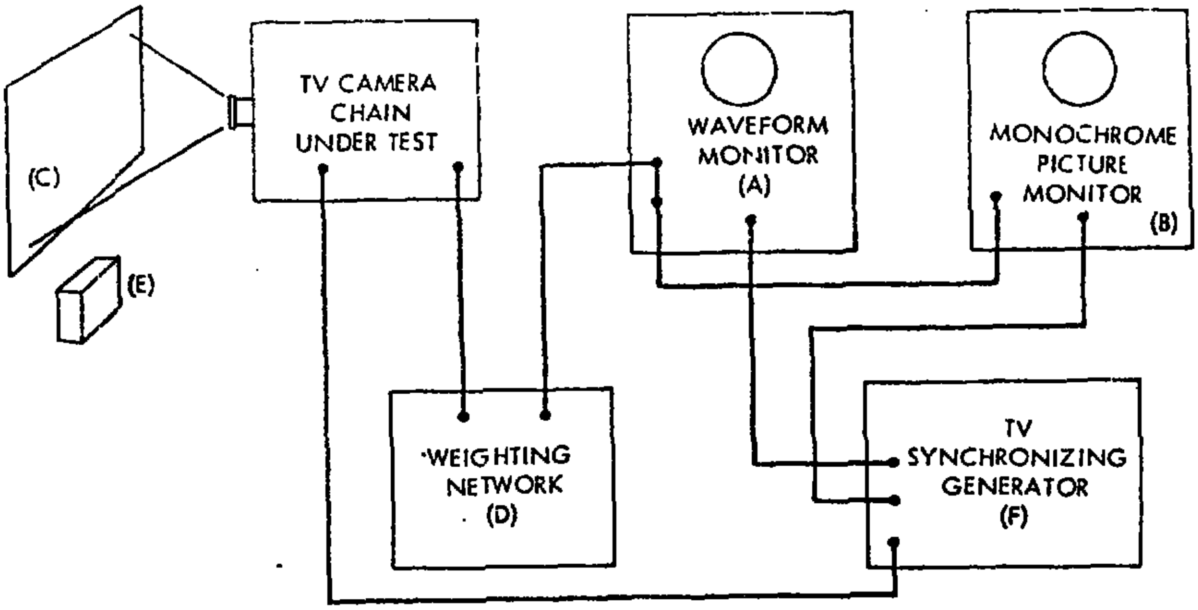
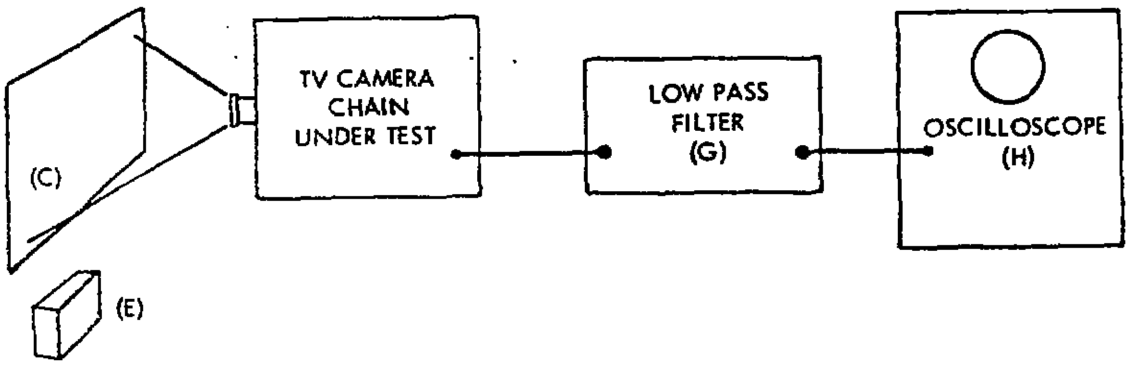



Figure 2-7. Measurement of Noise of TV Camera Chain.




NOTES:
1. WEIGHTING NETWORK INSERTION LOSS = 10 LOG$[1 + (\omega\tau)^2]$ dB, WHERE $\omega = 2\pi f$, f IS IN MEGAHERTZ, AND $\tau = 0.11$ MICROSECOND
2. ALL CONNECTIONS ARE COAXIAL TYPE
3. LOW PASS FILTER (G) ATTENUATES SIGNALS ABOVE ONE KILOHERTZ
4. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-7a. Measurement of Hum of TV Camera Chain.

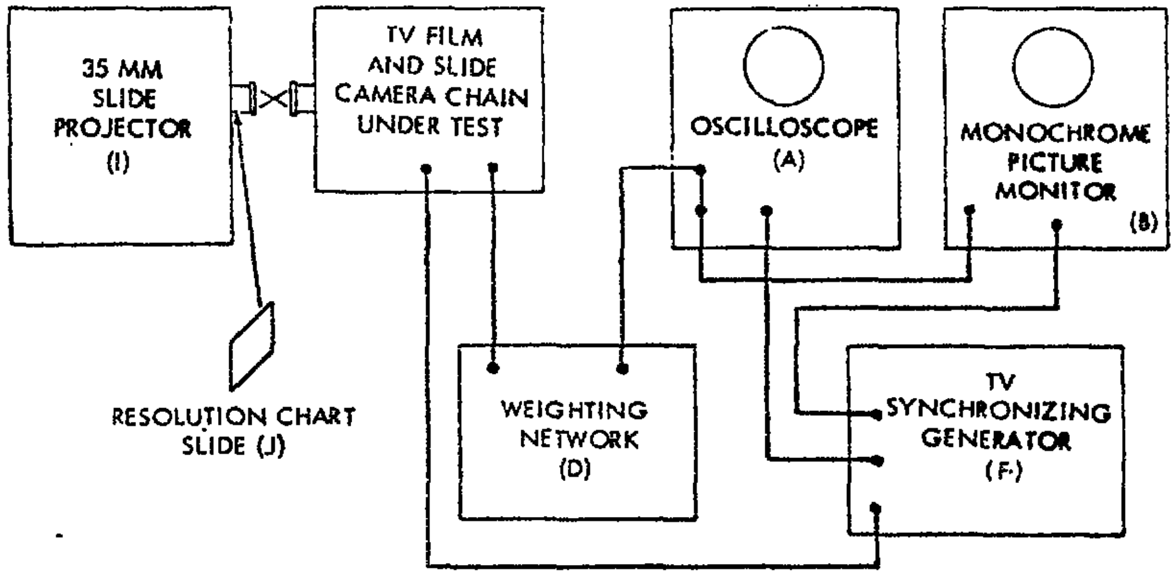
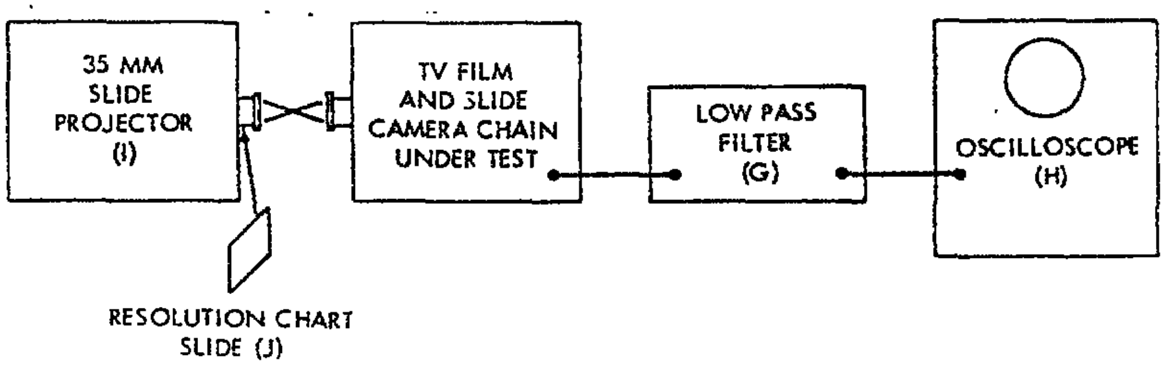



Figure 2-7b. Measurement of Noise of TV Film and Slide Camera Chain.




NOTES: 1. WEIGHTING NETWORK INSERTION LOSS = 10 LOG$[1 + (\omega\tau)^2]$dB, WHERE $\omega = 2\pi f$, F IS IN MEGAHERTZ, AND $\tau$ = 0.11 MICROSECOND
2. ALL CONNECTIONS ARE COAXIAL TYPE
3. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS
4. LOW PASS FILTER ATTENUATES SIGNALS ABOVE ONE KILOHERTZ

Figure 2-7c. Measurement of Hum of TV Film and Slide Camera Chain.

2.3.1.5 GEOMETRIC DISTORTION (TV CAMERA CHAINS). Geometric distortion is defined as distortion which would render, for example, a circle as anything other than a perfect circle at the system output.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of geometric distortion in various types of television camera chains as specified in the following paragraph:

GEOMETRIC DISTORTION. The combined effect of all distorting influences shall not displace any point in the picture from its correct position by more than ±1% of the picture height.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Geometric Distortion of a Monochrome Camera Chain | 2-8 |
| 2 | Measurement of Geometric Distortion of a Monochrome Film and Slide Camera Chain | 2-8a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Linearity Chart | A | 45 | 1,2 |
| Grating Pattern Generator | B | 10 | 1,2 |
| Monochrome Picture Monitor | C | 22 | 1,2 |
| Foot-candle Meter | - | 19 | 2 |
| 35mm Slide Projector | D | 9 | 2 |
| Linearity Chart Slide (35mm) | E | 45a | 2 |

d. TEST PROCEDURES

(1) MEASUREMENT OF GEOMETRIC DISTORTION OF MONOCHROME CAMERA CHAIN (Figure 2-8)

(a) Align and focus the camera under test upon Standard Linearity Chart (A). Connect Grating Pattern Generator (B) to the camera sync and to the camera video output in a manner that will not impair the performance of the video amplifier. Arrange generator to add to the camera output signal an electronically generated bar pattern, utilizing an approximate frequency of 315 kHz for the generation of vertical bars and a second frequency of 900 Hz for horizontal bars.

(b) Connect the camera chain video output to Monochrome Picture Monitor (C) which will represent a mixture of the bar pattern and the linearity chart image. Adjust pattern generator controls for maximum coincidence of the two patterns. Observe whether the bar intersections fall within either the inner rim of each linearity chart circle (1% of picture height accuracy) or within the outer rim of each circle (2% of picture height accuracy).

(2) MEASUREMENT OF GEOMETRIC DISTORTION OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-8a)

Align and focus the camera chain for optimum operation using 35mm Slide (E) of Linearity Chart in Slide Projector (D) as the visual input source. Otherwise follow same steps as in Procedure (1) above.

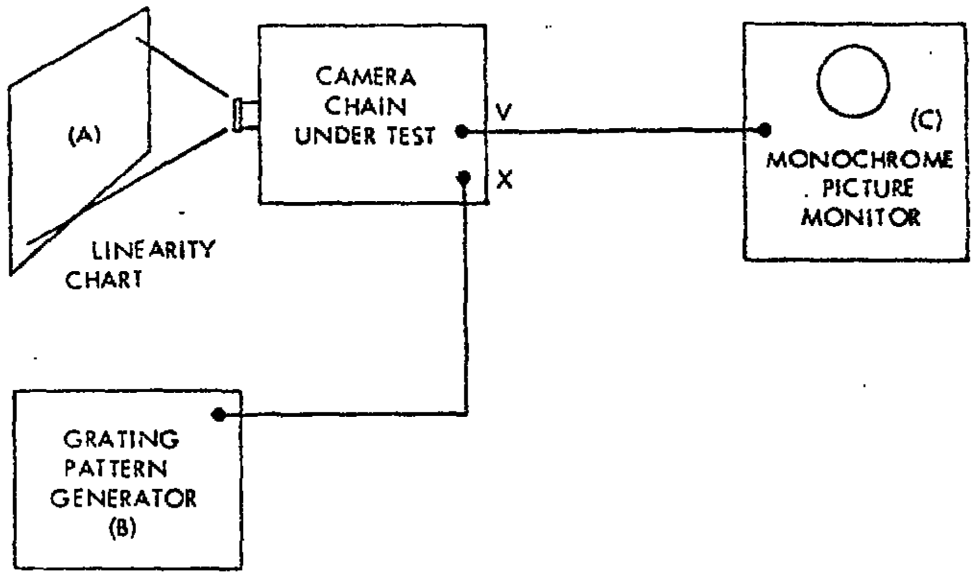
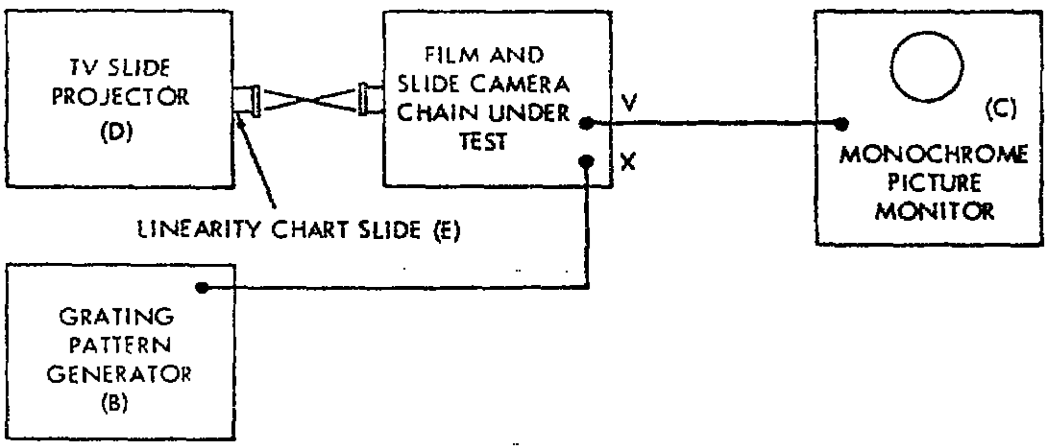



Figure 2-8. Measurement of Geometric Distortion of Camera Chain.




NOTES: 1. V = VIDEO OUTPUT
X = CONNECTION TO ADD PATTERN SIGNAL TO VIDEO OUTPUT
2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-8a. Measurement of Geometric Distortion of Film and Slide Camera Chain.

2.3.1.6 SHADING (TV CAMERA CHAINS)

This section concerns measurement of spurious brightness gradients introduced into the video signal by lack of uniform response in different areas of the camera raster. These shading errors may be caused by improper low frequency response, by uneven subject lighting or by blemishes on the tube itself.

a. APPLICABILITY. The test arrangements in subparagraph b. below, are applicable to the measurement of shading in various types of camera chains, as specified in the following paragraph:

SHADING CORRECTION. Horizontal and vertical shading compensation, if required, shall be such that the output video signal is flat within ±2.5% when the camera is viewing a uniformly illuminated field of white, or any shade of gray. An on-off switch shall be provided to permit insertion or removal of shading correction.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Shading of Monochrome Camera Chain | 2-9 |
| 2 | Measurement of Shading of Monochrome Film and Slide Camera Chain | 2-9a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Foot-candle Meter | A | 19 | 1 |
| Waveform Monitor | B | 21 | 1,2 |
| Monochrome Picture Monitor | C | 22 | 1,2 |
| Synchronizing Generator | D | 15 | 1,2 |
| Neutral Density Slides (set of 9) | - | 53 | 2 |
| 35mm Slide Projector | E | 9 | 2 |

d. PROCEDURES

(1) MEASUREMENT OF SHADING OF MONOCHROME CAMERA CHAIN (Figure 2-9)

(a) Provide a special visual background consisting of a uniform white cardboard or white cloth which has a low reflectance black vertical strip through the center. Illuminate background at 150 foot-candles, measured by Foot-candle Meter (A). Focus and align the camera upon the white background.

(b) Bridge the noncomposite camera chain output through Waveform Monitor (B) and terminate in Monochrome Picture Monitor (C). Provide external synchronization to the waveform monitor, picture monitor, and camera chain from Synchronizing Generator (D). Automatic gain, sensitivity, and level controls shall be switched off for this test.

(c) Adjust the camera chain video output to 0.7 V peak-to-peak, at the black-to-white transition, using the waveform monitor for measurement. Examine various lines of the raster with the waveform monitor, using the picture monitor to determine the position of the line selected, and measure the variation in signal level in different parts of each line. Also, operate the waveform monitor at field rate and measure the levels at different vertical locations. Calculate the maximum percentage variation in level observed in the white background areas.

(d) Repeat the above measurements with the background illuminated at 30 fc and 60 fc, in turn, without readjusting the camera signal level controls.

(2) MEASUREMENT OF SHADING OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-9a)

(a) Provide a visual input consisting of a 35mm TV Slide Projector (E) with a set of neutral-density filters of densities ranging from 0.1 through 0.9. Center on each slide a 9.25-inch wide vertical black bar of opaque tape or similar material. Focus and adjust the camera chain with the 0.1 neutral-density slide as visual input.

(b) Bridge the noncomposite output of the camera chain through Waveform Monitor (B) and terminate in Monochrome Picture Monitor (C). Provide external synchronization to the waveform monitor, picture monitor, and camera chain from Synchronization Generator (D). Automatic gain, sensitivity, white level, and black level controls shall be switched off for these tests.

(c) Adjust the camera chain video output to 0.7 V, peak-to-peak, at the black-to-white transition displayed on the waveform monitor. Measure the signal amplitudes at various locations in the white areas of the image, using both line and field rates of the waveform monitor. Calculate the maximum percentage variation observed.

(d) Repeat the above tests with three different neutral-density filters in the projector, including the 0.9 density slide, without readjusting the camera signal level controls.

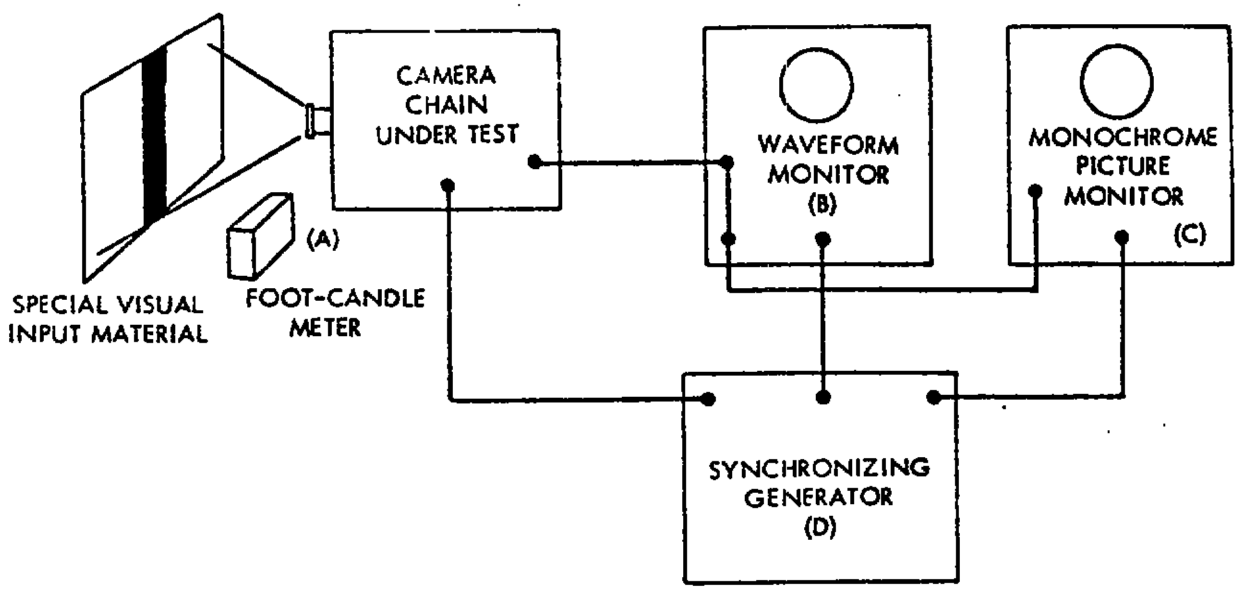
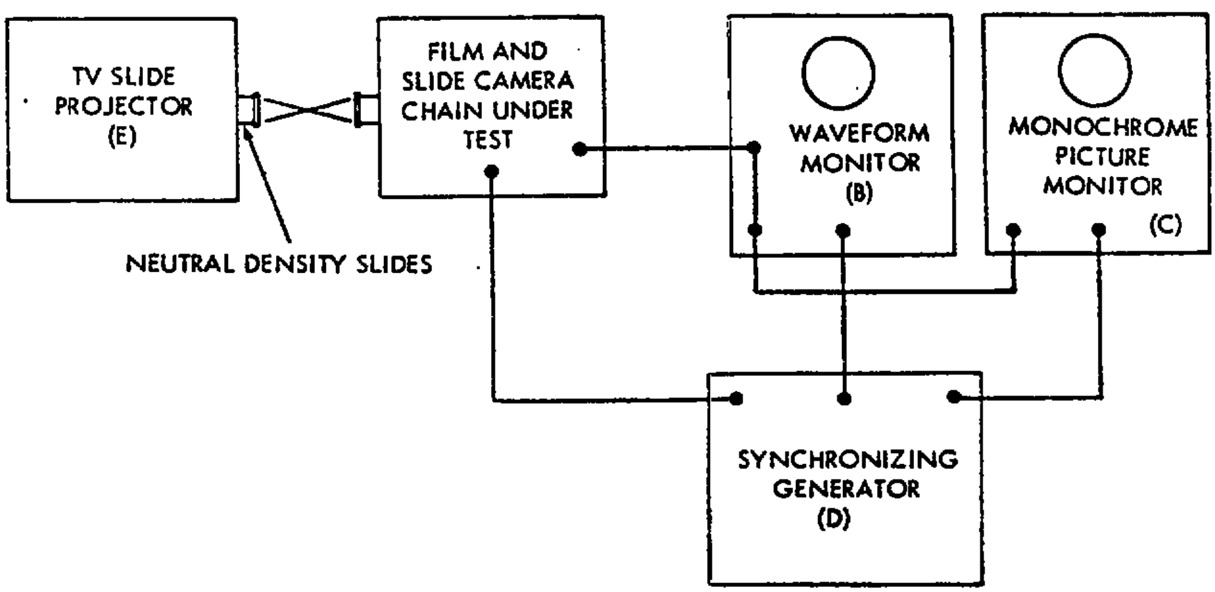



Figure 2-9. Measurement of Shading of Television Camera Chain.




NOTES: 1. ALL CONNECTIONS ARE COAXIAL TYPE
2. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-9a. Measurement of Shading of Film and Slide Camera Chain

2.3.1.7 GAMMA CORRECTION (TV CAMERA CHAINS)

The nonlinear input-output relationships encountered in television cameras and displays are commonly depicted by curves whose shapes can be expressed in terms of gamma, defined as the exponent of that power law which approximates the curve over the region of interest. Gamma correction circuits are commonly employed to compensate for the nonlinearities encountered in the picture generation and/or reproduction process.

a. APPLICABILITY. The test arrangements in subparagraph b. are applicable to the measurement of gamma correction in various types of camera chains as specified in the following paragraphs:

(1) GAMMA CORRECTION. Gamma correction shall be switchable to gamma factors of 0.5, 0.7, and 1.0. Frequency response, at gamma factors of 0.5 and 0.7, shall be within ±0.25 dB of the frequency response for the gamma factor of 1.0. The amplitude response to a 10-step staircase signal for each gamma factor, as measured from the preamplifier input to the camera chain output, shall be within ±3% of the values listed in Table III.

## TABLE III

## GAMMA CORRECTION STEP AMPLITUDES

| Step | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Input Step Amplitude as % of Input Peak Amplitude | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Output Step Amplitude as % of Output Peak Amplitude | | | | | | | | | | | |
| Gamma 0.5 | 0 | 32 | 45 | 55 | 63 | 71 | 77 | 84 | 89 | 95 | 100 |
| Gamma 0.7 | 0 | 20 | 32 | 43 | 53 | 62 | 70 | 78 | 86 | 93 | 100 |
| Gamma 1.0 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

(2) GAMMA CORRECTION (MONOCHROME FILM AND SLIDE CAMERA CHAIN). Selectable gamma correction shall be provided for positive and negative monochrome film or slide reproduction. Gamma values of 0.5, 0.7, 1.0 or 1.2 shall be selectable by a switch. The video signal amplitude from peak-white-to-reference-black shall not vary more than 5% at all of the various gamma values. Frequency response, at gamma settings of 0.5, 0.7 or 1.2, shall be maintained within ±0.25 dB of the frequency response for the gamma factor of 1.0.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Gamma Correction of TV Cameras (Image Orthicon Sections) | 2-10 |
| 2 | Measurement of Gamma Correction of TV Cameras (Vidicon Sections) | 2-10a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1,2 |
| Waveform Monitor | B | 21 | 1,2 |
| Oscilloscope (Line Selection) | C | 3 | 1,2 |

d. PROCEDURES

(1) MEASUREMENT OF GAMMA CORRECTION OF MONOCHROME CAMERA CHAIN (IMAGE ORTHICON SECTIONS) (Figure 2-10)

(a) Arragne TV Test Signal Generator (A) to provide a linear stairstep signal to the camera preamplifier input. The generator shall be adjusted to provide ten steps at 90% Average Picture Level (APL), noncomposite, black negative, and shall be terminated in its characteristic impedance. Connect Waveform Monitor (B) to the terminated video output (Y) of the camera chain. Cap camera lens. Set signal level to a value approximating that developed by normal operating current in the pickup tube load resistor and adjust the camera for 0.7 V, peak-to-peak, output signal amplitude.

(b) Measure the output amplitude above black of each step on the waveform monitor for each of the three gamma factor settings. Oscilloscope (C) may be used as an alternate for the waveform monitor to achieve higher sensitivity, if required.

(c) Rearrange the signal generator to apply a television multiburst frequency signal to the camera preamplifier input. The signal shall be noncomposite with the video content of approximately 10%, a setup of 50%, and an input level as in step (a). The burst frequencies shall be approximately 1, 3, 5, 8 and 10 MHz, and of equal amplitudes.

(d) Measure the output amplitudes of the frequency bursts for each of the three gamma settings. For each of the three sets of readings, the difference in amplitude of the 3, 5, 8 and 10 MHz bursts, relative to the 1 MHz burst, shall be calculated and expressed in decibels. Compare the three sets of decibel values.

(2) MEASUREMENT OF GAMMA CORRECTION OF MONOCHROME CAMERA CHAIN (VIDICON SECTIONS) (Figure 2-10a)

(a) Connect TV Test Signal Generator (A) to the vidicon camera preamplifier input (point V) through a resistive impedance $R_p$

that is at least ten times greater than the camera tube target load resistor $R_L$. It is recommended that a string of lower value resistors be used. These should be soldered together with short leads and arranged to minimize shunt capacitance across the string. The connection to the preamplifier shall be made as short as possible to minimize capacitive coupling and loading while providing a current feed input. If the vidicon target is dc coupled to the preamplifier input stage, it may be necessary to employ capacitor $C_1$ at the generator output to provide ac coupling. The vidicon tube socket shall be disconnected and the vidicon pins grounded directly or through a large capacitor.

(b) Perform steps (a), (b), (c) and (d) of Procedure (1), except that the stairstep input signal shall be black positive.

(3) MEASUREMENT OF GAMMA CORRECTION OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-10 and 2-10a)

Follow Procedure (1) for cameras employing Image Orthicon type pickup tubes, or Procedure (2) for cameras using Vidicon types, except: (1) there are four gamma settings to be tested consisting of 0.5, 0.7, 1.0 and 1.2, (2) multiburst test frequencies will be 1, 3, 4, 7 and 10 MHz.

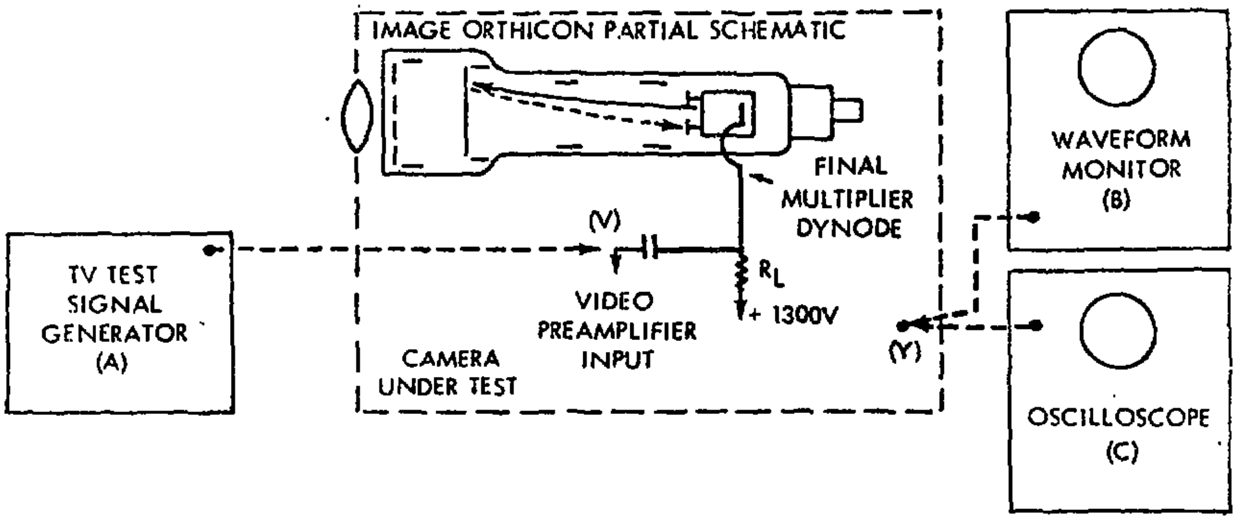
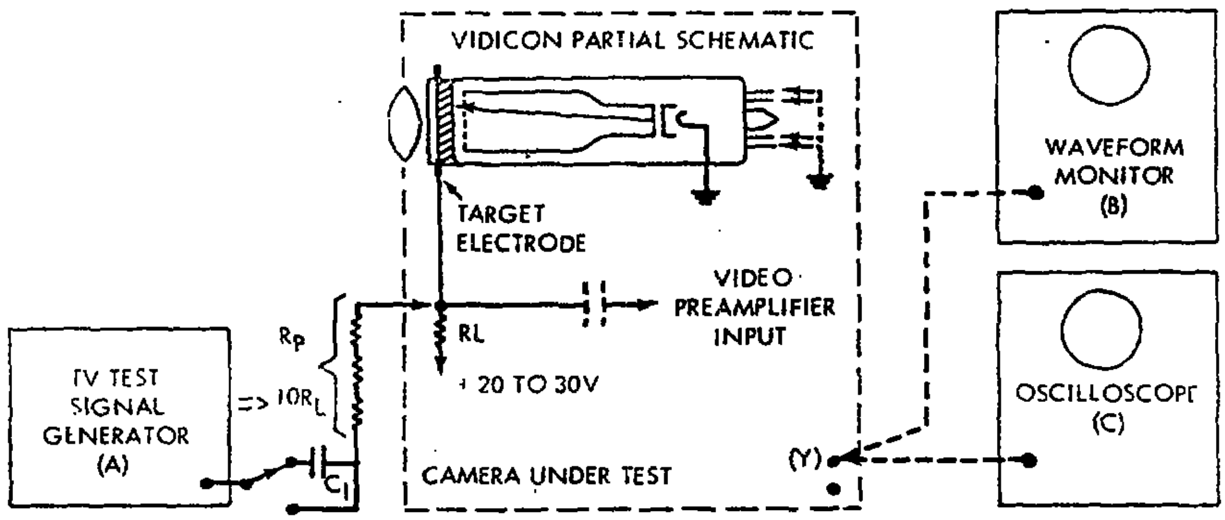



Figure 2-10. Measurement of Gamma Correction of TV Camera - Image Orthicon Type.




NOTES:
1. Rp IS A TEST SIGNAL INPUT RESISTOR COMPOSED OF SEVERAL RESISTORS ASSEMBLED WITH SHORT LEADS FOR MINIMUM CAPACITANCE. TOTAL RESISTANCE SHALL BE GREATER THAN TEN TIMES VIDICON TARGET LOAD RESISTOR ($R_L$)
2. $C_1$ IS A CAPACITOR THAT MAY BE REQUIRED TO ISOLATE DC VOLTAGES
3. Y = CAMERA VIDEO OUTPUT
4. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-10a. Measurement of Gamma Correction of TV Camera - Vidicon Type.

2.3.1.8 DEFELCTION CROSSTALK (TV CAMERAS)

This section is concerned with undesired signals introduced into the video signal from the camera deflection circuits. This type of interference is distinguishable from random noise by the fact that it is synchronous with, or harmonically related to, the camera horizontal and vertical sweep frequencies. These signals appear as vertical or horizontal "ghost" bars.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of deflection crosstalk in various types of camera chains as specified in the following paragraph:

DEFLECTION CROSSTALK. Components in the video signal due to deflection crosstalk shall not exceed a peak-to-peak value of 0.5% of the blanking-to-reference-white voltage.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Deflection Crosstalk in Monochrome Camera Chain | 2-11 |
| 2 | Measurement of Deflection Crosstalk in Monochrome Film and Slide Camera Chain | 2-11a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Standard Resolution Chart | A | 5 | 1 |
| Oscilloscope, Line Selector | B | 3 | 1,2 |
| Monochrome Picture Monitor | C | 22 | 1,2 |
| 35mm Slide Projector | D | 9 | 2 |
| 35mm Slide of Resolution Chart | - | 5a | 2 |
| Foot-candle Meter | E | 19 | 1 |

d. PROCEDURES

(1) MEASUREMENT OF DEFLECTION CROSSTALK IN MONOCHROME CAMERA CHAIN (Figure 2-11)

(a) Align and focus camera upon Standard Resolution Chart (A). Connect the camera chain output to Line Selector Oscilloscope (B) on a bridge-through basis and terminate in Monochrome Picture Monitor (C). Adjust the camera chain output to a level of 0.7 V, peak-to-peak, noncomposite, then cap the camera lens. Switch off all automatic controls.

(b) Examine the picture monitor for the presence of stationary vertical or horizontal bars. Adjust the sweep frequency of the oscilloscope slowly from 30 Hz upward and measure the peak-to-peak amplitude of any video signal waveform that becomes stationary at field or line frequencies, or their harmonics (disregard power line hum appearing in sine wave form at 60 Hz and adjacent harmonics). Calculate the percentage of these undesired signals relative to the peak-to-peak blanking-to-reference-white voltage established in step (a) above.

(2) MEASUREMENT OF DEFLECTION CROSSTALK IN MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-11a)

(a) Employ a 35mm slide of the standard resolution chart, mounted in 35mm Slide Projector (D) as a visual source for the camera chain.

(b) Follow the steps in Procedure (1) above.

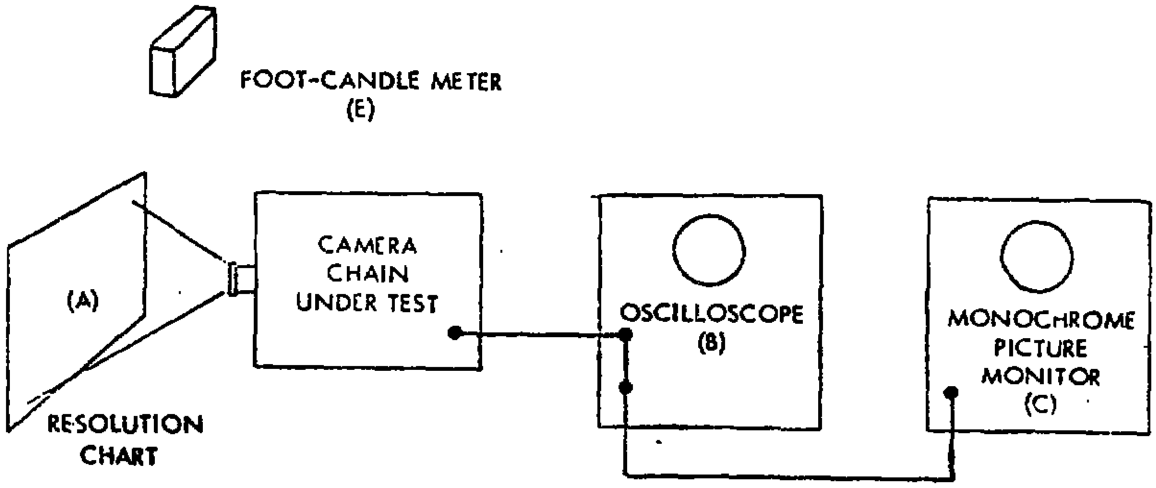



Figure 2-11. Measurement of Deflection Crosstalk in Television Camera Chain.

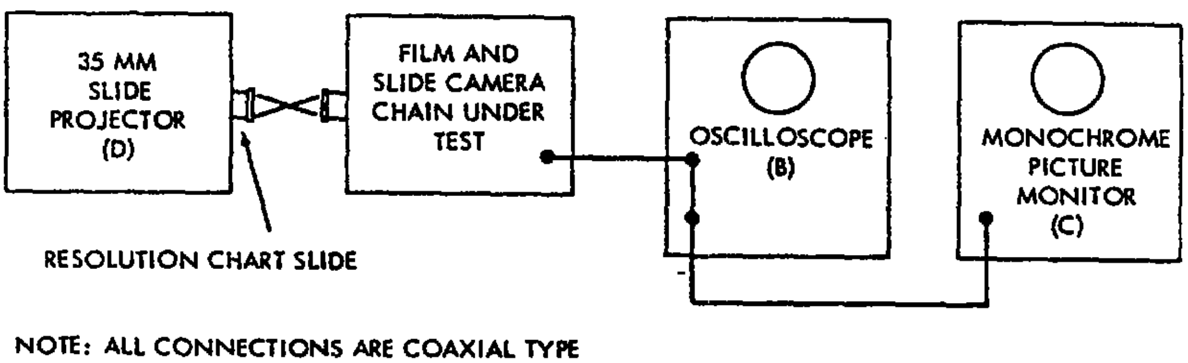



Figure 2-11a. Measurement of Deflection Crosstalk in Film and Slide Camera Chain.

2.3.1.9 SETUP INSERTION (TV CAMERAS)

Setup in television terminology refers to the separation in level between blanking and reference black levels. It can be defined as the ratio between the reference black level and the reference white level, both measured from blanking level, and expressed in percent. Measurements of setup are concerned with percent range of control, quality of automatic control in some applications, and the accuracy of setup tracking when multiple channels are adjusted by a single master control.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of setup in various types of camera chains as specified in the following paragraphs:

(1) OPERATIONAL CONTROLS. All monochrome camera chains shall be provided with both manual and automated operational controls. Automatic operational features shall be controllable at either of two positions; at the camera, or at the remote camera control assembly. It shall be possible to switch to manual or automatic control at either position; however, it shall not be possible to switch to automatic operation from the remote position when the switch on the camera is set for manual operation. Operating controls shall be identified as to function, conveniently located, protected against accidental displacement, and permanently marked.

(2) BLACK LEVEL CONTROL. All monochrome camera chains shall be provided with a manual control which will permit positioning of the reference picture blacks within a range from blanking level to 20% of white level. This control may also be called "pedestal" or "brightness." The setting of of the black level control may or may not affect the setting of the white level. A manual/automatic switch shall be provided

to select either of the two modes of operation. When in the automatic mode, an automatic black level control shall be provided which will sense the blackest portion of the video signal and set and maintain a fixed black level, within ±5%, within 0.5s as established by the manual black level control.

(3) WHITE LEVEL CONTROL. All monochrome camera chains shall be provided with a manual control which will permit positioning of the picture reference white level. This control may also be called "gain" or "contrast." The range of adjustment shall be uniform and continuous from zero to maximum gain. Adjustment of gain may or may not affect the setup level. A manual/automatic switch shall be provided to select either of the two modes of operation. When in the automatic mode, an automatic white level control shall be provided which will maintain proper white level, within ±5%, within 0.5s of the level established by the manual control, regardless of changes in black level or sensitivity. This feature shall be optional with image orthicon cameras where normal operational adjustments of one lens stop above the knee of the camera tube are employed.

(4) SENSITIVITY CONTROL. An electronic automatic sensitivity feature shall be provided which will sense overall light level variations as viewed by the camera and automatically adjust the camera sensitivity to provide a constant video output level. This operation shall compensate for light level variations of at least 100:1, and within this range the video output shall remain constant within 5%. A manual override sensitivity control, when activated, shall provide for sensitivity control for overall light level variations of 1000:1 minimum.

(5) OPERATIONAL CONTROLS. All monochrome camera chains shall be provided with manual and automated operational controls conforming to the characteristics specified in paragraphs a. (1), (2), (3) and (4) of live monochrome camera chains with the following addition: the automatic

sensitivity control shall be provided with a threshold control to limit the range of operation during film fades to black.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Setup Insertion of Monochrome Camera Chain | 2-12 |
| 2 | Measurement of Setup Insertion of Monochrome Film and Slide Camera Chain | 2-12a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Standard Resolution Chart | A | 5 | 1 |
| Waveform Monitor | B | 21 | 1,2 |
| 35mm Slide of Resolution Chart | - | 5a | 2 |
| 35mm Slide Projector | C | 9 | 2 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF SETUP INSERTION OF MONOCHROME CAMERA CHAIN (Figure 2-12)

(a) Align and focus the camera chain upon Standard Resolution Chart (A). Connect Waveform Monitor (B) across the terminated output of the camera chain. Adjust the controls to display the peak-white-to-blanking level signal over 100 IRE units of the monitor graticule.

(b) Adjust the setup control in several steps over its entire range. Measure at each step the number of IRE units between blanking level and black level and also between blanking level and white level. Calculate the ratio of the two measured values in percent at each step of the control.

(2) MEASUREMENT OF SETUP INSERTION OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-12a)

(a) Employ a 35mm slide of the Standard Resolution Chart, mounted in 35mm Slide Projector (C), as a visual source for the camera chain.

(b) Measure the setup adjustment range in the same manner as in Procedure (1) above.

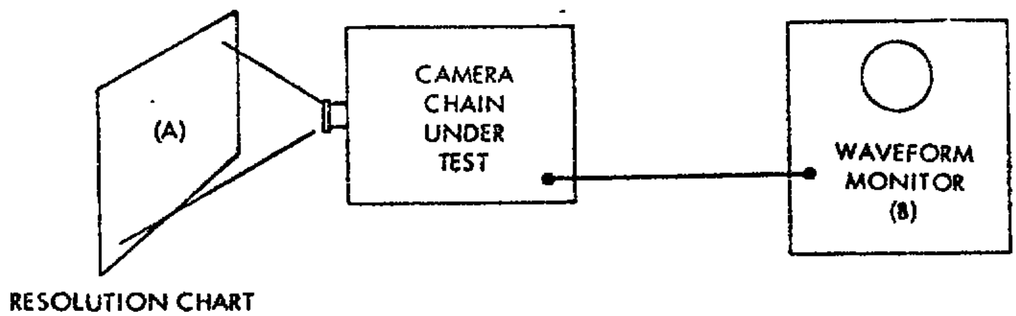



Figure 2-12. Measurement of Setup Insertion of TV Camera Chain.

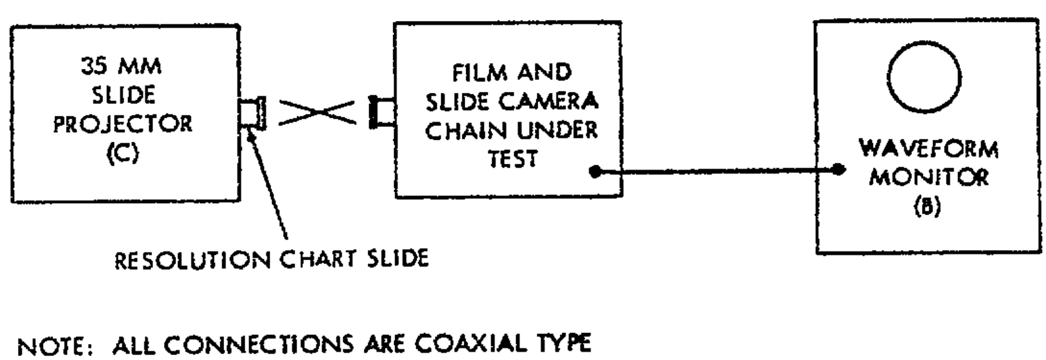



Figure 2-12a. Measurement of Setup Insertion of Film and Slide Camera Chain.

2.3.1.10 AUTOMATIC CONTROL (TV CAMERAS)

This subparagraph is concerned with the evaluation of methods used to stabilize television camera chain operation in the presence of several sources of variability: 1. visual source variations such as degree of illumination, contrast in subject matter, and density of films or slides; 2. pickup tube characteristics of short- and long- time drift in sensitivity with temperature, voltage regulation, light intensity and age; 3. variations in the video amplifiers and processing circuits and in the camera chain electronic system.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of automatic sensitivity control, automatic black level control, and automatic white level control in various types of television camera chains which include one or more of these features as specified in the following paragraphs:

(1) OPERATIONAL CONTROLS. All monochrome camera chains shall be provided with both manual and automated operational controls. Automatic operational features shall be controllable at either of two positions; at the camera, or at the remote camera control assembly. It shall be possible to switch to manual or automatic control at either position; however, it shall not be possible to switch to automatic operation from the remote position when the switch at the camera is set for manual operation. Operating controls shall be identified as to function, conveniently located, protected against accidental displacement, and permanently marked.

(2) BLACK LEVEL CONTROL. All monochrome camera chains shall be provided with a manual control which will permit positioning of the reference picture blacks within a range from blanking level to 20% of white level. The setting of the black level control shall not affect the setting of the white level. A manual/automatic switch shall be

provided to select either of the two modes of operation. When in the automatic mode, an automatic black level control shall be provided which will sense the blackest portion of the video signal and set and maintain a fixed black level, within ±5%, as established by the manual black level.

(3) WHITE LEVEL CONTROL. All monochrome camera chains shall be provided with a manual control which will permit positioning of the picture reference white level. The range of adjustment shall be uniform and continuous from zero to maximum gain. Adjustment of gain shall not affect the setup level. A manual/automatic switch shall be provided to select either of the two modes of operation. When in the automatic mode, an automatic white level control shall be provided which will maintain proper white level, within ±5% of the level established by the manual control, regardless of changes in black level or sensitivity. This feature shall be optional with image orthicon cameras where normal operational adjustments of one lens stop above the knee of the camera tube are employed.

(4) SENSITIVITY CONTROL. An electronic automatic sensitivity feature shall be provided which will sense overall light level variations as viewed by the camera and automatically adjust the camera sensitivity to provide a constant video output level. This operation shall compensate for light level variations of at least 100:1, and within this range the video output shall remain constant within 5%. A manual override sensitivity control, when activated, shall provide for sensitivity control for overall light level variations of 1000:1 minimum.

(5) OPERATIONAL CONTROLS. All monochrome camera chains shall be provided with manual and automated operational controls conforming to the characteristics specified in paragraphs a. (1), (2), (3) and (4)

above for live monochrome camera chains with the following addition: the automatic sensitivity control shall be provided with a threshold control to limit the range of operation during film fades to black.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| | Measurement of Automatic Sensitivity, Black Level, and White Level Control as applicable to: | |
| 1 | Monochrome Camera Chain | 2-13 |
| 2 | Monochrome Film and Slide Camera Chain | 2-13a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Standard Resolution Chart | A | 5 | 1 |
| Waveform Monitor | B | 21 | 1,2 |
| Monochrome Picture Monitor | C | 22 | 1,2 |
| Synchronizing Generator | D | 15 | 1,2 |
| Neutral-Density Filters (100/1 range) | E | 53 | 1,2 |
| Foot-candle Meter | F | 19 | 1 |
| High Contrast Special Chart | G | – | 1 |
| 35mm Slide of Standard Resolution Chart | H | 5a | 2 |
| 35mm Slide Projector | I | 9 | 2 |
| 35mm High Contrast Special Slides | J | – | 2 |

d. Procedures

See subparagrpah 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF AUTOMATIC SENSITIVITY, BLACK LEVEL, AND WHITE LEVEL CONTROL, AS APPLICABLE, OF MONOCHROME CAMERA CHAIN (Figure 2-13)

(a) With automatic controls switched on, focus and align the camera chain upon Standard Resolution Chart (A); set illumination at an average level for the type of pickup tube employed, and camera iris at the corresponding normal f-number. Connect the camera chain output on a bridge-through basis to Waveform Monitor (B) and terminate in Monochrome Picture Monitor (C). Supply external synchronization to the camera and both monitors from Synchronizing Generator (D). Adjust camera video output amplitude to 0.7 V, peak-to-peak, noncomposite on the waveform monitor, using line selection techniques.

(b) Reduce the optical input to the camera lens by a factor of 100 and remeasure the peak-to-peak video output amplitude on the waveform monitor. The optical input reduction can be accomplished by: 1. inserting 100:1 Neutral-Density Filter (E) in the optical path of the camera, or 2. by reducing the illumination on Chart (A), using Foot-candle Meter (F) as a measuring device, plus reducing the camera iris aperture (light varies inversely as the square of the f-number). Calculate the percentage change in output amplitude relative to the value established in step (a); this is a measure of the effectiveness of the automatic sensitivity control.

(c) Prepare a special High Contrast Chart (G) of the same dimensions as the Standard Resolution Chart and having the left half composed of high reflectance white cardboard, or similar material, and the right half of low reflectance black material. Remove chart (A) and focus and align the camera upon the white portion of chart (G), with average illumination of the chart. Adjust camera chain video output amplitude to 0.7 V, peak-to-peak, noncomposite on the waveform monitor. Adjust camera setup control to provide a black level of 10% of peak white level.

(d) Without changing any level or gain controls, realign camera to the center of Chart (G), such that the visual image, as observed on Picture Monitor (C), is one-half white and one-half black. Measure the peak white level and the black level on the waveform monitor.

(e) Repeat step (c) with the camera aligned and focused on the black half of Chart (G).

(f) Any changes in the black levels and white levels measured in steps (d), (e) and (f) will indicate the degree by which the automatic level control circuits deviate from complete effectiveness.

(g) Repeat steps (d), (e) and (f) with optical input to the camera lens reduced by a factor of ten, using a neutral-density filter of 10% light transmission in the optical path.

(2) MEASUREMENT OF AUTOMATIC SENSITIVITY, BLACK LEVEL, AND WHITE LEVEL OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-13a)

(a) Use 35mm slide of Resolution Chart (H) in Slide Projector (I) to provide the optical input for the camera chain. Connect camera chain output on a bridge-through basis to Waveform Monitor (B) and terminate in Monochrome Picture Monitor (C). Supply external synchronization to the camera and both monitors from Synchronizing Generator (D). Focus camera and adjust video output amplitude to 0.7 V, peak-to-peak, noncomposite on the waveform monitor, using line selection techniques with automatic controls switched on.

(b) Insert Neutral-Density Filter (E) in the optical path to reduce optical input to the camera lens by a factor of 100. Remeasure the peak-to-peak video output amplitude on the waveform monitor.

(c) Determine the effectiveness of the automatic sensitivity control by calculating the percentage change in output amplitude from step (a) to step (b) above.

(d) Prepare three 35mm Slides (J) to test effect of high contrast variation: 1. clear glass of 100% light transmission; 2. clear glass with 10% of area covered by opaque vertical bar; and 3. clear glass with 90% of area covered by opaque vertical bar. Insert clear glass slide in slide projector and adjust camera output to 0.7 V, peak-to-peak amplitude, and setup to 10% of peak white level.

(e) Insert the two partially opaqued slides, in turn, and measure white levels and black levels without readjusting gain controls.

(f) Repeat steps (d) and (e) above with neutral-density filter of 10% light transmission inserted in the optical path to reduce optical input by a factor of ten.

(g) Black level and white level amplitudes will not change significantly if automatic level control circuits are functioning correctly.

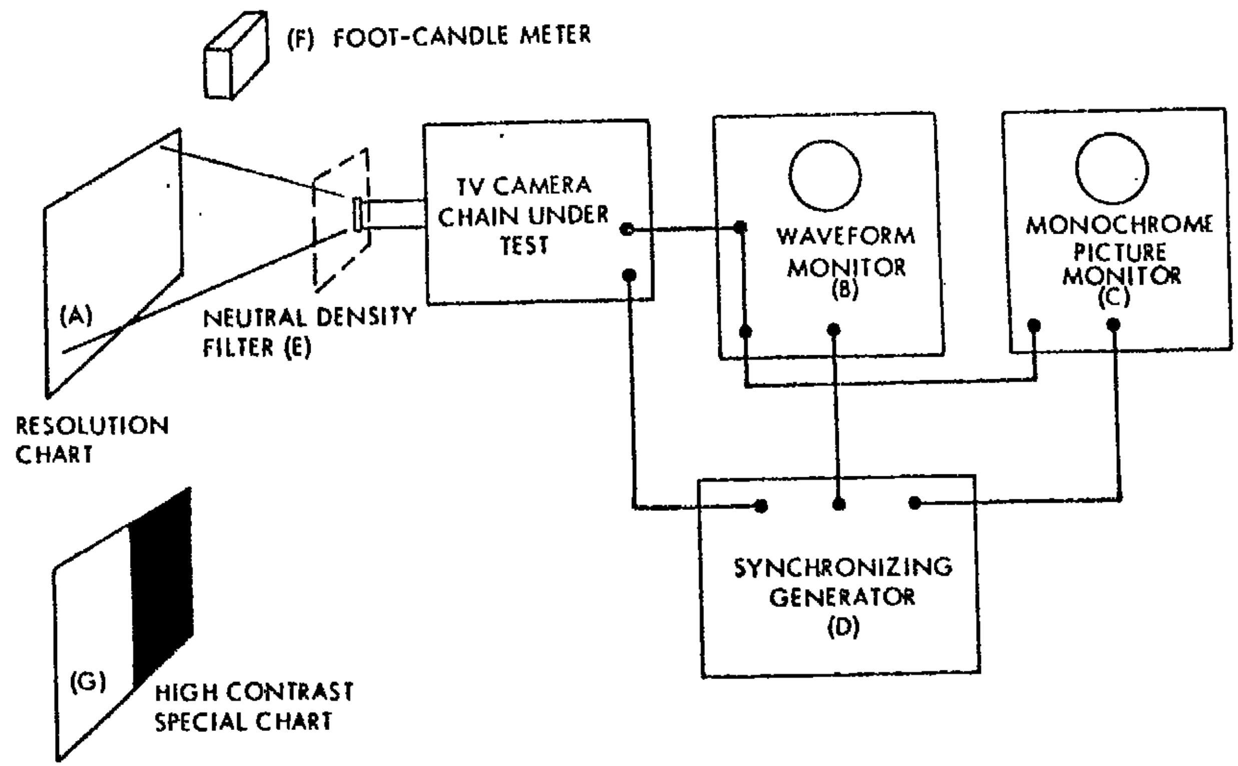
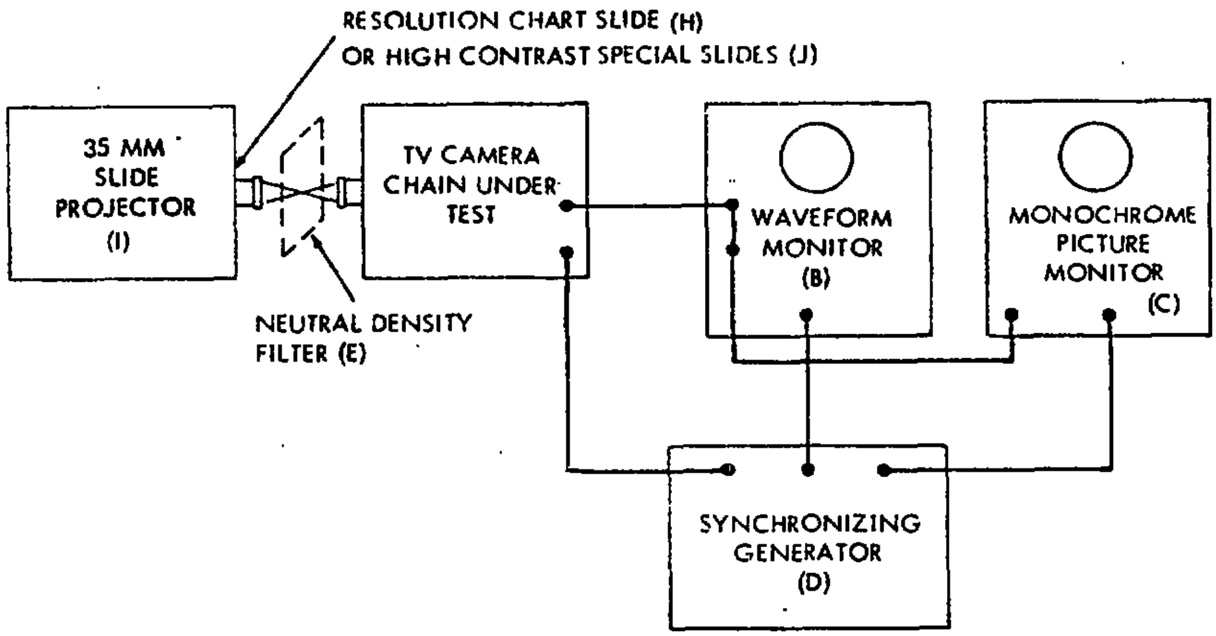



Figure 2-13. Measurement of Automatic Sensitivity, Black Level, and White Level Control of Monochrome Camera Chain.




NOTES: 1. ALL CONNECTIONS ARE COAXIAL TYPE
2. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-13a. Measurement of Automatic Sensitivity, Black Level, and White Level Control of Monochrome Film and Slide Camera Chain.

2.3.1.11 VERTICAL RESOLUTION (TV CAMERAS)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of vertical resolution in various types of television camera chains as specified in the following paragraph:

VERTICAL RESOLUTION. The vertical resolution of the camera shall be not less than 400 lines at any point in the picture.

b. TEST ARRANGEMENTS

| Arrangements | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Vertical Resolution in Monochrome Camera Chains | 2-14 |
| 2 | Measurement of Vertical Resolution in Monochrome Film and Slide Camera Chains | 2-14a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Standard Resolution Chart | A | 5 | 1 |
| Monochrome Picture Monitor | B | 22 | 1,2 |
| Synchronizing Generator | C | 15 | 1,2 |
| 35mm TV Slide Projector | D | 9 | 2 |
| 35mm Slide of Resolution Chart | E | 5a | 2 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF VERTICAL RESOLUTION OF MONOCHROME CAMERA CHAIN (Figure 2-14)

(a) Focus and align the television camera chain accurately upon Standard Resolution Chart (A). Connect camera chain video output to Monochrome Picture Monitor (B). Supply external synchronization to the camera chain and monitor from Synchronizing Generator (C). Adjust controls of monitor and camera for optimum display of the resolution chart image on the monitor, with the monitor underscanned to display the complete raster.

(b) Vertical resolution is measured by observation of the horizontal wedges of alternate black and white lines and noting the point along the converging wedge beyond which each individual line cannot be recognized. Readings should be taken both in the center and the corners of the display, interpolating the numbers adjacent to the wedges to arrive at resolution figures. Since the observations are subjective, it is desirable to record the average of several readings, preferably made by different observers.

(2) MEASUREMENT OF VERTICAL RESOLUTION OF MONOCHROME FILM AND SLIDE CAMERA CHAIN (Figure 2-14a)

(a) Insert 35mm Slide of Resolution Chart (E) into 35mm Television Slide Projector (D) and adjust to provide an accurately dimensioned optical image in the pickup tube of the camera under test.

(b) Follow the steps of Procedure (1) above, except for the change in visual source.

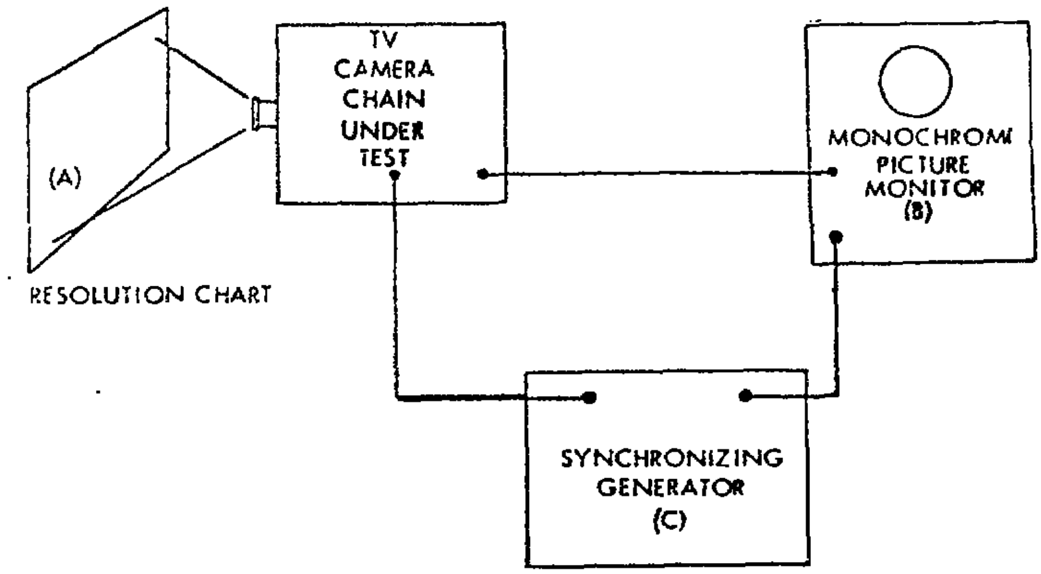
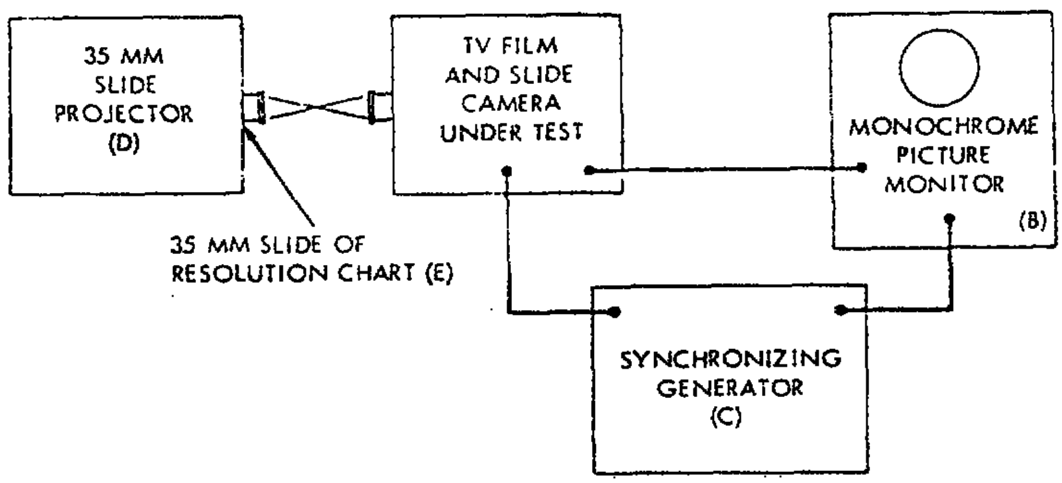



Figure 2-14. Measurement of Vertical Resolution of Monochrome Camera Chain.




NOTES: 1. ALL CONNECTIONS ARE COAXIAL TYPE
2. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-14a. Measurement of Vertical Resolution of Monochrome Film and Slide Camera Chain.

2.3.1.12 INTERNALLY GENERATED TRANSIENTS (TV CAMERA CHAINS)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of momentary picture distortions generated in television camera chains as specified in the following paragraph:

INTERNALLY GENERALLY TRANSIENTS. There shall be no detectable spurious signals such as "glitches" or "flashes" produced by the operation or switching of any circuit within the camera chain. This shall be true whether the camera is locally or remotely controlled.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Internally Generated Transients in TV Camera Chains | 2-15 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Resolution Chart | A | 5 | 1 |
| Foot-candle Meter | B | 19 | 1 |
| Monochrome Picture Monitor | C | 22 | 1 |

d. PROCEDURE

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF INTERNALLY GENERATED TRANSIENTS IN TELEVISION CAMERA CHAIN (Figure 2-15)

(1) Focus and align the camera chain under test upon Resolution Chart (A) illuminated at a level of 150 fc, as verified by Foot-candle Meter (B). Connect the camera chain video output to Monochrome Picture Monitor (C). All automatic controls of the camera chain should be switched off. Examine all areas of the monitor display for the presence of extraneous signals.

(2) Cap the camera lens externally to eliminate all light transmission. Without readjusting the camera, examine the monitor display for transients such as glitches and flashes while operating each camera chain control.

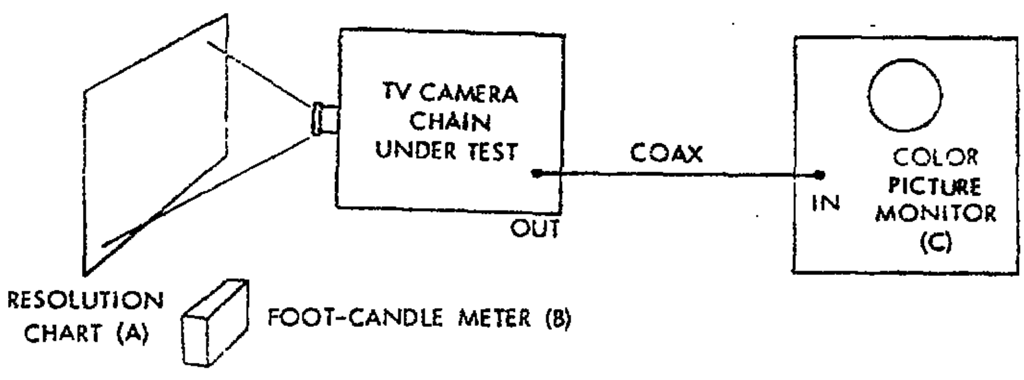



Figure 2-15. Measurement of Internally Generated Transients in TV Camera Chain.

2.3.1.13 POSITIVE/NEGATIVE SWITCH (TV FILM AND SLIDE CAMERA CHAINS)

A desirable feature of camera chains employed to televise films or slides is the ability to produce a positive type signal from sources that are either positive or negative. The camera chain should be equipped with a positive/negative switching circuit that will provide electronic inversion of the video signal when using a negative film. The switch should perform its function without requiring readjustments of video level of setup.

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of positive/negative switch operation of TV film and slide camera chains as specified in the following paragraph.

POSITIVE/NEGATIVE SWITCH. A switch shall be provided for electronic inversion of a composite monochrome video signal. The switch shall automatically provide correct setup position and level without further adjustment.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Positive/Negative Switch operation of TV Film and Slide Camera Chains | 2-16 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| 35mm TV Slide Projector | A | 9 | 1 |
| 35mm Negative Slide of Resolution Chart | B | 5g | 1 |
| Oscilloscope, Line Selector | C | 3 | 1 |
| Monochrome Picture Monitor | D | 22 | 1 |

d. PROCEDURE

See subparagrpah 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF POSITIVE /NEGATIVE SWITCH OPERATION OF TV FILM AND SLIDE CAMERA CHAIN (Figure 2-16)

(1) Connect the output of the film and slide camera chain under test on a bridge-through basis to line selector Oscilloscope (C) and terminate in Monochrome Picture Monitor (D). Employ 35mm Negative Slide of Resolution Chart (B) in TV Slide Projector (A) as visual source for the camera chain.

(2) Align and focus the camera upon the film slide. Switch the positive/negative switch back and forth and observe that a good

positive display can be provided on the picture monitor. Also, observe the waveforms on the oscilloscope, with the switch in alternate positions, and note any variations in setup or video level. The changes should not be great enough to necessitate readjustment of camera controls.

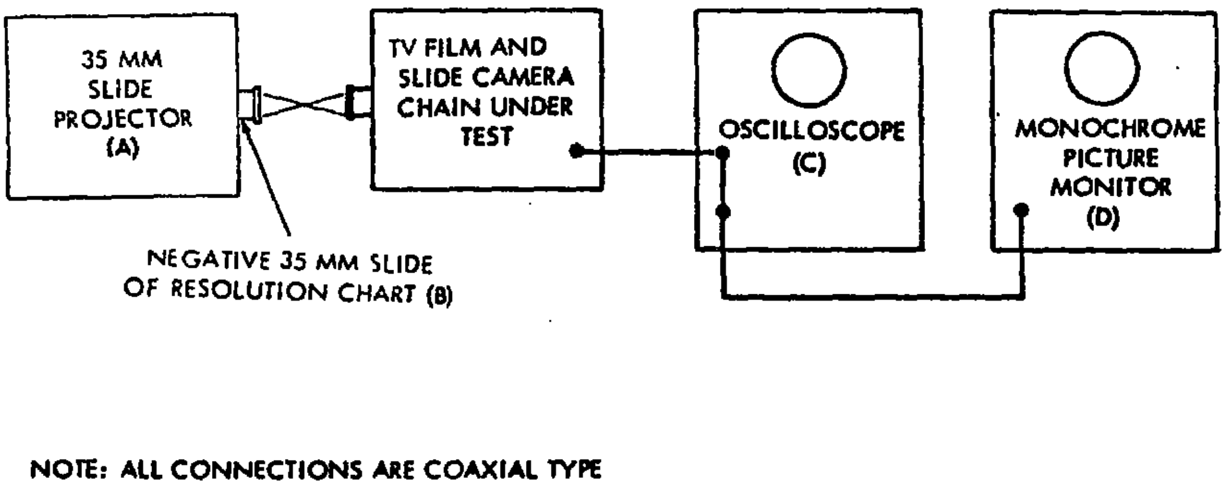



Figure 2-16. Measurement of Positive/Negative Switch Operation of TV Film and Slide Camera Chain.

2.3.1.14 GRAY SCALE REPRODUCTION (MONOCHROME CAMERA CHAIN)

The ability of a television camera chain to generate a video signal containing the correct contrast information from the original scene can be observed by scanning a "gray scale" chart and examining the video waveform or the picture reproduced on a high quality monitor. The chart customarily contains nine shades of gray plus background; each shade should be distinguishable in a properly generated and reproduced picture.

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of gray scale reproduction of monochrome camera chains as specified in the following paragraph:

GRAY SCALE REPRODUCTION. The camera chain, when set for a gamma factor of 0.7 and televising a Logarithmic Reflectance Chart, shall produce a signal in which all nine shades of gray and the gray background may be resolved, when displayed on a standard monochrome picture monitor. This performance shall be attained for image orthicon camera chains with 5 fc of white light and for vidicon camera chains with 25 fc of white light illuminating the chart.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Gray Scale Reproduction of Monochrome Camera Chain | 2-17 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Log Reflectance Chart | A | 52 | 1 |
| Monochrome Picture Monitor | B | 22 | 1 |
| Foot-candle Meter | C | 19 | 1 |

d. PROCEDURE

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF GRAY SCALE REPRODUCTION OF MONOCHROME CAMERA CHAIN (Figure 2-17)

(1) The camera chain under test should be aligned and focused upon the standard Logarithmic Reflectance Chart (A). Set the camera gamma factor at 0.7. Locate Foot-candle Meter (C) at the surface of the chart and adjust the white light illuminating the chart to a value of 5 fc for image orthicon type cameras, or to 25 fc for vidicon types.

(2) Connect the video output of the camera chain to Monochrome Picture Monitor (B), which has been previously tested for satisfactory gray scale reproduction. Adjust the camera chain for optimum performance and evaluate the monitor display subjectively. Observe whether each shade of the chart is distinguishable in the reproduced picture.

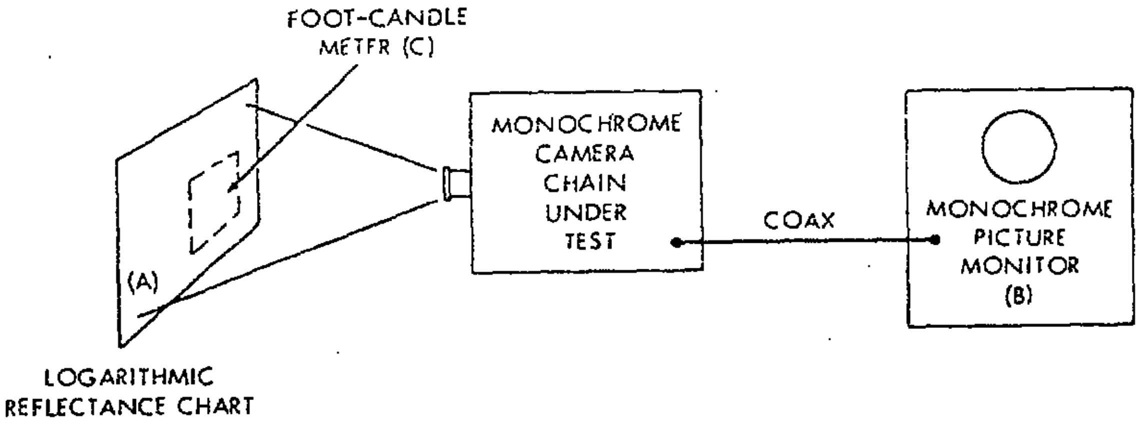



Figure 2-17. Measurement of Gray Scale Reproduction of Monochrome Camera Chain.

## 2.4 TV DISPLAY EQUIPMENT

### 2.4.1. TV VIEWFINDERS, PICTURE MONITORS, AND TELEVISION PROJECTORS (MONOCHROME)

#### 2.4.1.1 GEOMETRIC DISTORTION, ASPECT RATIO AND RASTER DIMENSIONS (TV DISPLAY EQUIPMENT)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of geometric distortion, aspect ratio and raster dimensions of TV picture monitors and TV projectors as specified in the following paragraphs:

(1) GEOMETRIC DISTORTION. The combined effects of all distortions shall not displace any point on the raster from its correct position by more than a specified percentage of the picture height. The percentage tolerance for monochrome equipment shall be ±1%.

(2) ASPECT RATIO. The width-to-height ratio of the picture is 4:3.

(3) SCAN SIZE. The normal scan shall provide a display in which all four corners of the raster are visible. The width and height controls shall have sufficient range to vary the raster size from -10% to +20% without exceeding the specified tolerance for geometric distortion.

(4) TRAPEZOIDAL DISTORTION. Projectors shall be capable of correcting keystone or trapezoidal distortion resulting from vertical tilt of the screen from a plane perpendicular to the optical axis of the projector within a range of ±15 degrees. This correction shall be achieved without exceeding the specified tolerance for geometric distortion or gray scale variation.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Geometric Distortion, Aspect Ratio and Raster Dimensions of TV Picture Monitors | 2-18 |
| 2 | Measurement of Geometric Distortion, Aspect Ratio and Raster Dimensions of TV Projectors. | 2-18a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Required for Method No. |
|---|---|---|---|
| Grating Pattern Generator | A | 10 | 1,2 |
| Slide Projector | B | 9 | 1,2 |
| Standard Linearity Chart Slide | - | 45a | 1,2 |

d. PROCEDURE

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF GEOMETRIC DISTORTION, ASPECT RATIO AND RASTER DIMENSIONS OF TV PICTURE MONITORS (Figure 2-18)

(a) Locate Slide Projector (B) on the axis of the monitor picture tube at a minimum distance of six times picture height. Focus the image from the Standard Linearity Chart Slide on the face of the picture tube. The chart shall occupy the same dimensions as the displayed raster on the monitor picture tube, when the raster is adjusted so that the four corners are at the edge of visibility.

(b) Connect Grating Pattern Generator (A) to the picture monitor. Set the generator to display on the monitor picture tube an electronically generated grating pattern to match the linearity chart. (The frequencies required are 315 kHz for the vertical grating bars and 900 Hz for the horizontal grating bars.) Adjust the two patterns for maximum coincidence and adjust brightness as necessary for optimum viewing.

(c) Geometric distortion shall be checked by examining all bar intersections with relation to the corresponding circles of the linearity chart. Intersections that fall within the inner white circles show that distortion at those points is not over 1% of picture height; intersections that fall within the outer black circles show that distortion at these points does not exceed 2% of picture height.

(d) Adjust the monitor controls to reduce the raster size 10% below the normal size and relocate the slide projector to restore maximum coincidence of the projected chart with the displayed grating pattern. Repeat the observations of the bar intersections relative to the linearity chart circles.

(e) Adjust the monitor controls to increase the raster size 20% above normal and relocate the slide projector to restore maximum coincidence of the projected chart with the displayed grating pattern. Repeat the observations of the bar intersections relative to the circles of the linearity chart.

NOTE: The requirements for aspect ratio and for normal scan size are met if step (c) measurements above are within specifications.

(2) MEASUREMENT OF GEOMETRIC DISTORTION, ASPECT RATIO AND RASTER DIMENSIONS OF TV PROJECTORS (Figure 2-18a)

(a) This test is basically a repetition of (1) above with the exception that the images are displayed on a projection screen and a test for trapezoidal (keystone) distortion is added.

(b) Locate the projection screen on the axis of the TV projector at a distance that will cause the screen dimensions to be 20% greater than the dimensions of the normal raster display. Position the slide projector on the axis of the projection screen and focus the standard linearity chart on the screen to occupy the same dimensions as the raster display.

(c) Connect the Grating Pattern Generator (A) to the TV projector. Set the generator to display on the projection screen an electronically generated grating pattern to match the linearity chart. (The frequencies required are 315 kHz for the vertical grating bars and 900 Hz for the horizontal grating bars.) Adjust the two patterns for maximum coincidence and adjust brightness as necessary for optimum viewing.

(d) Geometric distortion shall be checked by examining all bar intersections with relation to the corresponding circles of the linearity chart. Intersections that fall within the inner white circles indicate that distortion at these points does not exceed 1% of picture height; intersections that fall within the outer black circles show that distortion at these points does not exceed 2% of picture height.

(e) Adjust the TV projector controls to reduce the raster to 10% below the original size and reposition the slide projector to restore maximum coincidence of patterns. Repeat the geometric distortion check of step (d) above.

(f) Repeat step (e) above with the raster adjusted to 20% above the original size.

(g) Restore the raster to the original size. Tilt the projection screen forward and backward, in turn, and apply the corresponding keystone corrections at the TV projector. The slide projector shall be repositioned and tilted as required to maintain the optical axis perpendicular to the screen and centered on the display raster. Repeat the geometric distortion check with normal, reduced and enlarged raster sizes as in (d), (e) and (f) above.

(h) An alternate method of determining linearity and geometric distortion, which applies to both projection and direct-viewing systems, is provided here. Produce any dot or crosshatch pattern from the TV test signal generator (test item no. 13). DO NOT use a television camera with a pattern slide or chart, as this is considerably less accurate. Measure the sizes of the squares or between the dots with any convenient measuring device (household ruler, tape measure). Any deviation from the original pattern is entirely due to distortion of the monitor or projector. To measure geometric (keystone) distortion with projection systems, measure the angles at the corners of the display with a protractor. Any deviation from 90 is due entirely to keystone distortion of the system. This keystone test may also be used with standard monitors.

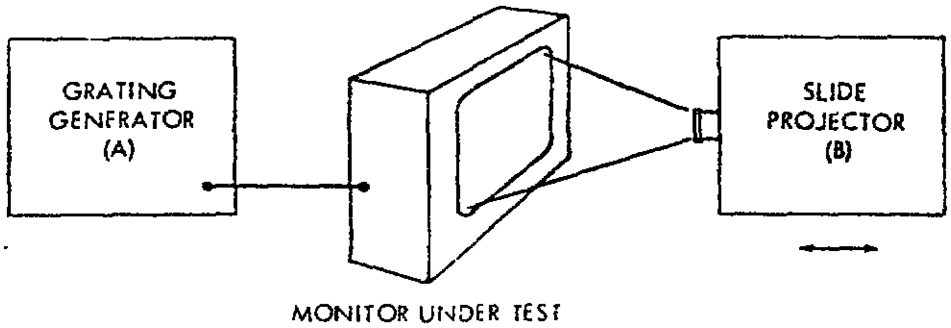
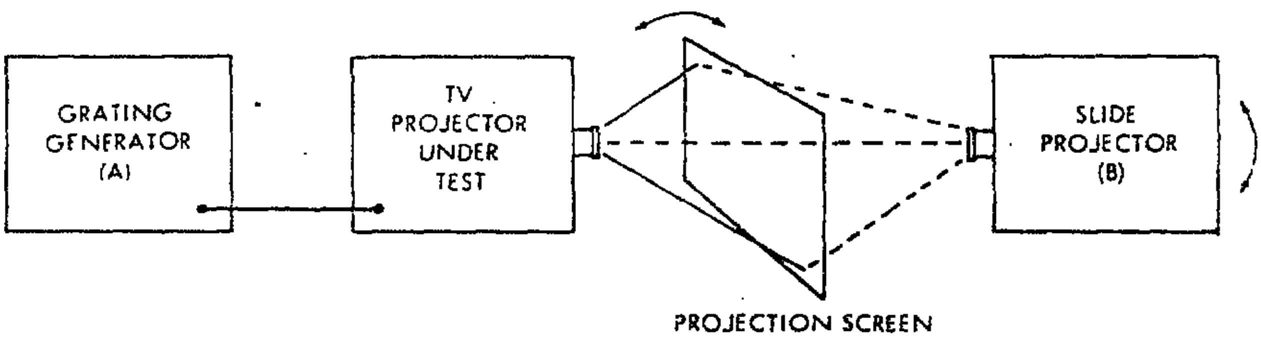



Figure 2-18. Measurement of Geometric Distortion, Aspect Ratio and Raster Dimensions of TV Picture Monitors.




NOTES: 1. THE SLIDE PROJECTOR SHALL BE MOVABLE HORIZONTALLY, VERTICALLY AND IN TILT
2. THE PROJECTION SCREEN SHALL BE ADJUSTABLE TO PROVIDE ± 15° TILT

Figure 2-18a. Measurement of Geometric Distortion, Aspect Ratio and Raster Dimensions of TV Projectors.

2.4.1.2 RESOLUTION, BRIGHTNESS (TV DISPLAY EQUIPMENT)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of resolution and brightness of television picture monitors and television projectors as specified in the following paragraphs:

(1) RESOLUTION. Horizontal resolution at the specified brightness level shall be at least 800 lines at the center of the display faceplate and 700 lines at the corners. Vertical resolution shall be at least 400 lines.

(2) BRIGHTNESS (MONOCHROME PICTURE MONITOR). The brightness of the CRT display shall be adjustable up to the following levels as related to the tube dimension:

| Tube Dimension | Brightness |
|---|---|
| 14 inch | 100 foot-lamberts |
| 17 inch | 100 foot-lamberts |
| 21 inch | 35 foot-lamberts |
| 23 inch | 30 foot-lamberts |
| 25 inch | 30 foot-lamberts |

(3) BRIGHTNESS (CAMERA VIEWFINDER ONLY). Display highlight brightness shall be at least 100 foot-lambert concurrent with the specified resolution.

(4) BRIGHTNESS (MONOCHROME TELEVISION PROJECTOR). The projector shall provide highlight brightness levels, related to screen dimensions, as listed below (for screens of unity gain). Variation in brightness in any area of the plane of the screen shall not exceed $\pm 30\%$ of the value measured at the center of the plane. Note that these specifications are <u>not</u> normally met by color projectors even when reproducing monochrome images.

| Image Size (feet) | Screen Brightness (at center) |
|---|---|
| 6 x 8 | 62 foot-lamberts |
| 9 x 12 | 28 foot-lamberts |
| 12 x 16 | 16 foot-lamberts |
| 15 x 20 | 10 foot-lamberts |
| 24 x 32 | 4 foot-lamberts |

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Resolution and Brightness of TV Picture Monitors (Monochrome) | 2-19 |
| 2 | Measurement of Resolution and Brightness of TV Projectors (Monochrome) | 2-19a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Foot-Lambert Meter | A | 12 | 1,2 |
| Foot-Candle Meter | B | 19 | 2 |
| TV Test Signal Generator | C | 13 | 2 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF RESOLUTION AND BRIGHTNESS OF TV PICTURE MONITORS - MONOCHROME (Figure 2-19)

(a) Select the multiburst pattern on the TV test signal generator (test item no. 13). Limiting Resolution is defined as the frequency at which no lines appear.

(b) Determine the limiting resolution by viewing the monitor at a distance no greater than four times picture height. The resolution limit is the position on the displayed horizontal and vertical wedges of the chart where the individual lines are no longer distinguishable. Use Resolution Chart (D) for measuring resolution at the corners of the display.

(2) MEASUREMENT OF RESOLUTION AND BRIGHTNESS OF TV PROJECTORS - MONOCHROME (Figure 2-19a)

(a) Monochrome Camera Chain (A) shall have a known horizontal resolution capability of at least 800 lines at the center and 700 lines at the corners, plus a vertical resolution of 400 lines in all areas. A noncomposite video signal obtained by focusing the camera on Standard Resolution Chart (C) shall be applied to the video input of the TV projector under test. The chart image from the projector shall be displayed on one of the specified projection screens and projector controls shall be adjusted for optimum performance. Measure brightness at the screen with Foot-Lambert Meter (B) and adjust projector to provide the brightness specified in paragraph 2.4.1.2 a. (4) for the selected screen size, making allowance for any variation from unity gain of the screen (e.g., when screen gain is 1.5, divide reading by 1.5).

(b) View the projection screen from a distance not exceeding four times the picture height and determine resolution from the position on the displayed horizontal and vertical wedges of the chart where the individual lines are no longer distinguishable. The ambient illumination at the screen should be less than 0.5 fc during this measurement, as measured by Foot-Candle Meter (F).

(c) Employ Resolution Chart (D) for measuring resolution at the corners of the display.

(d) Remove camera chain and in its place connect TV Test Signal Generator (C) to the projector video input. Set the generator to supply an electronically generated flat field of white. Measure variations in brightness by placing Foot-Lambert Meter (B) facing the projector, and taking readings of projected beam intensity at distances and locations corresponding to the center and the extremes of the screen.

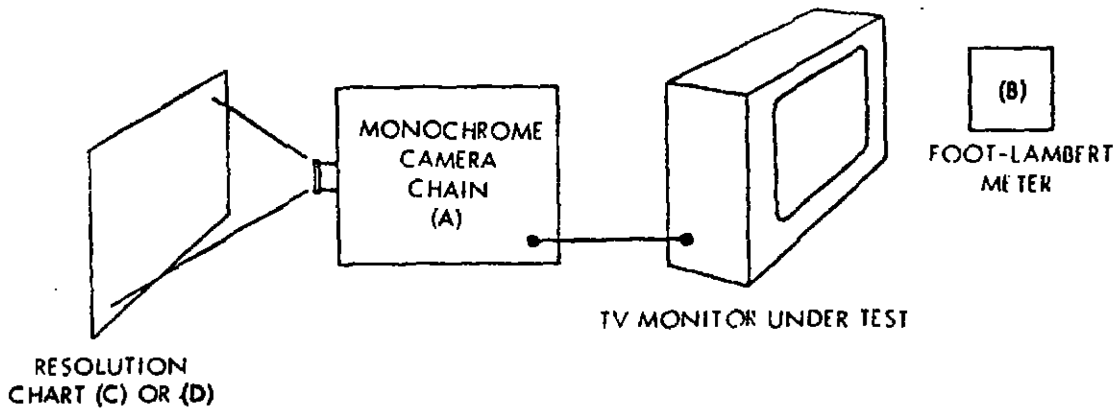



Figure 2-19. Measurement of Resolution and Brightness of TV Picture Monitors - Monochrome.

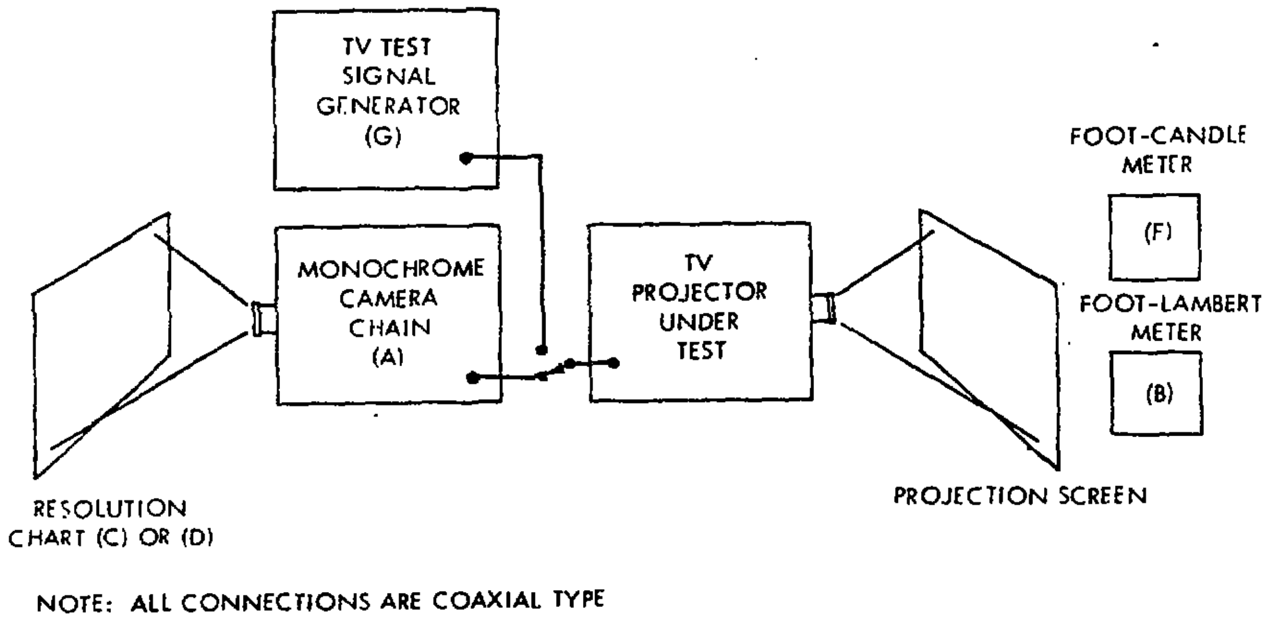



Figure 2-19a. Measurement of Resolution and Brightness of TV Projectors - Monochrome.

2.4.1.3 INTERLACE (TV DISPLAY EQUIPMENT)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of interlace of television picture monitors and television projectors as specified in the following paragraph:

INTERLACE. The displacement of any scanning line from a center position between lines of the alternate field shall not exceed 10% of the distance between the lines of the alternate field.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Interlace of Television Picture Monitors | 2-20 |
| 2 | Measurement of Interlace of Television Projectors | 2-20a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No, in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1,2 |
| Camera, Film | B | 50 | 1,2 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF INTERLACE OF TELEVISION PICTURE MONITORS (Figure 2-20)

(a) For monochrome monitors, connect TV Test Signal Generator (A) to the terminated video input of the television picture monitor under test. Adjust the generator to provide a composite video signal at a voltage level of 1.0 V, peak-to-peak. The composite signal shall consist of 0.6 V, peak-to-peak, of setup in lieu of picture content and 0.4 V, peak-to-peak, of synchronizing signal. Set monitor for internal synchronization and adjust brightness to a level convenient for still photography.

(b) Use Film Camera (B) to photograph the display, employing film that will permit enlargement sufficient to allow measurement of adjacent interlaced scanning lines at a separation of at least one centimeter. Use a shutter speed of one-thirtieth of a second.

(c) Determine the accuracy of the interlace by measuring the photographs in the central portion to avoid areas of possible distortion caused by the film camera or enlarger lenses.

(2) MEASUREMENT OF INTERLACE OF TELEVISION PROJECTORS (Figure 1-20a)

Follow the same steps as in Procedure (1) above, except that photographs shall be made of the projection screen display instead of a picture tube display.

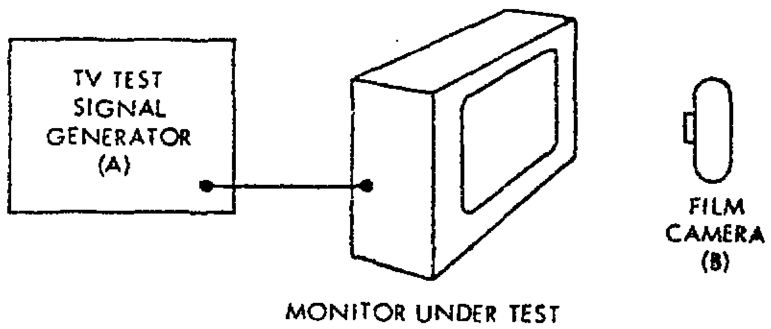



Figure 2-20. Measurement of Interlace of TV Picture Monitors.

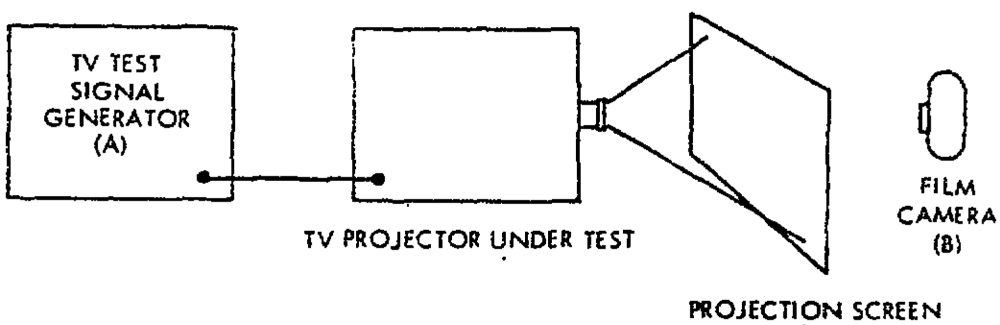



Figure 2-20a. Measurement of Interlace of TV Projectors.

2.4.1.4 NOISE AND HUM (TV DISPLAY EQUIPMENT)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of noise and hum of television display equipment as specified in the following paragraphs:

(1) HUM AND NOISE (CAMERA VIEWFINDER). The rms value of all extraneous signals generated within the viewfinder shall be at least 60 dB below the normal peak-to-peak video level appearing at the driven element of the CRT.

(2) HUM AND NOISE (MONOCHROME, PICTURE MONITOR AND TELEVISION PROJECTOR). The weighted rms value of hum and noise contributed by the display equipment shall be at least 65 dB below the normal peak-to-peak video signal level at the driven element(s) controlling the electron beam(s). Weighting shall be accomplished by a network having an insertion loss equal to $10 \log [1 + (\omega\tau)^2]$ dB, where $\omega = 2\pi f$, f is in MHz and $\tau = 0.11$ μsec.

b, TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Combined Noise and Hum in Camera Viewfinder | 2-21 |
| 2 | Combined Noise and Hum in Monochrome Picture Monitor | 2-21a |
| 3 | Signal-to-Noise Ratio and Hum in Monochrome Television Projector (Large Screen) | 2-21b |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Standard Resolution Chart | A | 5 | 1 |
| Foot-Lambert Meter | B | 12 | 1 |
| Monochrome Camera Chain | C | 7 | 1 |
| Oscilloscope, Wideband, Line-selector | D | 3 | 1,2,3 |
| True RMS Voltmeter (High Imp.) | E | 11 | 1,2,3 |
| TV Test Signal Generator | F | 13 | 2,3 |
| Synchronizing Generator | G | 15 | 2,3 |
| Filter, Low-Pass | H | 51 | 3 |
| Filter, High-Pass | I | 57 | 3 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF COMBINED NOISE AND HUM IN A CAMERA VIEWFINDER (Figure 2-21)

(a) Focus Monochrome Camera Chain (C) upon Resolution Chart (A) and illuminate chart at a level of 100 foot-lamberts as measured by Foot-Lambert Meter (B). Connect the camera chain output to $V_1$, the viewfinder video input and adjust all controls for optimum display with viewfinder video input signal level set at 0.7 V, peak-to-peak.

(b) Apply wideband Oscilloscope (D) in a bridging connection across the output of the viewfinder video amplifier, Vo, and measure the peak-to-peak amplitude of the video signal.

(c) Remove the camera signal from the viewfinder input and terminate the input with 75 ohms. Replace the oscilloscope at Vo with True RMS Voltmeter (E) and measure the rms value of combined noise and hum on the viewfinder video amplifier output.

(d) Calculate the ratio of the peak-to-peak signal level established in step (a) to the rms noise and hum voltage measured in step (c), and convert to decibel form.

(2) MEASUREMENT OF COMBINED NOISE AND HUM IN MONOCHROME PICTURE MONITOR (Figure 2-21a)

(a) Adjust TV Test Signal Generator (F) to supply a noncomposite video signal consisting of normal blanking pulses and a square wave of approximately 15,750 Hz during the horizontal line interval. When properly adjusted, the picture will consist of a black section and a white section, side by side. Apply video signal with approximately 10% setup at a level of 0.7 V, peak-to-peak, to the video amplifier input of the display equipment under test. Supply external synchronizing signals to generator and display equipment from Synchronizing Generator (H). Switch off dc restorer and adjust brightness and contrast controls to convenient levels between midpoint and maximum range.

(b) Connect wideband Oscilloscope (D) to the output of the video amplifier and supply external synchronization to the oscilloscope from Synchronizing Generator (H). Measure the peak-to-peak video signal voltage of the square wave.

(c) Remove the test signal from the display equipment video amplifier input and terminate this input with 75 ohms resistive.

Replace the oscilloscope with high impedance True RMS Voltmeter (E) and measure the rms value of combined noise and hum at the output of the weighting network.

(d) Calculate the ratio of the peak-to-peak video signal established in step (a) above to the rms noise and hum voltage measured in step (c) above and convert to decibel form.

(3) MEASUREMENT OF SIGNAL-TO-NOISE RATIO AND HUM IN MONOCHROME TELEVISION PROJECTOR (Figure 2-21b)

(a) Perform steps (a) and (b) of Procedure (2) above with one addition: insert High-Pass Filter (J) between Weighting Network (G) and Oscilloscope (D).

(b) Measure the peak-to-peak noise amplitude appearing in the black portion of the signal with the oscilloscope sweep operating at line frequency. Calculate the rms noise value, using the approximation that rms noise amplitude is equivalent to peak-to-peak noise amplitude divided by six.

(c) Calculate the weighted signal-to-noise ratio from the signal amplitude measured in (a) and the rms noise amplitude obtained in (b) above. Convert to decibel form.

(d) Remove the test signal from the display equipment video amplifier imput and terminate this input with 75 ohms resistive. Connect True RMS Voltmeter (E) via Low-Pass Filter (I) to the output of Weighting Network (G), in place of the high-pass filter and oscilloscope. Measure the rms voltage appearing at the output of the low-pass filter.

(e) Calculate the ratio of signal to hum from the signal amplitude measured in (a) above and the rms hum amplitude measured in (d) above. Convert the ratio to decibel form.

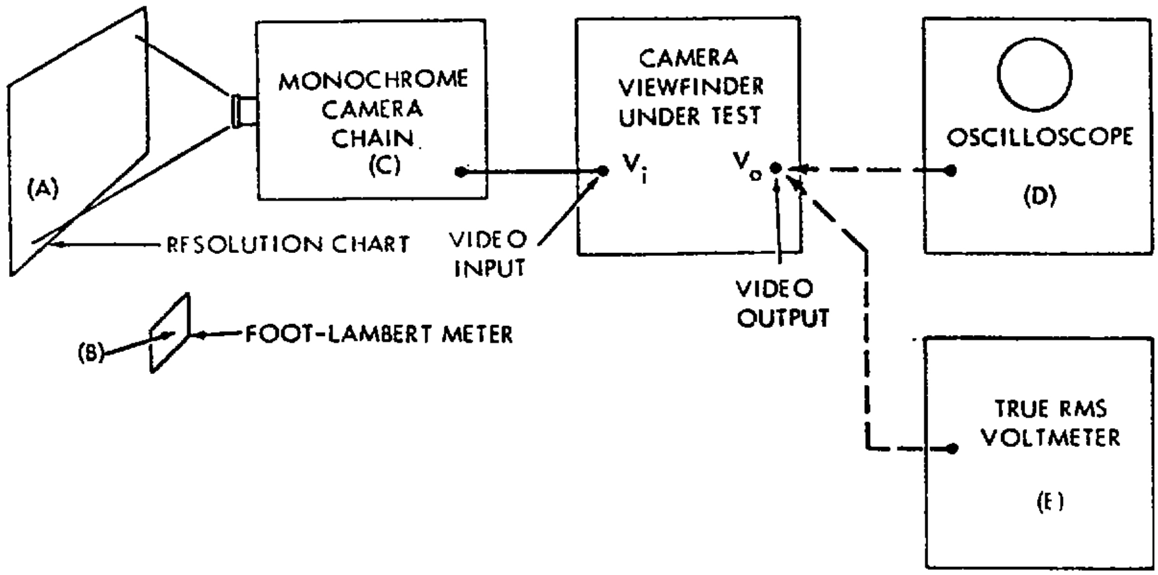
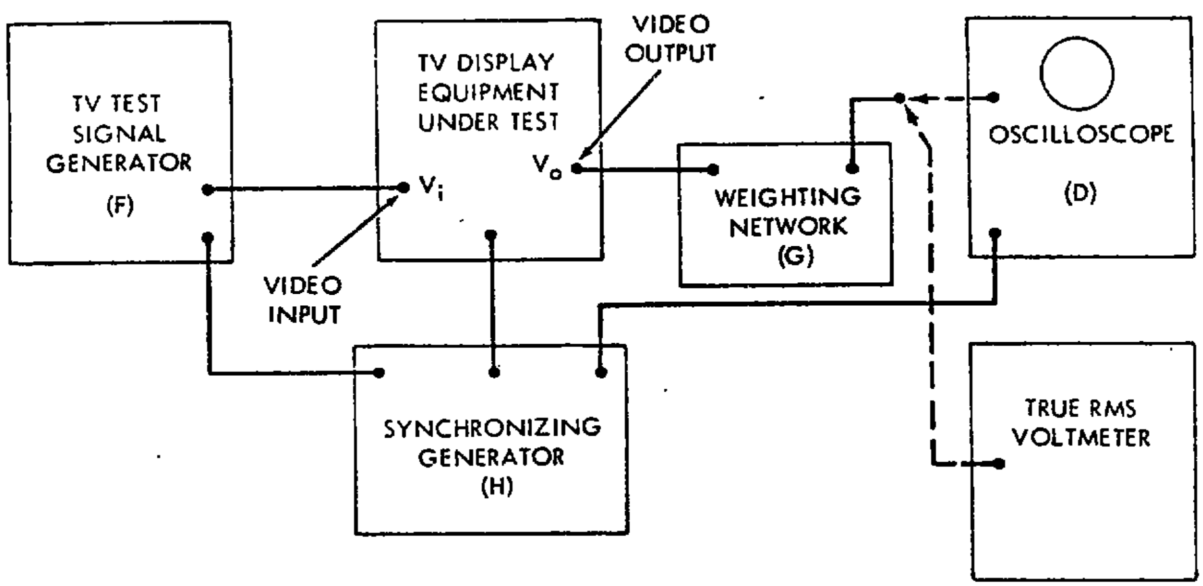
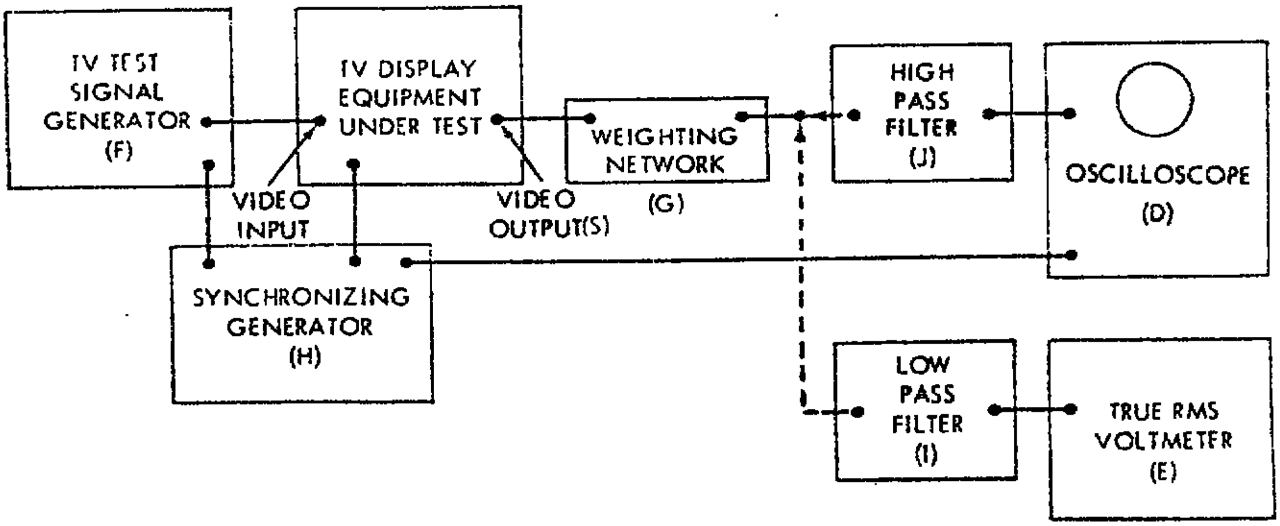



Figure 2-21. Measurement of Combined Noise and Hum in Camera Viewfinder.




NOTES:
1. WEIGHTING NETWORK INSERTION LOSS = $10 \log [1 + (\omega\tau)^2]$ dB, WHERE $\omega = 2\pi f$, f IS IN MEGAHERTZ, AND $\tau = 0.11$ MICROSECOND
2. ALL CONNECTIONS ARE COAXIAL TYPE
3. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-21a. Measurement of Combined Noise and Hum in TV Display Equipment.




NOTES:
1. WEIGHTING NETWORK INSERTION LOSS = $10 \text{ LOG}[1 + (\omega\tau)^2]$ dB, WHERE $\omega = 2\pi f$, f IS IN MEGAHERTZ, AND $\tau$ = 0.11 MICROSECOND.
2. I = LOW PASS FILTER WITH CUT OFF AT ONE KILOHERTZ.
3. J = HIGH PASS FILTER WITH CUT OFF AT ONE KILOHERTZ.
4. ALL CONNECTIONS ARE COAXIAL TYPE.
5. UTILIZE A PULSE DISTRIBUTION AMPLIFIER TO PROVIDE THE REQUIRED NUMBER OF SYNCHRONIZING PULSE OUTPUTS

Figure 2-21b. Measurement of Signal-to-Noise and Hum in TV Display Equipment.

2.4.1.5 FREQUENCY RESPONSE (TV DISPLAY EQUIPMENT - MONOCHROME)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of high-frequency response and low-frequency response of monochrome viewfinders, monochrome picture monitors and monochrome television projectors. The tests are applicable to the standards specified in the following paragraphs:

(1) FREQUENCY RESPONSE

Monochrome Signal. The frequency response to a monochrome signal, between the video input terminal(s) and the driven element(s) which control the electron beam(s), shall be flat ±1 dB from 30 Hz to 10 MHz.

(2) LOW-FREQUENCY TILT. The low-frequency tilt to a 60 Hz square wave input signal shall not exceed 1%, as measured at the input to the control elements of the kinescope.

b. TEST ARRANGEMENTS

| Arrangements | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of High-Frequency Response of TV Display Equipment-Monochrome | 2-22 |
| 2 | Measurement of Low-Frequency Response of TV Display Equipment-Monochrome | 2-22 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1,2 |
| Oscilloscope, Wideband | B | 3 | 1,2 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF FREQUENCY RESPONSE OF TV DISPLAY EQUIPMENT - MONOCHROME (Figure 2-22)

(a) Remove the video amplifier output connection (Vo) from the kinescope. Connect wideband Oscilloscope (B) by low-capacitance probe to Vo. Add sufficient capacitance ($C_1$) to oscilloscope probe capacitance ($C_p$) to equal ($C_L$), the normal load capacitance of the driven element.

(b) Connect TV Test Signal Generator (A) to the terminated video input and provide a noncomposite 100 kHz sine wave, interrupted by vertical and horizontal blanking intervals. Set input level to 0.7 V, peak-to-peak.

(c) Set brightness and contrast controls at approximately midpoint. Measure video output levels on the oscilloscope as the sine wave frequency from the test generator is slowly increased from 30 Hz to 10 MHz. Record the measurements at frequencies of 30, 60, 100, 200 and 500 Hz; 1, 2, 5, 10 and 100 kHz; and 1, 2, 3, 3.58, 4, 6, 8 and 10 MHz.

(d) Convert voltage variations to decibel form.

(2) MEASUREMENT OF LOW-FREQUENCY TILT OF TV DISPLAY EQUIPMENT - MONOCHROME (Figure 2-22)

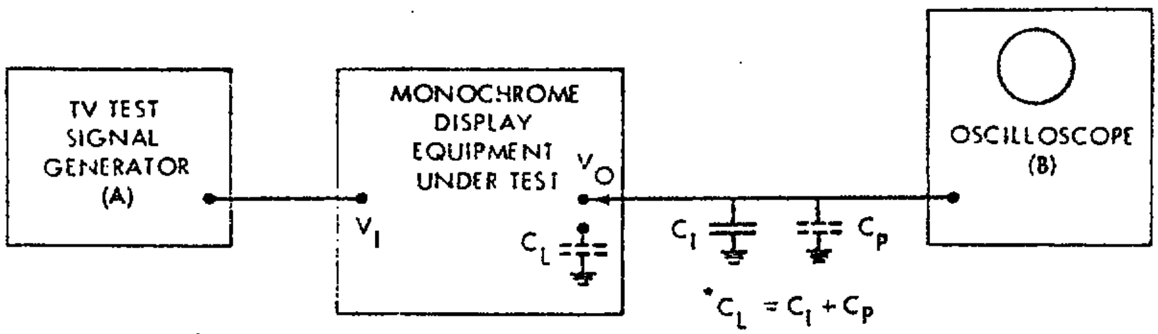
Low-frequency response is evaluated in terms of the ability of the equipment to pass low-frequency square waves with minimum tilt. Tilt is a form of distortion of a rectangular pulse characterized by the introduction of slope on the horizontal components of the pulse; it is measured as the ratio, expressed as a percentage, between the amplitude of the slope component and the amplitude of the pulse.

(a) Repeat Step (a) of Procedure (1) above.

(b) Adjust TV Test Signal Generator (A) to provide a 60 Hz square wave. Connect the generator to the terminated video input and set the signal input level to 0.7 V, peak-to-peak. The dc restorer shall be switched off.

(c) Measure the tilt by scaling the oscilloscope presentation of the 60 Hz square wave.*

**Prior to this test, the signal generator-oscilloscope combination shall have been checked for freedom from tilt at 60 Hz. Allowance shall be made for any tilt contributed by the test equipment.*




NOTES: 1. $V_I$ = VIDEO INPUT TERMINAL

$V_O$ = OUTPUT OF VIDEO AMPLIFIER (DISCONNECTED FROM DRIVEN ELEMENT OF PICTURE TUBE OR BEAM CONTROL ELEMENT OF TV PROJECTOR)

$C_P$ = OSCILLOSCOPE PROBE CAPACITANCE

$C_I$ = CAPACITOR ADDED TO $C_p$ TO SIMULATE $C_L$

*$C_L$ = DRIVEN ELEMENT CAPACITANCE (VALUE FROM MFGR'S DATA)

2. CONNECTIONS ARE COAXIAL TYPE

Figure 2-22. Measurement of Frequency Response of TV Display Equipment - Monochrome.

2.4.1.6 GRAY SCALE REPRODUCTION (TV DISPLAY EQUIPMENT - MONOCHROME)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of gray scale reproduction of monochrome television display equipment as specified in the following paragraph:

GRAY SCALE REPRODUCTION. Nine shades of gray and the white background shall be distinguishable in the visual display of a standard resolution chart at the normal brightness level.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Gray Scale Reproduction of Camera Viewfinder of Monochrome Picture Monitor | 2-23 |
| 2 | Measurement of Gray Scale Reproduction of Monochrome Television Projector | 2-23 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Monochrome Camera Chain | A | 7 | 1,2 |
| Resolution Chart | B | 5 | 1,2 |
| Foot-Lambert Meter | C | 12 | 1 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF GRAY SCALE REPRODUCTION OF CAMERA VIEWFINDER OR MONOCHROME PICTURE MONITOR (Figure 2-23)

(a) Employ as a video source a Monochrome Camera Chain (A) which has met the gamma correction measurement specified in Section 2.3.1.7 of this document. Align and focus the camera upon Resolution Chart (B). Connect the camera chain output to the video input of the display equipment under test.

(b) Using Foot-Lambert Meter (C), adjust the highlight brightness of the display to the value specified for the tube size used (see Section 2.4.1.2). Set the contrast for optimum gray scale reproduction, and evaluate the gray scale subjectively, noting whether nine shades of gray, plus the white background, are distinguishable. Compare evaluation with specifications.

(2) MEASUREMENT OF GRAY SCALE REPRODUCTION OF MONOCHROME TELEVISION PROJECTOR (Figure 2-23)

This measurement is in accordance with Procedure (1) above, except that the display is projected onto a screen (see Section 2.4.1.2 to determine the specified brightness for the screen size employed). Make allowance for any variation from unity gain of the screen (e.g., when screen gain is 1.5, divide foot-lambert meter reading by 1.5).

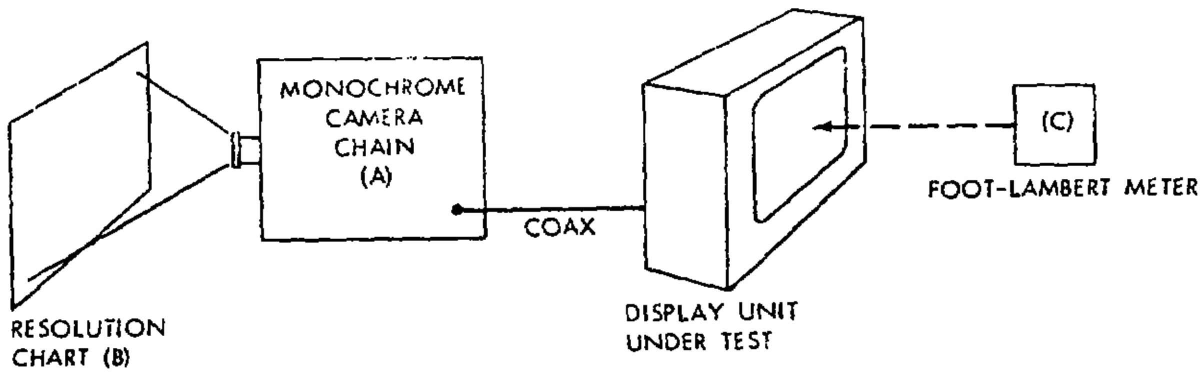



Figure 2-23. Measurement of Gray Scale Reproduction of TV Display Equipment.

## 2.5 TV SIGNAL DISTRIBUTION AND AUXILIARY EQUIPMENT

### 2.5.1 VIDEO SWITCHERS, VIDEO MIXING AMPLIFIERS, SPECIAL EFFECTS GENERATORS, VIDEO DISTRIBUTION AMPLIFIERS, VIDEO EQUALIZATION AMPLIFIERS, AND PULSE DISTRIBUTION AMPLIFIERS

#### 2.5.1.1 FREQUENCY RESPONSE (TV SIGNAL DISTRIBUTION AND AUXILIARY EQUIPMENT)

a. APPLICABILITY. The frequency response measurements in this section include the characteristics of amplitude versus frequency, low-frequency tilt, and overshoot. The test arrangements in subparagraph b. below are applicable to the frequency response characteristics of video switchers, video mixing amplifiers, special effects generators, video distribution amplifiers, video equalization amplifiers and pulse distribution amplifiers as specified in the following paragraphs:

(1) VIDEO SWITCHERS

(a) FREQUENCY RESPONSE. The frequency response between video input and output connectors shall be flat within ±0.5 dB from 30 Hz to 10 MHz for any available combination of switch connections.

(b) LOW-FREQUENCY TILT. The low-frequency tilt introduced on a 60 Hz square wave input signal shall be less than 1%.

(c) OVERSHOOT. Overshoot introduced on a square wave input signal having a rise time of 0.1 μsec shall be less than 1%.

(2) VIDEO MIXING AMPLIFIERS

(a) FREQUENCY RESPONSE. Frequency response between input and output connectors shall be flat within ±0.5 dB from 30 Hz to 10 MHz.

(b) LOW-FREQUENCY TILT. The low-frequency tilt to a 60 Hz square wave input shall be less than 1%.

(c) OVERSHOOT. Overshoot to a square wave input signal having a rise time of 0.1 μsec shall be less than 1%.

(3) SPECIAL EFFECTS GENERATORS

(a) FREQUENCY RESPONSE. The video frequency response of the generation, from any input to any output, shall be flat ±0.5 dB from 30 Hz to 10 MHz. The frequency response shall be maintained for any type of special effect and for any setting of the wipe and/or position controls.

(b) OVERSHOOT AND LOW-FREQUENCY TILT. Low-frequency tilt introduced to a 1.0 V, peak-to-peak, 60 Hz square wave shall be less than 1%. Overshoot introduced on a square wave input having a rise time of 0.1 μsec shall not exceed 1%.

(4) VIDEO DISTRIBUTION AMPLIFIERS

(a) FREQUENCY RESPONSE (BANDWIDTH). The frequency response of the amplifier shall be flat within ±0.25 dB from 30 Hz to 10 MHz.

(b) LOW-FREQUENCY TILT. Low-frequency tilt introduced on a 60 Hz square wave shall not exceed 1%.

(c) OVERSHOOT. Maximum overshoot superinduced on a square wave having a rise time of 50 ns shall not exceed 2%.

(5) VIDEO EQUALIZATION AMPLIFIERS

FREQUENCY RESPONSE. The frequency response of the amplifier, when set to "flat" position, shall be flat within ±1 dB from 30 Hz to 10 MHz.

(6) PULSE DISTRIBUTION AMPLIFIERS

(a) OUTPUT PULSE SHAPE. The pulse distribution amplifier will reshape and/or regenerate the input signal and provide output signals with rise and decay times not exceeding 100 ns and an overshoot of less than 2%.

(b) INPUT SIGNAL CHARACTERISTICS. The input signals shall be as depicted in Figure 2-32 (Synchronizing Generator Waveforms). Additionally, the amplifier shall meet all performance requirements when input pulse signals having rise times in the range of 50 to 250 ns are applied.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Amplitude vs Frequency Response of Video Switcher | 2-24 |
| 2 | Measurement of Amplitude vs Frequency Response of Video Mixing Amplifier | 2-24a |
| 3 | Measurement of Amplitude vs Frequency Response of Special Effects Generator | 2-24b |

b. TEST ARRANGEMENTS (cont.)

| | | |
|---|---|---|
| 4 | Measurement of Amplitude vs Frequency Response of Video Distribution Amplifier | 2-24c |
| 5 | Measurement of Amplitude vs Frequency Response of Video Equalization Amplifier | 2-24d |
| 6 | Measurement of Tilt and Overshoot of Video Distribution and Auxiliary Equipment: Video Switcher, Video Mixing Amplifier, Special Effects Generator, Video Distribution Amplifier | 2-24e |
| 7 | Measurement of Overshoot and Rise Time of Pulse Distribution Amplifier | 2-24f |
| 8 | Measurement of Low-Frequency Tilt of Pulse Distribution Amplifier | 2-24g |
| 9 | Synchronizing Generator Waveforms | 2-24h |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Sine Wave Oscillator | A | 2 | 1,2,4,5 |
| Oscilloscope | B | 3 | 1,2,4,5,6,7,8 |
| TV Test Signal Generator | C | 13 | 3,6 |
| Waveform Monitor | D | 21 | 3 |
| Monochrome Picture Monitor | E | 22 | 3 |
| Square Wave Generator | F | 4 | 6,7 |
| Synchronizing Generator | G | 15 | 8 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF AMPLITUDE VS FREQUENCY RESPONSE OF VIDEO SWITCHER (Figure 2-24)

(a) Apply a 100 kHz sine wave, adjusted to 1.0 V peak-to-peak, from Sine Wave Oscillator (A) to one of the switcher video inputs. Connect Oscilloscope (B) to one of the switcher outputs, terminated in 75 ohms; switch this output to the test input. Set gain control to unity. Do not use Sync-adder.

(b) Gradually raise the oscillator frequency from 30 Hz to 10 MHz, and observe amplitude response on the oscilloscope. Record measurements at 30, 60, 100, 200, 400 and 500 Hz; 1, 10, 100 and 500 kHz; and at 1, 2, 3.58, 4, 6, 8 and 10 MHz.

(c) Terminate all outputs and switch them concurrently to the input under test. Repeat the measurements described in step (b) above.

(d) Repeat steps (a) and (b) above until at least three different input/output combinations have been tested.

(e) Convert amplitude measurements to decibel form.

(2) MEASUREMENT OF AMPLITUDE VS FREQUENCY RESPONSE OF VIDEO MIXING AMPLIFIER (Figure 2-24a)

(a) Connect Sine Wave Oscillator (A) to both inputs of video mixing amplifier and terminate in 75 ohms. Connect Oscilloscope (B) to one terminated output of amplifier. Set Sine Wave Oscillator signal level to 1.0 V peak-to-peak, for all frequencies. Set amplifier gain for unity for both inputs.

(b) With the video mixing controls set, in turn, to provide maximum output from each input signal, measure the output level at the following input frequencies: 30, 60, 100 and 500 Hz; 1, 2, 5, 10, 100 and 500 kHz; and 1, 2, 3.58, 5, 8 and 10 MHz. Change the oscillator frequency slowly between each measurement and observe oscilloscope to verify flatness of response.

(c) With the video mixing controls set to provide 50% of maximum output from each input signal, the response shall be measured at 30, 60 and 100 Hz; 1, 10 and 100 kHz; and at 1, 3.58, and 10 MHz.

(d) Convert amplitude measurements of steps (b) and (c) to decibel form.

(3) MEASUREMENT OF AMPLITUDE VS FREQUENCY RESPONSE OF SPECIAL EFFECTS GENERATOR (Figure 2-24b)

(a) Adjust TV Test Signal Generator (C) to provide a sine wave with horizontal and vertical blanking intervals. Connect Test Signal Generator, in turn, to each of the two video inputs of the special effects generator and set input levels to 1.0 V peak-to-peak.

(b) One output of the special effects generator shall be bridged through line selector Waveform Monitor (D) to Monochrom Picture Monitor (E). Externally synchronize both monitors.

(c) Measure frequency response for each video channel by line selector techniques at the following frequencies: 30, 60, 100, 200 and 500 Hz; 1, 2, 5, 10, 100 and 500 kHz; and 1, 2, 3.58, 5, 8 and 10 MHz. Convert data to decibel form.

(d) Set wipe controls at mid-position and set the wipe pattern selector to wipe in a vertical line moving along the horizontal axis. Measure frequency response at 30 Hz, 3.58 MHz and 10 MHz to verify that frequency response is not affected by wipe action.

(4) MEASUREMENT OF AMPLITUDE VS FREQUENCY RESPONSE OF VIDEO DISTRIBUTION AMPLIFIER (Figure 2-24c)

(a) Connect output of Sine Wave Oscillator (A) to the terminated input of the video distribution amplifier. Set gain of amplifier at unity and adjust sine wave signal level to 1.0 V peak-to-peak.

(b) Connect Oscilloscope (B) to each terminated output of the video distribution amplifier, in turn, and measure the output amplitude at the following frequencies: 30, 60, 100, 200 and 500 Hz; 1, 2, 5, 10, 100 and 500 kHz; and 1, 2, 4, 6, 8 and 10 MHz.

(c) Convert amplitude data to decibel form.

(5) MEASUREMENT OF AMPLITUDE VS FREQUENCY RESPONSE OF VIDEO EQUALIZATION AMPLIFIER (Figure 2-24d)

(a) Connect output of Sine Wave Oscillator (A) to input terminal of video equalization amplifier and set input level to 1.0 V peak-to-peak. Terminate amplifier output, adjust amplifier gain to unity and set amplifier for flat response.

(b) Connect Oscilloscope (B) to terminated amplifier output and measure signal amplitude at the following frequencies: 30, 60, 100, 200 and 500 Hz; 1, 2, 5, 10, 50, 100 and 500 kHz; and 1, 2, 4, 6, 8 and 10 MHz.

(c) Convert amplitude data to decibel form.

(6) MEASUREMENT OF TILT AND OVERSHOOT OF VIDEO DISTRIBUTION AND AUXILIARY EQUIPMENT (Figure 2-24e)

Low-frequency response is evaluated in terms of the ability of the equipment to pass low-frequency square waves with minimum tilt. Tilt is a form of distortion of a rectangular pulse characterized by the introduction of slope on the horizontal components of the pulse; it is measured as ratio, expressed as a percentage between the amplitude of the slope component and the amplitude of the pulse.

Overshoot can be described as the amount by which a transient rise exceeds its final value. It is commonly tested by applying a square pulse signal to the equipment under test and measured as a percentage by which the first peak following the rise exceeds the flat top amplitude of the pulse.

Prior to performing measurements of tilt and overshoot, it is important to determine that the test equipment combination of square wave generator and wideband oscilloscope is satisfactory with regard to these parameters. Otherwise, allowance must be made for any contribution to tilt and overshoot by the test equipment.

(a) TILT - VIDEO SWITCHER

1. Connect output of Square Wave Generator (F) to one terminated input of video switcher. With switcher gain set at unity, apply a 60 Hz square wave to the switcher input at a level of 1.0 V peak-to-peak. Do not use sync adder.

2. Connect Oscilloscope (B) to one terminated output of the switcher and measure tilt by observation of the oscilloscope display.

3. Repeat steps 1 and 2 above for various input/output combinations.

(b) TILT - VIDEO MIXING AMPLIFIER

1. Connect output of Square Wave Generator (F) to both inputs of the video mixing amplifier with the inputs terminated in 75 ohms. Apply a 60 Hz square wave signal to the inputs at a level of 1.0 V peak-to-peak.

2. Terminate each output in 75 ohms and connect Oscilloscope (B) across one of the output terminals.

_3_. Set the video mixing controls to feed each input, in turn, to the output and measure the tilt on the oscilloscope display.

_4_. Reset the video mixing controls to provide 50% video from each input channel and remeasure tilt on the oscilloscope.

(c) TILT - SPECIAL EFFECTS GENERATOR

_1_. Utilize TV Test Signal Generator (C), instead of Square Wave Generator (F), to provide a 60 Hz square wave with horizontal and vertical blanking intervals and connect, in turn, to each terminated video input. Adjust gain of special effects generator to unity and set input signal-level to 0.7 V peak-to-peak.

_2_. Connect Oscilloscope (B) to one terminated output terminal and measure tilt of the square wave on the oscilloscope display.

(d) TILT - VIDEO DISTRIBUTION AMPLIFIER

_1_. Connect output of Square Wave Generator (F) to the terminated input of the video distribution amplifier and set the amplifier for nominal unity gain. Apply a 60 Hz square wave signal of 1.0 V peak-to-peak, to the amplifier input.

_2_. Connect Oscilloscope (B) to each terminated output, in turn, and measure the tilt on the oscilloscope display.

(e) OVERSHOOT - VIDEO SWITCHER

_1_. Connect output of Square Wave Generator (F) to one terminated input of the video switcher. With switcher gain set at unity, apply a 1.0 megacycle (Mc) square wave to the switcher input at a level of 1.0 V peak-to-peak. Rise time of square wave shall be 0.1 μsec. Sync-adder shall not be used.

2. Connect Oscilloscope (B) to one terminated output of the switcher and measure overshoot on the displayed waveform.

3. Repeat steps 1 and 2 above for various input/output combinations.

(f) OVERSHOOT - VIDEO MIXING AMPLIFIER

1. Connect the output of Square Wave Generator (F) to both inputs of the video mixing amplifier, with each input terminated in 75 ohms. Apply a 1.0 MHz square wave signal to the inputs at a level of 1.0 v peak-to-peak. The square wave signal shall have a rise time of 0.1 μsec.

2. Terminate each output in 75 ohms and connect Oscilloscope (B) across one of the output terminals.

3. Set the video mixing controls to feed each input, in turn, to the output and measure overshoot on the oscilloscope display.

4. Reset the video mixing controls to provide 50% video from each input channel and remeasure overshoot on the oscilloscope.

(g) OVERSHOOT - SPECIAL EFFECTS GENERATOR

1. Employ TV Test Signal Generator (C) instead of Square Wave Generator (F) to provide a 15.75 kHz square wave having a rise time of 0.1 μsec and with horizontal and vertical blanking intervals. Apply square wave signal at a level of 0.7 V peak-to-peak, to each terminated video input, in turn, with gain set at unity.

2. Connect Oscilloscope (B) to one terminated output terminal and measure overshoot on the displayed waveform.

(h) OVERSHOOT - VIDEO DISTRIBUTION AMPLIFIER

1. Connect output of Square Wave Generator (F) to the terminated input of the video distribution amplifier and set the amplifier for unity gain. Apply a 1.0 MHz square wave, having a rise time of 50 ns, to the amplifier input at a level of 1.0 V peak-to-peak.

2. Connect Oscilloscope (B) to each terminated output, in turn, and measure overshoot on the displayed waveform.

(7) MEASUREMENT OF OVERSHOOT AND RISE TIME OF PULSE DISTRUBUTION AMPLIFIER (Figure 2-24f)

(a) Connect Square Wave Generator (F) to the terminated input of the pulse distribution amplifier and set generator to provide a 100 kHz square wave with rise and decay times of 50 ns. Adjust signal input level to 4.0 V peak-to-peak.

(b) Connect Oscilloscope (B) to each terminated output, in turn, and measure the overshoot, rise time, and decay time on the displayed waveform.

(c) Repeat steps (a) and (b) with an input signal having a rise time of 250 ns.

(8) MEASUREMENT OF LOW-FREQUENCY TILT OF PULSE DISTRIBUTION AMPLIFIER (Figure 2-24g)

(a) Apply the mixed blanking signal from Synchronizing Generator (G) to the terminated input of the pulse distribution amplifier. Adjust the input level of 4.0 V peak-to-peak.

(b) Connect Oscilloscope (B) to each terminated output, in turn, and measure tilt on the displayed waveform.

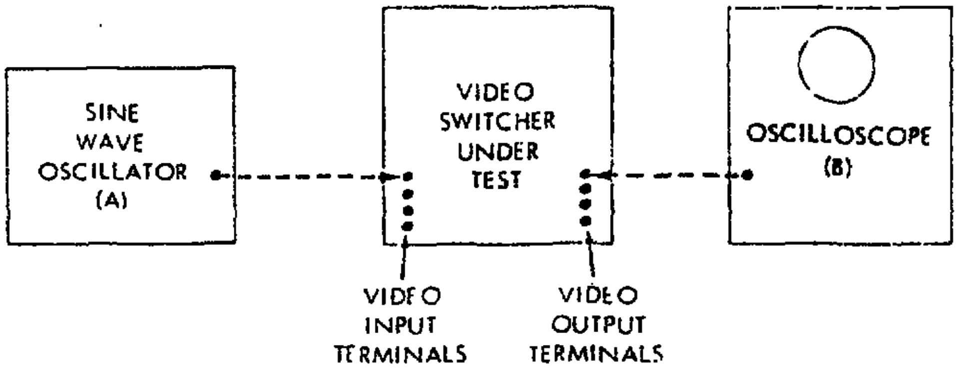
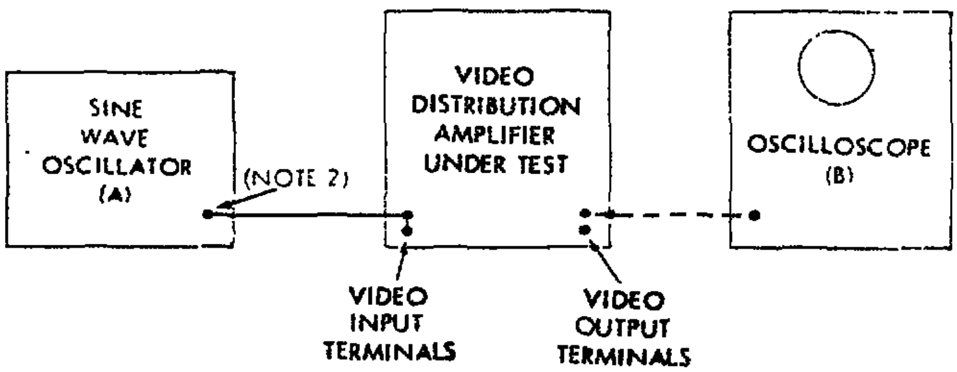



Figure 2-24. Measurement of Amplitude Versus Frequency Response of Video Switcher.




NOTE: 1. ALL CONNECTIONS ARE COAXIAL TYPE
2. TERMINATE OSCILLATOR IN 75 OHMS

Figure 2-24a. Measurement of Amplitude Versus Frequency Response of Video Mixing Amplifier.

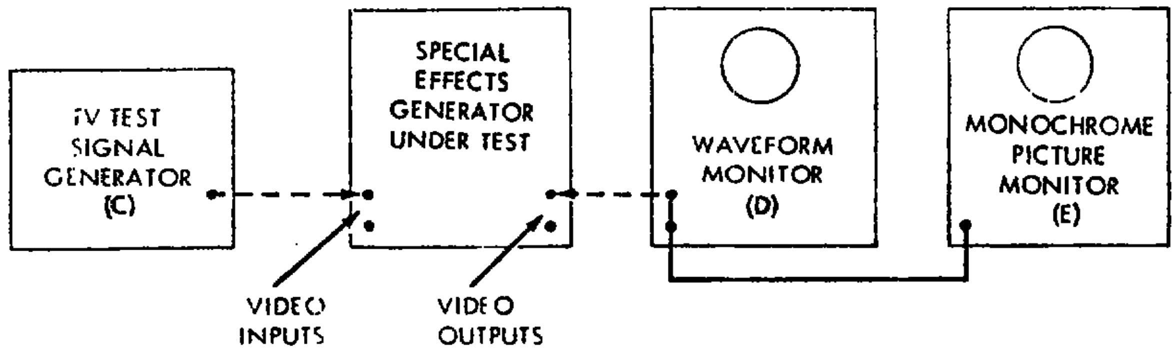
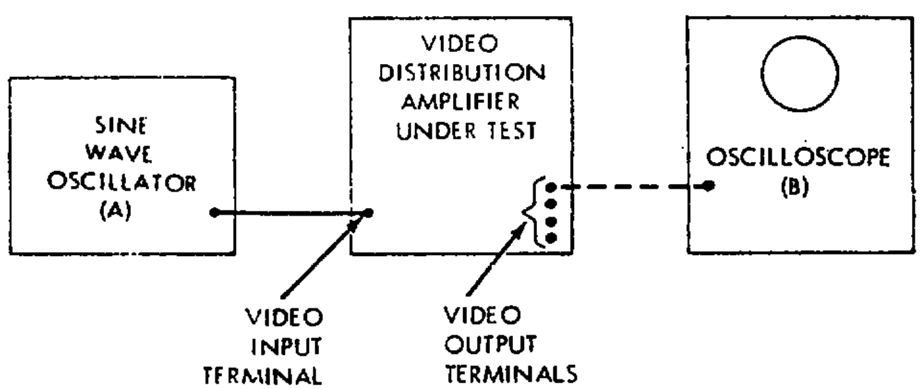



Figure 2-24b. Measurement of Amplitude Versus Frequency Response of Special Effects Generator.




NOTE: ALL CONNECTIONS ARE COAXIAL TYPE.

Figure 2-24c. Measurement of Amplitude Versus Frequency Response of Video Distribution Amplifier.

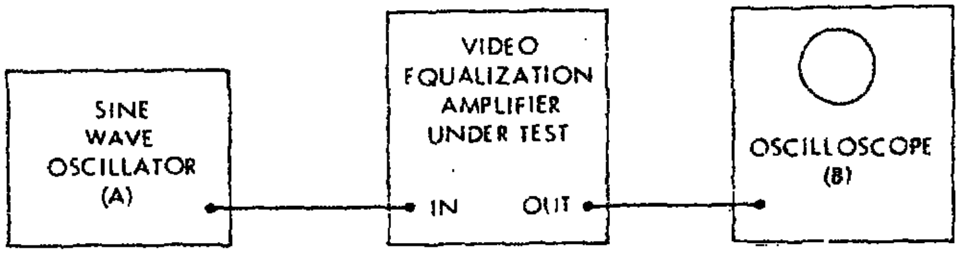
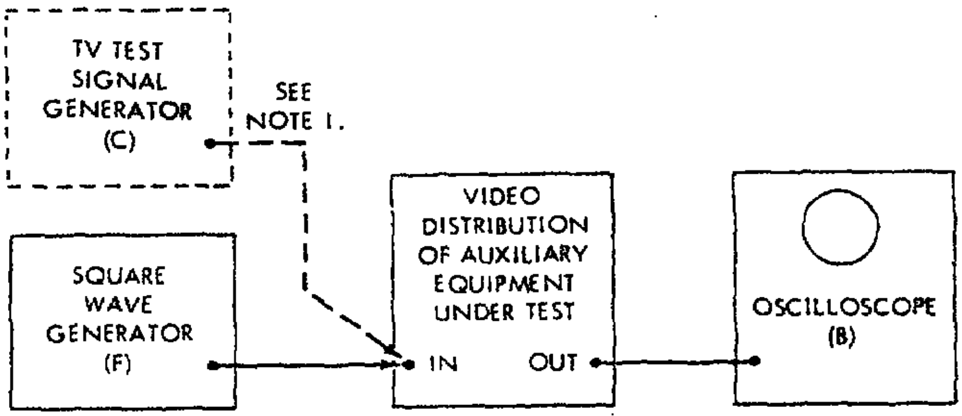



Figure 2-24d. Measurement of Amplitude Versus Frequency Response of Video Equalization Amplifier.




NOTES:
1. TV TEST SIGNAL GENERATOR (C) IS USED IN PLACE OF SQUARE WAVE GENERATOR (F) IN TESTING THE SPECIAL EFFECTS GENERATOR
2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-24e. Measurement of Tilt and Overshoot of Video Distribution and Auxiliary Equipment: Video Switcher, Video Mixing Amplifier, Special Effects Generator, Video Distribution Amplifier.

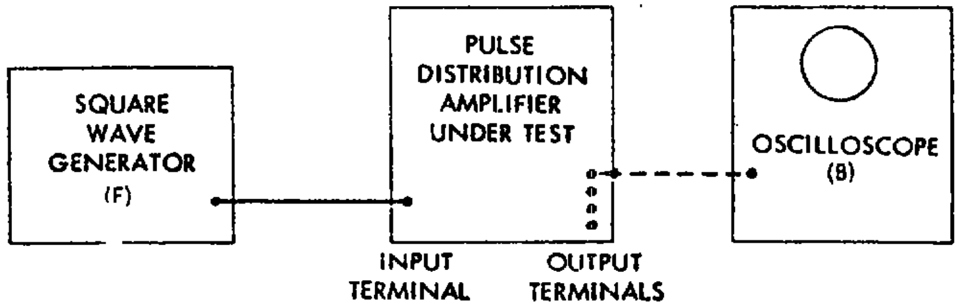
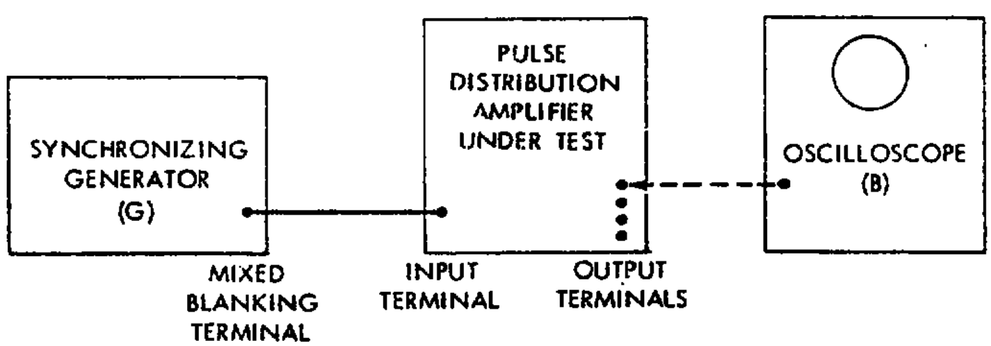
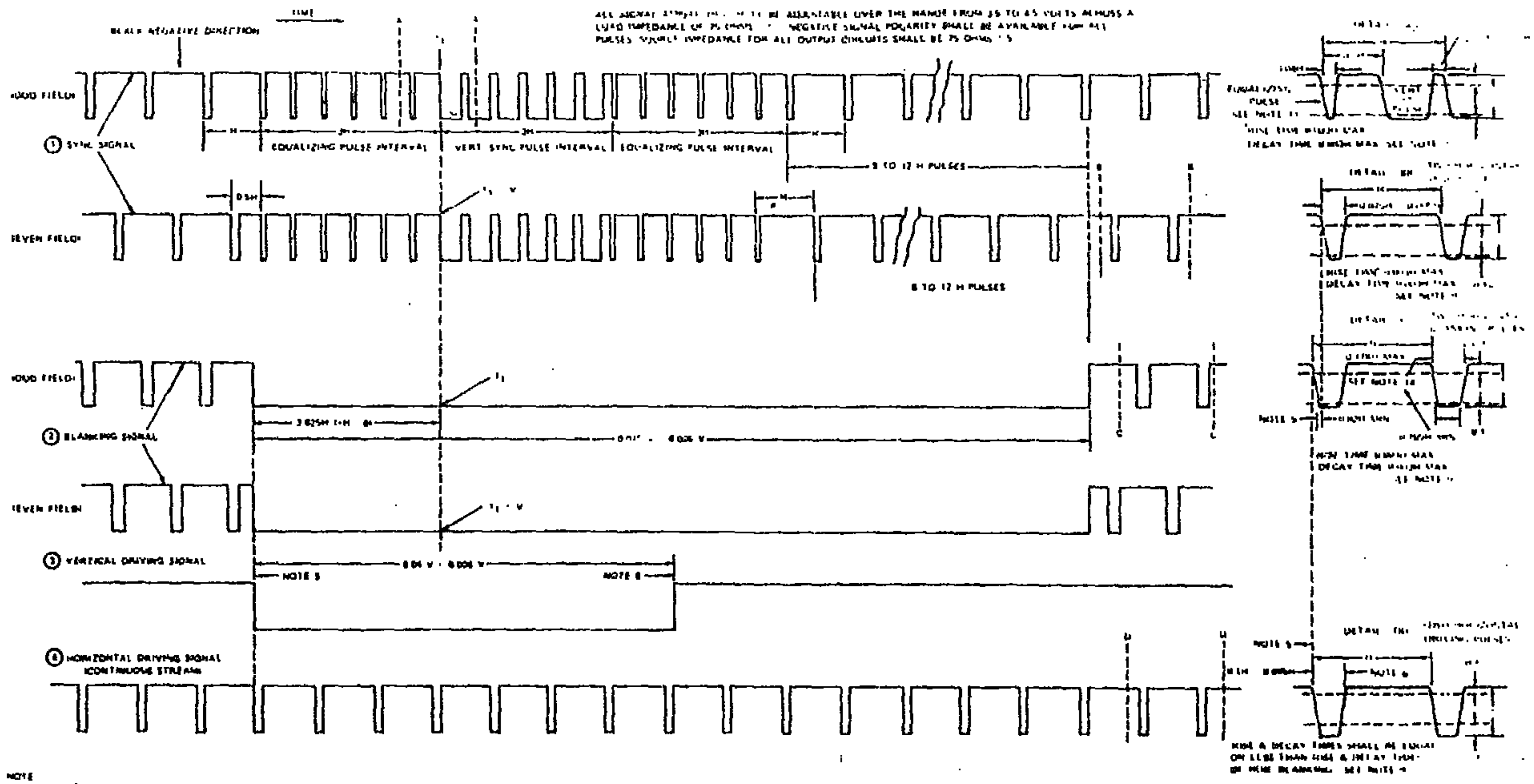



Figure 2-24f. Measurement of Overshoot and Rise Time of Pulse Distribution Amplifier.




NOTE: CONNECTIONS ARE COAXIAL TYPE

Figure 2-24g. Measurement of Low-Frequency Tilt of Pulse Distribution Amplifier.




NOTE

1 H — TIME FROM START OF ONE LINE TO START OF NEXT LINE
2 V — TIME FROM START OF ONE FIELD TO START OF NEXT FIELD
3 LEADING AND TRAILING EDGES OF VERTICAL DRIVING AND VERTICAL BLANKING SIGNALS SHOULD BE COMPLETE IN LESS THAN 0.1H
4 ALL TOLERANCES AND LIMITS SHOWN IN THIS DRAWING ARE PERMISSIBLE ONLY FOR LONG TIME VARIATIONS
5 TIMING ADJUSTMENT IF ANY SHALL INCLUDE THIS CONDITION
6 THE VERTICAL DRIVING PULSE DURATION SHALL BE 0.04V [illegible] THE HORIZONTAL DRIVING PULSE DURATION SHALL BE 0.1H [illegible]
7 THE TIME RELATIONSHIP AND WAVEFORM OF THE BLANKING AND SYNC SIGNALS SHALL BE SUCH THAT THEIR ADDITION WILL RESULT IN A STANDARD SIGNAL. THE TIME RELATIONSHIP SHALL BE ADJUSTABLE IN ORDER TO SATISFY THE RELATIONSHIP FOR THE CONDITION WHERE THE BLANKING SIGNAL IS DELAYED WITH RESPECT TO THE SYNC SIGNAL OVER THE RANGE FROM 0.0H TO [illegible]
8 THE STANDARD VALUES OF FREQUENCY AND RATE OF CHANGE OF FREQUENCY FOR THE HORIZONTAL COMPONENTS OF THE SYNC SIGNAL AT THE OUTPUT OF THE PICTURE LINE AMPLIFIER SHALL ALSO APPLY TO THE HORIZONTAL COMPONENTS OF THE OUTPUT SIGNALS FROM THE RECOMMENDED SYNC GENERATOR
9 ALL RISE AND DECAY TIMES SHALL BE MEASURED BETWEEN 0.1 AND 0.9 AMPLITUDE REFERENCE LINES
10 THE TIME OF OCCURRENCE OF THE LEADING EDGE OF ANY HORIZONTAL PULSE N OF ANY GROUP OF TWENTY HORIZONTAL PULSES APPEARING ON ANY OF THE OUTPUT SIGNALS FROM A STANDARD SYNC GENERATOR SHALL NOT DIFFER FROM NH BY MORE THAN [illegible] WHERE H IS THE AVERAGE INTERVAL BETWEEN THE LEADING EDGES OF THE PULSES AS DETERMINED BY AN AVERAGING PROCESS CARRIED OUT OVER A PERIOD OF NOT LESS THAN 20 NOR MORE THAN 100 LINES
11 EQUALIZING PULSE AREA SHALL BE BETWEEN 0.45 AND 0.5 OF THE AREA OF A HORIZONTAL SYNC PULSE
12 THE OVERSHOOT ON ANY OF THE PULSES SHALL NOT EXCEED 5 [illegible]
13 THE OUTPUT LEVEL OF THE BLANKING SIGNAL AND THE SYNC SIGNAL SHALL NOT VARY MORE THAN [illegible] UNDER THE FOLLOWING CONDITIONS

A THE AC VOLTAGE SUPPLYING THE SYNC GENERATOR SHALL BE IN THE RANGE BETWEEN 115V AND 125V AND SHALL NOT VARY MORE THAN [illegible]V DURING TEST
B A PERIOD OF [illegible] HOURS CONTINUOUS OPERATION SHALL BE CONSIDERED ADEQUATE FOR THIS MEASUREMENT AFTER SUITABLE WARM UP
C THE ROOM AMBIENT SHALL BE IN THE RANGE BETWEEN 20 DEG AND [illegible] DEG C AND SHALL NOT CHANGE MORE THAN [illegible] DEG C DURING THIS TEST

14 ADJUSTMENT SHALL BE POSSIBLE BETWEEN MINIMUM AND MAXIMUM LIMITS SO THAT ASPECT RATIO CAN BE SET TO THE NOMINAL VALUE

Figure 2-24h. Synchronizing Generator Waveforms.

2.5.1.2 HUM AND NOISE (TV SIGNAL DISTRIBUTION AND AUXILIARY EQUIPMENT)

Hum and noise are treated in this section as a single source of interference, generally measured in terms of a ratio, in decibels, of the normal peak-to-peak value of the desired signal to the rms amplitude of combined hum and noise.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of hum and noise for various signal distribution and auxiliary components as specified in the following paragraphs:

(1) SYNCHRONIZING GENERATORS

HUM AND NOISE. The peak-to-peak level of hum and noise on any output shall be at least 50 dB below normal peak-to-peak output voltage level.

(2) VIDEO SWITCHERS

HUM AND NOISE. The rms value of internally generated hum and noise appearing on the switcher output shall be at least 60 dB below the nominal output level of 1.0 V peak-to-peak.

(3) VIDEO MIXING AMPLIFIERS

HUM AND NOISE. The rms value of hum and noise shall be at least 60 dB below a video output level of 1.0 V peak-to-peak.

(4) SPECIAL EFFECTS GENERATORS

HUM AND NOISE. Hum and noise in any channel shall be at least 60 dB below the nominal composite video output level of 1.0 V peak-to-peak.

(5) VIDEO DISTRIBUTION AMPLIFIERS

HUM AND NOISE. The rms value of hum and noise shall be at least 60 dB below the nominal composite video output level of 1.0 V peak-to-peak.

(6) VIDEO EQUALIZING AMPLIFIERS

HUM AND NOISE. The rms value of hum and noise shall be at least 60 dB below a nominal output level of 1.0 V peak-to-peak, with the amplifier set for unity gain.

(7) PULSE DISTRIBUTION AMPLIFIERS

HUM AND NOISE. The rms value of hum and noise shall be at least 60 dB below a signal output level of 4.0 V peak-to-peak.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Hum and Noise in Synchronizing Generator | 2-25 |
| 2 | Hum and Noise in Video Switcher | 2-25a |
| 3 | Hum and Noise in a Video Mixing Amplifier | 2-25a |
| 4 | Hum and Noise in a Special Effects Generator | 2-25a |
| 5 | Hum and Noise in a Video Distribution Amplifier | 2-25a |
| 6 | Hum and Noise in a Video Equalization Amplifier | 2-25a |
| 7 | Hum and Noise in a Pulse Distribution Amplifier | 2-25a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Synchronizing Generator | B | 15 | 1 |
| True RMS Voltmeter | C | 11 | 1 |
| Oscilloscope (Wideband) | D | 3 | 1 through 7 |
| TV Test Signal Generator | E | 13 | 3 through 7 |

d. PROCEDURES

(1) MEASUREMENT OF HUM AND NOISE IN A SYNCHRONIZING GENERATOR (Figure 2-25)

(a) Using Oscilloscope (D), adjust all pulse output signals of the synchronizing generator to a value of 4.0 V peak-to-peak.

(b) Examine the outputs, in turn, using calibrated high sensitivity ranges of the oscilloscope to measure peak-to-peak amplitudes of all undesired waveforms. These may be differentiated from the desired signals by shape, trace broadening, crawling caused by lack of synchronization, and similar effects. Periodic noise such as power supply hum, spikes and harmonics can usually be identified by varying the oscillosope sweep frequency until the undesired waveform is stationary and noting the horizontal repetition rate.

(c) Calculate the ratio of the peak-to-peak amplitude of the desired signal, established in step (a) above, to the maximum peak-to-peak value of the undesired signal and express in decibel form.

(2) MEASUREMENT OF HUM AND NOISE IN A VIDEO SWITCHER (Figure 2-25a)

(a) Apply a 1.0 kHz sine wave signal from Generator (E) at a level of 1.0 V peak-to-peak, to one input of the video switcher. Terminate each switcher output in 75 ohms and connect Oscilloscope (D) across one output. Adjust the gain control to the setting where the output level is 1.0 V peak-to-peak (unity gain). Remove the generator and terminate each input in 75 ohms.

(b) Connect True RMS Voltmeter (C) across each output and record the voltages. Repeat the measurement for various input-output switch combinations.

(c) Calculate the ratio of the peak-to-peak signal amplitude, established in step (a) above to each rms voltage measured in step (b) above. Convert ratio to decibel form.

(3) MEASUREMENT OF HUM AND NOISE IN A VIDEO MIXING AMPLIFIER (Figure 2-25a)

(a) Connect TV Test Signal Generator (E) to one terminated video input connector of the video mixing amplifier and apply a sine wave signal of approximately 1.0 kHz at a level of 1.0 V peak-to-peak (.354 V rms). Connect True RMS Voltmeter (C) to one terminated output connector and adjust the amplifier for unity gain (.354 V rms output).

(b) Remove the input signal and measure the rms value of combined hum and noise on the voltmeter with the amplifier input terminated.

(c) Calculate the ratio of the 1.0 V peak-to-peak input signal set in step (a) above to the rms hum and noise voltage measured in step (b) above and express in decibel form.

(d) Repeat steps (a), (b) and (c) above for the remaining input channel.

(e) After each measurement, rotate the video mixing control lever for the channel under test over its range to determine whether noise is generated by operation of the control.

(4) MEASUREMENT OF HUM AND NOISE IN A SPECIAL EFFECTS GENERATOR (Figure 2-25a)

(a) Connect TV Test Signal Generator (E) to one terminated video input terminal of the special effects generator and adjust generator to supply a noncomposite television test signal having as picture content a sine wave of approximately 1.0 kHz. Terminate all other inputs and outputs in 75 ohms. Connect Oscilloscope (D) to one output terminal and adjust output level to 1.0 V peak-to-peak.

(b) Remove the input signal and terminate the input in 75 ohms. Remove the oscilloscope and connect True RMS Voltmeter (C) to one terminated output. Record the combined rms hum and noise voltage.

(c) Calculate the ratio of the 1.0 V peak-to-peak, input signal established in step (a) above to the rms hum and noise voltage measured in step (b) above. Express in decibel form.

(d) Repeat steps (a), (b) and (c) above for the second video input.

(5) MEASUREMENT OF HUM AND NOISE IN A VIDEO DISTRIBUTION AMPLIFIER (Figure 2-25a)

(a) Connect TV Test Signal Generator (E) to the terminated input terminal of the video distribution amplifier and apply a sine wave signal of approximately 1.0 kHz at a level of 1.0 V peak-to-peak, measured by Oscilloscope (D). Connect True RMS Voltmeter (C) to one terminated output connector and adjust the amplifier for 1.0 V peak-to-peak output (0.354 V rms).

(b) Remove the input signal and measure the rms value of combined hum and noise on the amplifier output, with the input terminated.

(c) Calculate the ratio of the 1.0 V peak-to-peak signal level set in step (a) above to the rms hum and noise voltage measured in step (b) above and convert to decibel form.

(6) MEASUREMENT OF HUM AND NOISE IN A VIDEO EQUALIZATION AMPLIFIER (Figure 2-25a)

(a) Connect TV Test Signal Generator (E) to the terminated input connector of the video equalization amplifier and adjust to provide a 1.0 kHz sine wave at a level of 1.0 V peak-to-peak (0.354 V rms) at the amplifier input as measured by Oscilloscope (D). Connect True RMS Voltmeter (C) to the terminated amplifier output and adjust amplifier gain for an output reading of 0.354 V rms (unity gain).

(b) Remove the input signal and measure the rms value of combined hum and noise on the amplifier output with the input terminated.

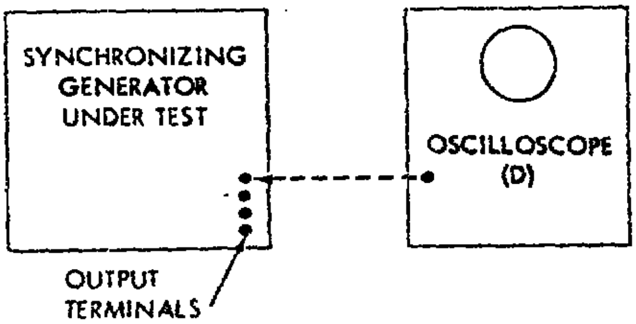
(c) Calculate the ratio of the 1.0 V peak-to-peak signal to the rms voltage of step (b) above and convert to decibel form.

(7) MEASUREMENT OF HUM AND NOISE OF A PULSE DISTRIBUTION AMPLIFIER (Figure 2-25a)

(a) Connect TV Test Signal Generator (E) to the terminated input of the pulse distribution amplifier. Arrange the generator to supply a 100 kHz square wave at a level of 4.0 V peak-to-peak to the amplifier as measured by Oscilloscope (D). Terminate all amplifier outputs in 75-ohm loads, connect oscilloscope to one output and adjust amplifier gain to unity (4.0 V peak-to-peak output).

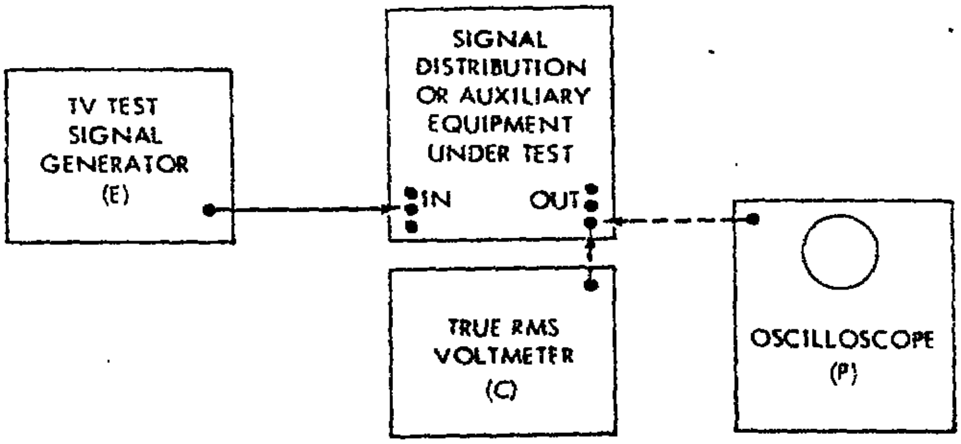
(b) Remove the input signal, terminate the input connector, remove the oscilloscope and connect True RMS Voltmeter (C) to one of the outputs. Measure the rms voltage of combined hum and noise.

(c) Calculate the ratio of the 4.0 V peak-to-peak signal output voltage to the rms hum and noise voltage measured in step (b) above. Convert the voltage ratio to decibel form.




NOTE: ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-25. Measurement of Hum and Noise in a Synchronizing Generator.




NOTE: CONNECTIONS ARE COAXIAL TYPE

Figure 2-25a. Measurement of Hum and Noise in Signal Distribution and Auxiliary Equipment.

2.5.1.3 GAIN AND LEVEL (TV SIGNAL DISTRIBUTION AND AUXILIARY EQUIPMENT)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of gain and/or output level for various television signal distribution and auxiliary equipments as specified in the following paragraphs.

(1) VIDEO SWITCHERS

GAIN. Video gain shall be continuously adjustable over a minimum range of ±3 dB. The gain shall remain constant within ±0.5 dB when the primary power voltage is varied ±10% from a nominal value of 120 V at 60 Hz.

(2) VIDEO MIXING AMPLIFIERS

GAIN. The amplifier shall operate nominally at unity gain. Gain shall be independently adjustable for each input channel over a range of at least ±3 dB. (This adjustment is independent of mix/fade functions.) Gain shall remain constant within ±0.5 dB when the primary power voltage is varied ±10% from a nominal 120 V at 60 Hz.

(3) SPECIAL EFFECTS GENERATORS

GAIN. The gain of each channel shall be adjustable to unity and shall be constant ±5% under line voltage variations of ±10% from a nominal value of 120 V at 60 Hz.

(4) VIDEO DISTRIBUTION AMPLIFIERS

GAIN. The signal level of the four video outputs shall be adjustable by a gain control having a minimum range of -10 dB to +8 dB. Signal levels at the outputs shall be within ±0.5 dB of coincidence at any setting of the gain control. The gain shall remain constant within ±0.5 dB when the primary power of 120 V is varied ±10%.

(5) VIDEO EQUALIZATION AMPLIFIERS

(a) GAIN. The gain of the amplifier without equalization applied shall be continuously adjustable from -10 dB to +12 dB.

(b) OUTPUT LEVEL. The nominal video output level shall be 0.7 V (noncomposite) or 1.0 V (composite) peak-to-peak when terminated in a resistive load of 75 ohms ±2%. The output level shall not vary more than ±1.0% when the primary power voltage of 120 V is varied ±10%.

(6) PULSE DISTRIBUTION AMPLIFIERS

OUTPUT LEVEL. When terminated in a 75 ohm resistive load, the output level shall remain constant ±2% when the input signal is varied between 2.0 V and 6.0 V peak-to-peak and the primary power voltage is varied simultaneously ±10% from 120 V at 60 Hz.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Gain and/or Output Level in Television Signal Distribution and Auxiliary Equipment | 2-26 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Procedures |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1 through 6 |
| Oscilloscope | B | 3 | 1 through 6 |
| Variac | C | 61 | 1 through 6 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF GAIN IN VIDEO SWITCHER (Figure 2-26)

(a) Adjust TV Test Signal Generator (A), or a calibrated audio oscillator, to supply a 1.0 kHz sine wave signal of 1.0 V peak-to-peak into one terminated input of the video switcher. Terminate one output in 75 ohms and connect to Oscilloscope (B).

(b) With sync-adder unused, measure peak-to-peak output level as the gain control is adjusted over its entire range. Calculate the ratio of output levels to input level and convert to decibels of gain.

(c) Repeat steps (a) and (b) above for different combinations of input and output terminals.

(d) Perform steps (a) and (b) above with gain set at unity and measure output level with primary power voltages set at 108 V, 120 V and 132 V. Calculate variation of gain in decibels for each power line voltage change.

(2) MEASUREMENT OF GAIN IN VIDEO MIXING AMPLIFIER (Figure 2-26)

(a) Adjust TV Test Signal Generator (A), or a calibrated audio oscillator, to supply a 1.0 kHz sine wave signal of 1.0 V peak-to-peak, into one terminated input of the video mixing amplifier. Terminate one output in 75 ohms and connect to Oscilloscope (B). Set the video mixing control to feed the input signal to the output.

(b) Measure the peak-to-peak output level as the gain control is varied over its full range. Calculate the ratio of output levels to the input level and convert to decibels gain or loss.

(c) Set gain at unity at 120 V primary input voltage. Remeasure gain with line voltage set at 108 V and at 132 V.

(3) MEASUREMENT OF GAIN OF SPECIAL EFFECTS GENERATOR (Figure 2-26)

(a) Set TV Test Signal Generator (A) to supply a 10-step staircase video signal at a level of 0.7 V noncomposite to one terminated program input of the special effects generator. Connect Oscilloscope (B) to one terminated video output.

(b) Adjust gain control until output voltage is equal to the input voltage (unity gain) while the power line voltage is set at 120 V. Measure the change in output level as the power line voltage is varied to 108 V and to 132 V. Calculate the percentage change in gain for each change in line voltage.

(4) MEASUREMENT OF GAIN OF VIDEO DISTRIBUTION AMPLIFIER (Figure 2-26)

(a) Adjust TV Test Signal Generator (A), or a calibrated sine wave oscillator, to supply a 100 kHz sine wave signal to the input of one amplifier unit. Set input level at 0.5 V peak-to-peak, as measured on an oscilloscope. Connect Oscilloscope (B) to one terminated output of the amplifier unit.

(b) Adjust gain control for maximum gain and measure output voltage, also connect oscilloscope to the three remaining terminated outputs, in turn, and measure the output voltages. Calculate the voltage gain at each output and convert to decibel form. Verify that the specified gain is realized for each output, and that all four gain values coincide within the specified tolerance.

(c) Adjust gain control to provide outputs of 0.5 V, 0.75 V and 1.0 V, in turn, and again determine the coincidence of the four output levels.

(d) Increase input signal level to 2.5 V peak-to-peak, and set gain control for minimum gain. Measure the output voltage at each terminated output and compute the amplifier loss in decibels at each terminal. Evaluate measurements for compliance with specified loss figure, and coincidence tolerance.

(e) Adjust gain control to provide outputs of 1.0 V, 1.5 V and 2.0 V, in turn, and measure all four outputs for coincidence of levels.

(f) Set the primary power line voltage to 120 V, adjust the input signal to 1.0 V and set gain at unity as measured at one output on the oscilloscope. Change the power line voltage to 108 V and

132 V, in turn, and measure the change in output level. Calculate whether gain is constant within the specified tolerance in decibels.

(5) MEASUREMENT OF GAIN AND OUTPUT LEVEL OF VIDEO EQUALIZATION AMPLIFIER (Figure 2-26)

(a) Set amplifier for zero equalization. Connect Oscilloscope (B) to the terminated output of the amplifier. Connect TV Test Signal Generator (a), or a sine wave oscillator, to the terminated input of the amplifier. Apply a sine wave signal of approximately 100 kHz at a level sufficient to develop 1.4 V, peak-to-peak, across the output with the amplifier gain control set at maximum.

(b) Measure the input voltage with the oscilloscope and calculate the voltage gain of the amplifier.

(c) Reduce the amplifier gain to minimum and adjust the input voltage to a level sufficient to restore the output level to 1.4 V peak-to-peak. Measure the input voltage and calculate the voltage loss of the amplifier.

(d) Convert the voltage gain or loss figures to decibel form and evaluate for compliance with specifications.

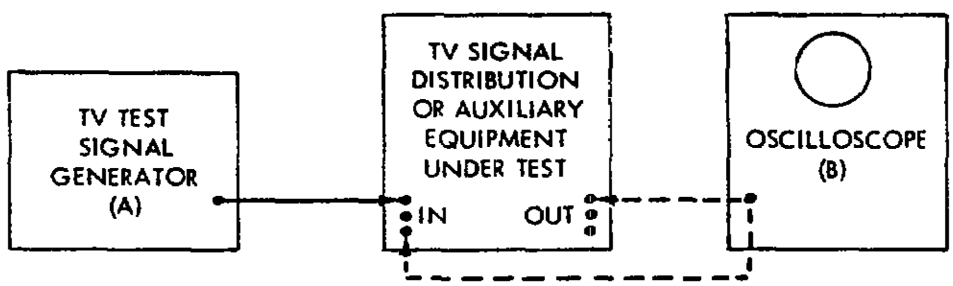
(e) With power line voltage adjusted to 120 V, set amplifier gain control to provide 1.0 V peak-to-peak, output with 1.0 V peak-to-peak, input (unity gain). Measure the output voltage as line voltage as adjusted to 108 V and 132 V, in turn. Determine whether percent variation in output voltage level conforms to specifications.

(6) MEASUREMENT OF OUTPUT LEVEL OF PULSE DISTRIBUTION AMPLIFIER (Figure 2-26)

(a) Connect TV Test Signal Generator (A), or a calibrated square wave generator, to provide a 100 kHz square wave signal to the terminated input of the pulse distribution amplifier; the square wave should have a rise and decay time of 100 ns maximum. Connect Oscilloscope (B) to one of the terminated outputs of the amplifier and adjust output level to 4.0 V peak-to-peak, with input voltage set to 4.0 V peak-to-peak.

(b) Measure the maximum variation in output voltage as the input voltage is varied between 2.0 V and 6.0 V peak-to-peak. Convert the output voltage variations to percentage and check for conformance with specifications.

(c) With power line voltage adjusted to 120 V and input voltage set at 4.0 V peak-to-peak, adjust amplifier for output voltage of 4.0 V peak-to-peak. Change power line voltage to 108 V and 132 V, in turn, and measure corresponding variations in output voltage level. Convert output level changes to percentages and compare with specifications.




NOTE: CONNECTIONS ARE COAXIAL TYPE

Figure 2-26. Measurement of Gain or Level of TV Signal Distribution and Auxiliary Equipment.

2.5.1.4 CROSSTALK (TV SIGNAL DISTRIBUTION AND AUXILIARY EQUIPMENT)

(a) APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of crosstalk in television signal distribution and auxiliary equipment as specified in the following paragraphs:

(1) VIDEO SWITCHERS

CROSSTALK. Interchannel video crosstalk isolation shall be at least 50 dB at frequencies below 5 MHz, at least 40 dB between 5 MHz and 10 MHz.

(2) VIDEO MIXING AMPLIFIERS

CROSSTALK. The crosstalk isolation between input channels when either channel control is set to the OFF position and the other channel control is at maximum shall be at least 50 dB for nominal input levels.

(3) SPECIAL EFFECTS GENERATORS

CROSSTALK. Crosstalk isolation between channels at nominal input levels shall be at least 50 dB at frequencies below 5 MHz.

(4) VIDEO DISTRIBUTION AMPLIFIERS

CROSSTALK. Crosstalk isolation between video distribution amplifiers within the same assembly shall be at least 60 dB below 5 MHz; 50 dB from 5 MHz to 10 MHz.

(5) PULSE DISTRIBUTION AMPLIFIERS

CROSSTALK. Crosstalk isolation between pulse distribution amplifiers within the same assembly shall be at least 60 dB, up to a frequency of 10 MHz.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| | Measurement of crosstalk in: | |
| 1 | Video Switcher | 2-27 |
| 2 | Video Mixing Amplifier | 2-27a |
| 3 | Special Effects Generator | 2-27b |
| 4 | Video Distribution Amplifier | 2-27c |
| 5 | Pulse Distribution Amplifier | 2-27d |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Procedure |
|---|---|---|---|
| Sine Wave Oscillator | A | 2 | 1,2,4, |
| Oscilloscope (high Gain, Wideband) | B | 3 | 1,2,4,5 |
| TV Test Signal Generator | C | 13 | 3 |
| Waveform Monitor | D | 21 | 3 |
| Monochrome Picture Monitor | E | 22 | 3 |
| Square Wave Generator | F | 4 | 5 |
| Synchronizing Generator | G | 15 | 3 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in caryying out all test procedures.

(1) MEASUREMENT OF CROSSTALK IN VIDEO SWITCHER (Figure 2-27)

(a) Terminate one input of the video switcher in 75 ohms. Connect remaining inputs, each terminated in 75 ohms, to multiple outputs of Sine Wave Oscillator (A) and set signal input level to 1.0 V peak-to-peak, at a frequency of 1.0 kHz. Set video switcher gain to unity. Sync-adder shall not be used.

(b) Terminate all video switcher output terminals in 75 ohms. Connect Oscilloscope (B) to one of the output terminals and switch each of the remaining outputs to one of the signal inputs.

(c) Switch the test input (that has no signal applied) to the output that connects to the oscilloscope and measure the amplitude of any 1.0 kHz crosstalk signal observed on the display. Adjust sine wave oscillator frequency to 100 kHz, 3.58 MHz and 10 MHz, in turn, and measure the peak-to-peak crosstalk amplitude on the oscilloscope at each frequency.

(d) Repeat steps (a), (b) and (c) above for several combinations of input and output terminals.

(e) Calculate the ratio of input voltage from step (a) above to each crosstalk voltage and convert to decibels. Compare with specifications.

(2) MEASUREMENT OF CROSSTALK IN VIDEO MIXING AMPLIFIER (Figure 2-27a)

(a) Terminate each input and output of the video mixing amplifier in 75 ohms. Connect Sine Wave Oscillator (A) to one amplifier input and apply a 10 MHz sine wave signal at a level of 1.0 V peak-to-peak. Connect High Gain Wideband Oscilloscope (B) to one of the output terminals.

(b) Set the video mixing control for the input connected to the sine wave oscillator to the minimum position, and set the other input video mixing control to the maximum position. Set gain at unity.

(c) Measure with the oscilloscope the peak-to-peak amplitude of 10 MHz signal appearing at the output. Calculate the ratio of the input voltage of step (a) above and the output voltage; this value, converted to decibels, should be compared to the specified crosstalk limit.

(d) Repeat steps (a), (b) and (c) above with the inputs interchanged.

(3) MEASUREMENT OF CROSSTALK IN SPECIAL EFFECTS GENERATOR (Figure 2-27b)

(a) Set up TV Test Signal Generator (C) to supply a 10 MHz sine wave, with horizontal and vertical blanking intervals, to one video input of the special effects generator under test. Terminate all video inputs in 75 ohms and set signal input level to 1.0 V peak-to-peak. Connect one special effects generator video output on a bridge-through basis to Waveform Monitor (D) and terminate in Monochrome Picture Monitor (E). Terminate remaining output (s) in 75 ohms. Provide external synchronization to both monitors from Synchronizing Generator (G).

(b) Set the waveform monitor for line display. Set the wipe controls at mid-position and set the pattern selector to wipe in a vertical line moving along the horizontal axis. Measure on the waveform monitor line display the amplitude of the video signal appearing in the black portion of the frame and the video signal in other portions of the frame. Determine the ratio of the amplitudes and convert to decibel form.

(c) Repeat steps (a) and (b) above with the inputs to the two video channels reversed.

(4) MEASUREMENT OF CROSSTALK IN VIDEO DISTRIBUTION AMPLIFIER (Figure 2-27c)

(a) Connect high gain Wideband Oscilloscope (B) to one output of the video amplifier unit under test and terminate the amplifier input in 75 ohms. Bridge the inputs of all the remaining video distribution amplifiers together and connect to Sine Wave Oscillator (A). Set the oscillator frequency to 100 kHz and adjust input level to the amplifiers to 1.0 V peak-to-peak. Set all amplifiers for unity gain.

(b) Measure the crosstalk signal amplitude on the oscilloscope at 100 kHz and 1 Mhz, 3.58 MHz, 5 MHz 8 MHz and 10 MHz. Take the ratio of the peak-to-peak input voltage of step (a) above to the measured peak-to-peak crosstalk voltage and convert to decibel form for comparison with specifications.

(c) Repeat steps (a) and (b) above several times using a different amplifier as the test amplifier each time.

(5) MEASUREMENT OF CROSSTALK IN PULSE DISTRIBUTION AMPLIFIER (Figure 2-27d)

(a) Terminate the input of one pulse distribution amplifier in 75 ohms and connect one output of this amplifier to Oscilloscope (B). Bridge the inputs of all remaining pulse distribution amplifiers together, terminate in 75 ohms, and connect to Square Wave Generator (F). Set all amplifier gains to unity. Adjust the generator to supply a 100 kHz square wave at an amplitude of 4.0 V peak-to-peak with a rise and decay time of approximately 100 ns.

(b) Measure the amount of 100 kHz crosstalk signal on the oscilloscope. Determine the ratio of the peak-to-peak input voltage from the generator, established in step (a) above, to the peak-to-peak crosstalk voltage. Convert to decibel form for comparison with specifications.

(c) Repeat steps (a) and (b) above several times using a different amplifier as the test amplifier each time.

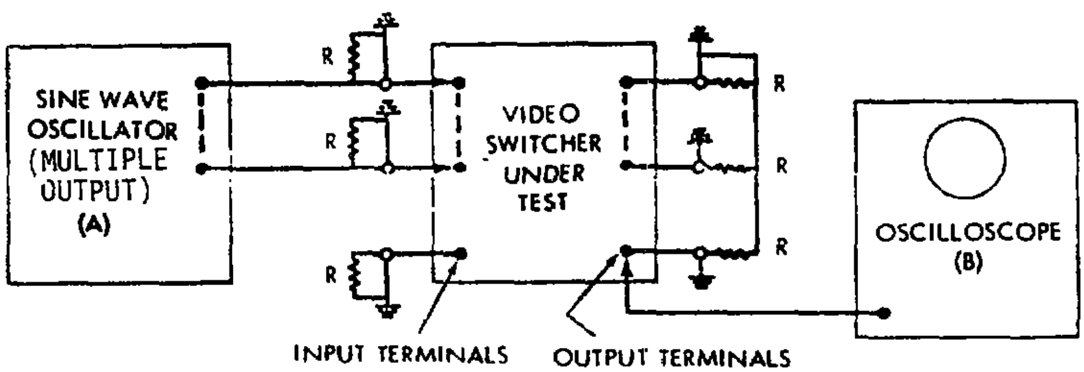
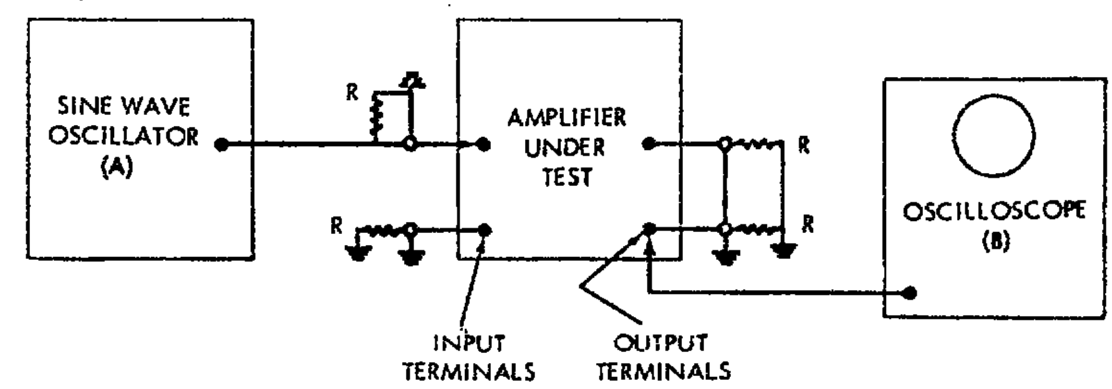



Figure 2-27. Measurement of Crosstalk in Video Switcher.




NOTES: 1. R = 75 OHMS

2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-27a. Measurement of Crosstalk in Video Mixing Amplifier.

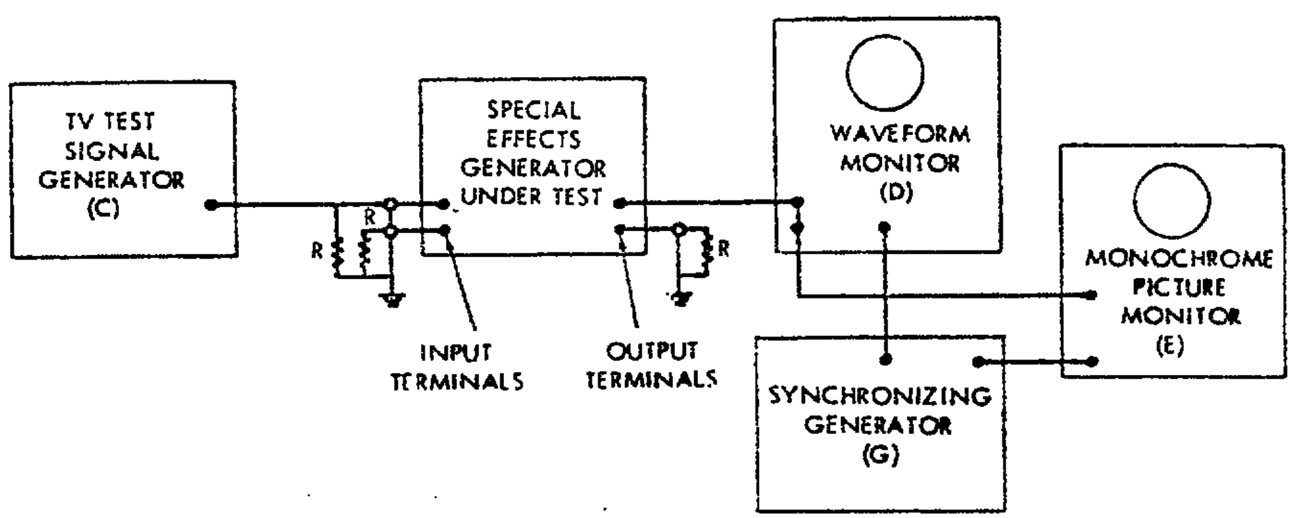
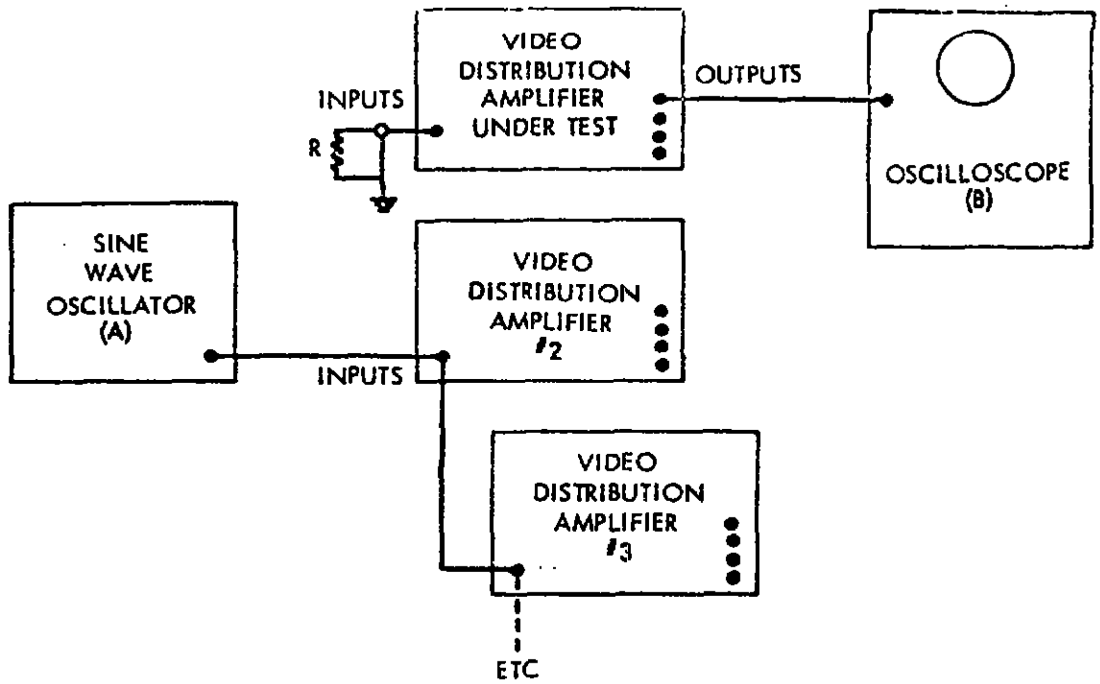
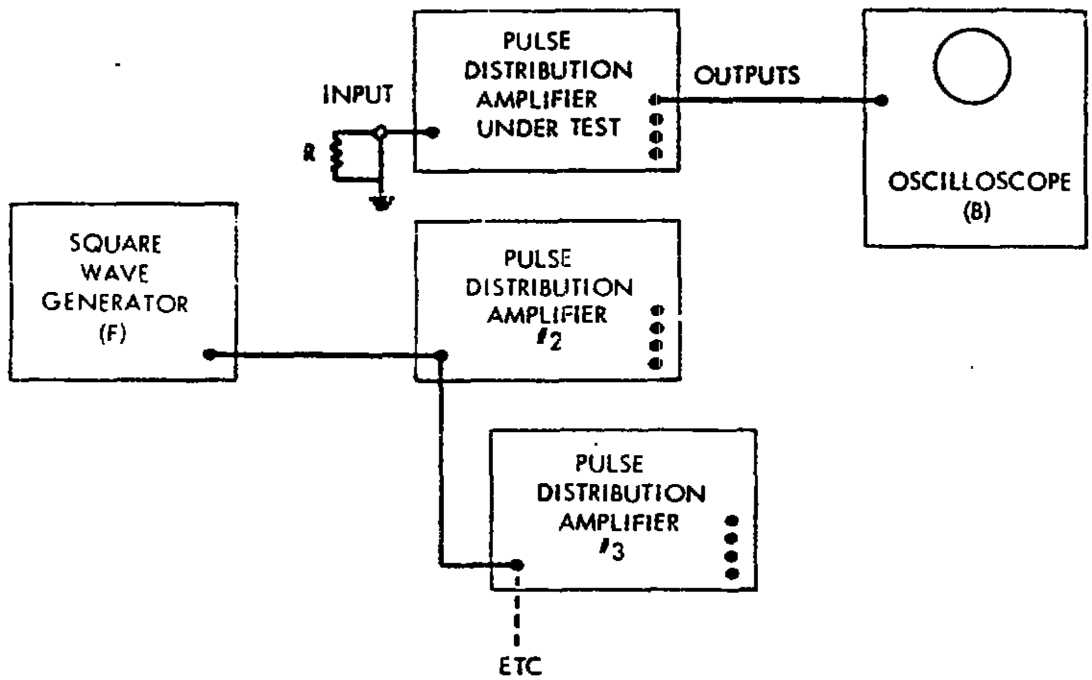



Figure 2-27b. Measurement of Crosstalk in Special Effects Generator.




NOTES: 1. R = 75 OHMS
2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-27c. Measurement of Crosstalk in Video Distribution Amplifier.




NOTES: 1. R = 75 OHMS
2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-27d. Measurement of Crosstalk in Pulse Distribution Amplifier.

2.5.1.5 DELAY (TV SIGNAL DISTRIBUTION AND AUXILIARY EQUIPMENT)

The passage of video or pulse signals through various signal distribution amplifiers and auxiliary devices produces time delays that must be kept within definite limits. The total input-to-output path delay is one parameter controlled in devices that process a single video or pulse signal. Other equipments that process more than one signal may have additional requirements pertaining to the differential delay between two signal paths. In some instances, delay is determined in terms of phase shift and then converted to time measurements.

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of delay and differential delay in television signal distribution and auxiliary equipment as specified in the following paragrpahs:

(1) VIDEO SWITCHERS

DIFFERENTIAL DELAY. The path delay at 3.58 MHz on any video input/output connection shall not differ more than 5.0 ns from the path delay at any other video input/output connection. The differential path delay at any other frequency within the passband from 30 Hz to 10 MHz shall not exceed 10 ns. This specification allows handling of color signals.

(2) VIDEO MIXING AMPLIFIERS

(a) DELAY. Video delay from input to output connectors shall not exceed 50 ns.

(b) DIFFERENTIAL DELAY. The total path delay at 3.58 MHz, from one input connector to an output connector, shall not differ more than 1.0 ns from the total path delay of a signal of the same frequency from the other input connector to the same output connector. Differential delay at any other frequency within the passband of the amplifier shall not exceed 5.0 ns.

(3) SPECIAL EFFECTS GENERATORS.

(a) VIDEO PATH DELAY

1. Total video path delay from input connector to output connector shall not exceed 50 ns.

2. Differential path delay from either input to either output at 3.58 MHz shall not exceed 1.0 ns. Differential delay at any other frequency from 30 Hz to 10 MHz shall not exceed 5.0 ns.

(b) VIDEO DISBRIBUTION AMPLIFIERS

DELAY. Input-to-output delay at any frequency in the passband shall not exceed 20 ns.

(c) PULSE DISTRIBUTION AMPLIFIERS

DELAY. Input-to-output signal delay shall not exceed 50 ns.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Delay and Differential Delay in Video Switchers | 2-28 |
| 2 | Measurement of Delay and Differential Delay in Video Mixing Amplifier | 2-28a |
| 3 | Measurement of Delay and Differential Delay in Special Effects Generator | 2-28b |
| 4 | Delay in Video Distribution Amplifier | 2-28c |
| 5 | Delay in Pulse Distribution Amplifier | 2-28d |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Sine Wave Oscillator | A | 2 | 1,2,4 |
| Phase Meter, Video | B | 23 | 1,2,3,4 |
| TV Test Signal Generator | C | 13 | 3 |
| Oscilloscope | D | 3 | 5 |
| Square Wave Generator | E | 4 | 5 |
| Oscilloscope, Dual Trace | F | 28 | 5 |

d. PROCEDURES

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF DELAY AND DIFFERENTIAL DELAY IN VIDEO SWITCHER (figure 2-28)

(a) Apply to one terminated input of the video switcher a 3.58 MHz sine wave signal of 1.0 V peak-to-peak amplitude. Set switcher gain at unity. Do not use sync-adder.

(b) Connect one input of Phase Meter (B) to the active input of the video switcher and connect the second input of the phase meter to one of the switcher outputs, terminated in 75 ohms.

(c) With the input signal switched to the selected output measure the phase shift through the switcher, in degrees. Also measure the phase shift at 1.0 MHz and 10 MHz. Convert phase shift in degrees into delay time, in nanoseconds (ns), by calculation.

$$\text{Delay in nanoseconds} = 2.78 \times \frac{\text{phase shift in degrees}}{\text{frequency in megahertz}}$$

(d) Repeat steps (a), (b) and (c) above for various input-output switching combinations. Determine the difference between the maximum and the minimum delay at each frequency and compare with specifications.

(2) MEASUREMENT OF DELAY AND DIFFERENTIAL DELAY IN VIDEO MIXING AMPLIFIER (Figure 2-28a)

(a) Connect one input of Phase Meter (B) to one terminated input of the video mixing amplifier and connect the second input of the phase meter to one terminated output of the amplifier. Apply a 1.0 MHz sine wave signal of 1.0 V peak-to-peak amplitude to the amplifier input connected to the phase meter.

(b) Measure with the phase meter to the phase shift between the input and the output signals; convert phase shift in degrees to delay in ns.

(c) Repeat steps (a) and (b) above for the second input-output path.

(d) With one phase meter input connected to one video mixing amplifier output, connect the second phase meter input and the sine wave generator signal to one amplifier input and then to the second amplifier input, in turn. Observe the difference in phase shift for these two paths at frequencies of 1.0, 3.58, 5, 8, and 10 MHz. Convert the differential phase shift to differential delay, by calculation.

(3) MEASUREMENT OF DELAY AND DIFFERENTIAL DELAY IN SPECIAL EFFECTS GENERATOR (Figure 2-28b)

(a) Apply to one video input of the special effects generator a 1.0 MHz sine wave with horizontal and vertical blanking intervals supplied by TV Test Signal Generator (C). Set input signal level at approximately 1.0 V peak-to-peak.

(b) Connect the two inputs of Phase Meter (B) to the active input and output of the special effects generator. Measure the phase shift in degrees at each of the following frequencies: 1.0 MHz, 3.58 MHz, 5 MHz, 8 MHz and 10 MHz. Convert the phase shifts to time delays, by calculation.

(c) Repeat steps (a) and (b) above for each input/output combination.

(d) Determine the difference between the maximum and minimum delay for each frequency and compare with specifications.

(4) MEASUREMENT OF DELAY IN VIDEO DISTRIBUTION AMPLIFIER (Figure 2-28c)

(a) Connect Sine Wave Generator (A) to the terminated input of the distribution amplifier and apply a sine wave signal of 100 kHz at a level of 1.0 V peak-to-peak. Set amplifier to unity gain.

(b) Connect one input of Phase Meter (B) to the distribution amplifier input, and connect the second phase meter input to one of the amplifier outputs. Measure the phase shift between input and output at the following frequencies: 100 kHz, 200 kHz and 500 kHz; 1 Mhz, 2 MHz, 3.58 MHz, 5 MHz and 10 MHz. Convert the phase shifts into time delays by calculation and compare with specifications.

(c) Repeat steps (a) and (b) above with the phase meter connected to each of the remaining outputs, in turn.

(5) MEASUREMENT OF DELAY IN PULSE DISTRIBUTION AMPLIFIER (Figure 2-28d)

(a) Connect Square Wave Generator (E) to the terminated input of the pulse distribution amplifier, and apply a square wave of 100 kHz at an amplitude of 4.0 V peak-to-peak. Rise time and decay time should be approximately 100 ns. Verify with Oscilloscope (D). Set gain at unity.

(b) Use Dual Trace Oscilloscope (F) to measure the input and output waveforms on separate traces. Using a calibrated time base, scale the time delay between the input and output pulse. Compare with specifications.

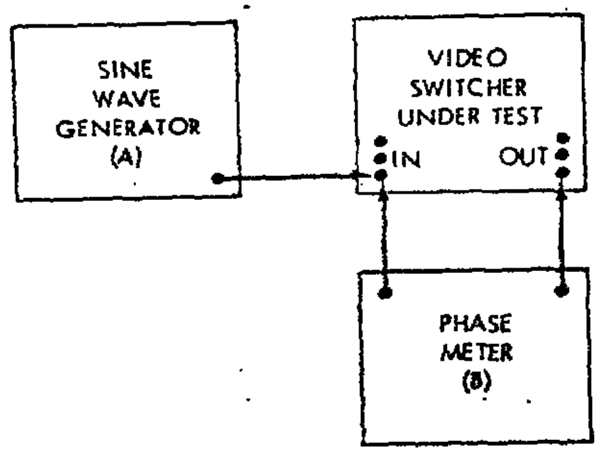



Figure 2-28. Measurement of Delay in Video Switcher.

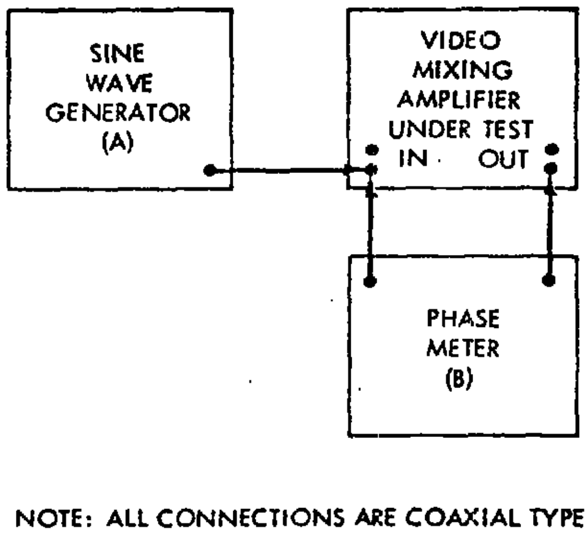



Figure 2-28a. Measurement of Delay in Video Mixing Amplifier.

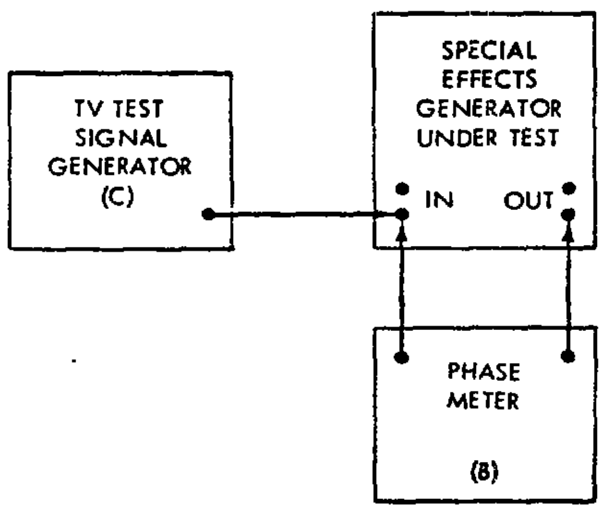



Figure 2-28b. Measurement of Delay in Special Effects Generator.

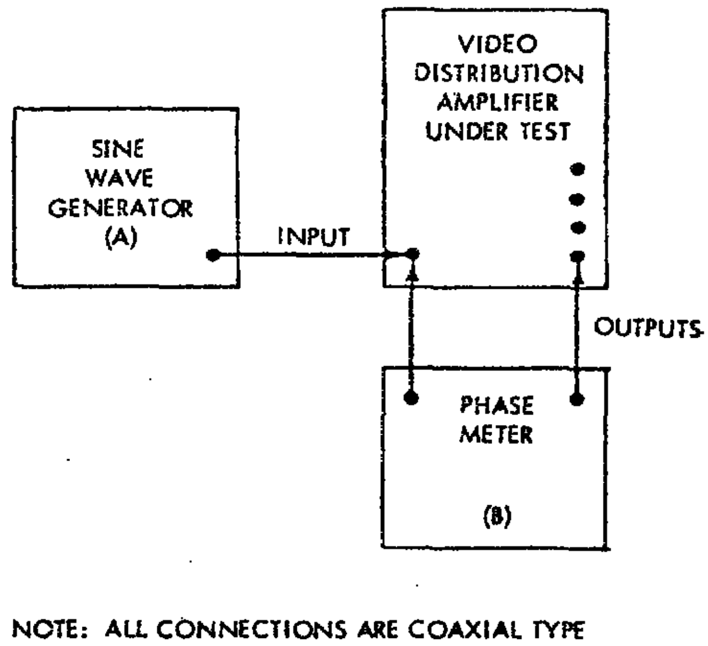



Figure 2-28c. Measurement of Delay in Video Distribution Amplifier.

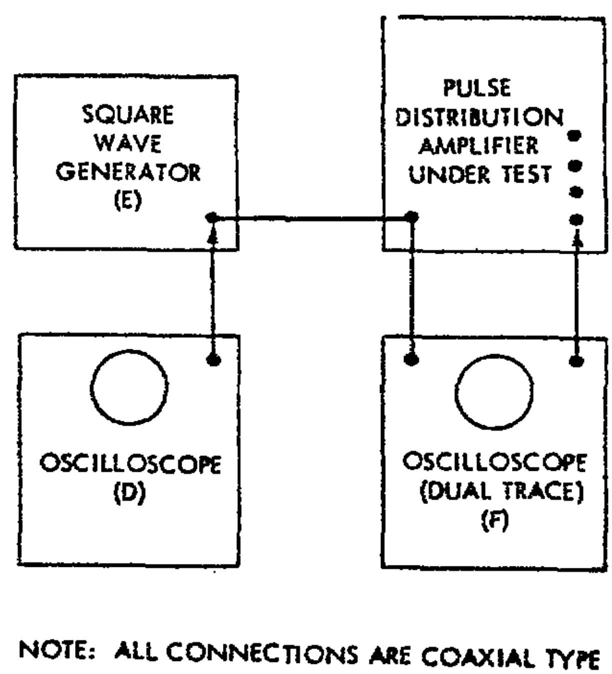



Figure 2-28d. Measurement of Delay in Pulse Distribution Amplifier.

## 2.5.2 TV WAVEFORM MONITOR

### 2.5.2.1 FREQUENCY RESPONSE (TV WAVEFORM MONITOR)

(a) APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of amplitude versus frequency response and low-frequency tilt in a television waveform monitor as specified in the following paragraphs:

(1) DISPLAYS. The monitor shall provide a selection of any one of four amplitude versus frequency response characteristics. These shall be as follows:

(a) Flat - Within ±0.1 dB from 60 Hz to 5 MHz and within ±0.3 dB from 5 MHz to 10 MHz.

(b) IRE - Flat ±0.1 dB from 60 Hz to 3 MHz and at least 20 dB down at 3.58 MHz and above (1958 Standard IRE 23S-1).

(c) Low - Not more than 3 dB down at 400 kHz and at least 14 dB down at 500 kHz and above.

(d) Chroma - 3 ±0.5 dB down at ±400 kHz from center frequency of 3.58 MHz and proceeding on down at frequencies greater than 400 kHz from the center frequency. This is required for color systems, but is a normal attribute of such equipment.

(2) INPUT/OUTPUT. The frequency response shall be flat within ±1.0 dB from 30 Hz to 10 MHz.

(3) LOW-FREQUENCY TILT. Low-frequency tilt to a 60 Hz square wave input signal shall be less than 1% of peak-to-peak amplitude.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Amplitude versus Frequency Response in Television Waveform Monitor | 2-29 |
| 2 | Measurement of Low-Frequency Tilt in Television Waveform Monitor | 2-29 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1,2 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF AMPLITUDE VERSUS FREQUENCY RESPONSE OF TELEVISION WAVEFORM MONITOR (Figure 2-29)

(a) Connect the output of TV Test Signal Generator (A), or a calibrated sine wave generator, to a terminated video input of the waveform monitor. Switch the dc restorer off, set the horizontal and vertical magnifiers to X1, the display switch to "two field," and the frequency response switch to "flat."

(b) Set the sine wave input signal to 50 kHz and adjust the input level to obtain a deflection of 100 IRE units on the monitor graticule. Reduce the frequency to 60 Hz and slowly raise the frequency to 10 MHz while observing the monitor display to verify that the specified response tolerance is not exceeded. Record measurements at the following frequencies: 60 Hz, 100 Hz and 500 Hz; 1 kHz, 2 kHz, 5 kHz, 10 kHz, 100 kHz and 500 kHz; 1 MHz, 2 MHz, 3 MHz, 3.58 MHz, 5 MHz, 8 MHz and 10 MHz.

(c) Set frequency response switch of monitor to "IRE" and repeat measurements of step (b) above.

(d) Set frequency response switch of monitor to "Low Pass" and measure response at 60 Hz, 100 Hz and 500 Hz; 1 kHz, 2 kHz, 5 kHz, 10 kHz, 100 kHz, 200 kHz, 300 kHz, 400 kHz and 500 kHz.

(e) Set frequency response switch of monitor to "Chroma" and adjust the sine wave amplitude at 3.58 MHz to obtain a deflection of 100 IRE units. Vary the sine wave frequency slowly over the frequency range from 3.0 to 4.2 MHz and measure the response at 3.0 MHz, 3.2 MHz, 3.4 MHz, 3.6 MHz, 3.8 MHz, 4.0 MHz and 4.2 MHz.

(f) Convert the recorded measurements to decibel form and compare with specifications.

(2) MEASUREMENT OF LOW-FREQUENCY TILT OF TELEVISION WAVEFORM MONITOR (Figure 2-29)

Low-frequency response is evaluated in terms of the ability of the equipment to display low-frequency square waves with minimum tilt. Tilt is a form of distortion of a rectangular pulse characterized by the introduction of slope on the horizontal components of the pulse; it is measured as the ratio, expressed as a percentage, between the amplitude of the slope component and the amplitude of the pulse.

(a) Connect TV Test Signal Generator (A) to a terminated video input of the waveform monitor under test. Arrange the generator to provide a composite video signal with a 60 Hz square wave in lieu of picture content. Adjust the input level to provide a square wave amplitude of 100 IRE units on the monitor display.

(b) Measure the tilt by observation of the monitor graticule.

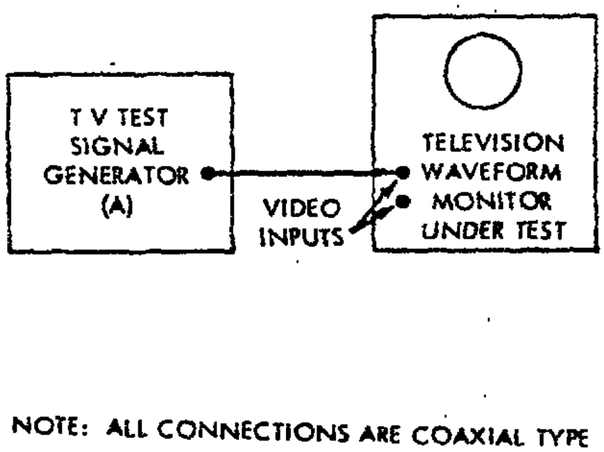



Figure 2-29. Measurement of Frequency Response of TV Waveform Monitor.

2.5.2.2 DC RESTORATION (TV WAVEFORM MONITOR)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of dc restoration in a television waveform monitor as specified in the following paragraph:

DC RESTORATION. A dc restorer shall be provided for stabilization of the blanking pulse backporch at a constant level ±4 IRE units during changes in average picture level from 10% to 90%. In color systems, the presence of a color burst on the backporch shall not cause the base line to shift. The color burst shall not be distorted, clipped or degraded. A switch shall be provided for bypassing the dc restorer circuit. The capability of the monitor to provide sine wave and square wave displays at approximately 60 Hz shall not be impared by operation of the dc restorer.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of DC Restoration in Television Waveform Monitor | 2-30 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1 |
| Synchronizing Generator | B | 15 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF DC RESTORATION IN TELEVISION WAVEFORM MONITOR (Figure 2-30)

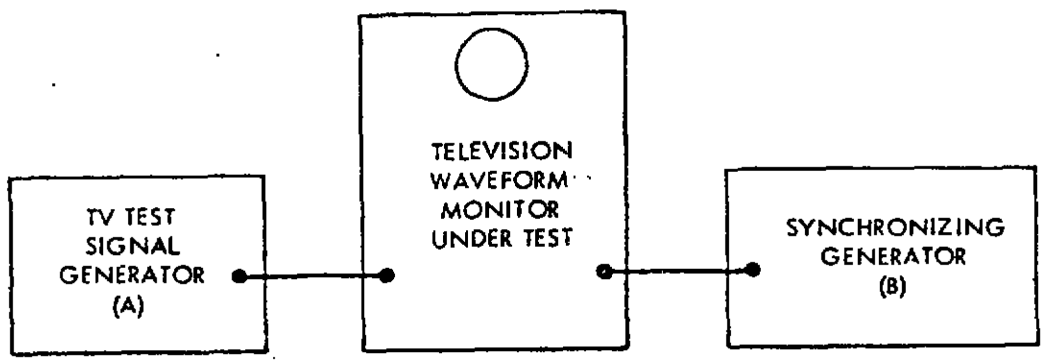
(1) Provide external synchronization to the waveform monitor from Synchronizing Generator (B).

(2) Connect TV Test Signal Generator (A) to one terminated video input of the monitor. Arrange generator to supply a noncomposite picture signal consisting of rectangular pulses of appropriate duty cycle to develop a flat field of white on the monitor display.

(3) With the dc restorer on and the vertical magnifier at X1, adjust the signal level to a peak-to-peak value of 90 IRE units. Gradually change the signal level from 90 IRE units to 10 IRE units and measure the variations in level of the blanking pulse backporch displayed on the monitor.

(4) Remove the rectangular pulse signal and arrange the generator to supply a 60 Hz sine wave at a peak-to-peak level of 100 IRE units to zero and measure the variations in the level of the negative peaks of the sine wave signal.

(5) Compare observations with specifications to verify compliance.




NOTE: ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-30. Measurement of DC Restoration in TV Waveform Monitor.

2.5.2.3 DISPLAY EXPANSION AND CALIBRATION (TV WAVEFORM MONITOR)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of vertical display expansion, horizontal display expansion and internal calibration facilities of television waveform monitors as specified in the following paragraphs:

(1) GAIN

(a) VERTICAL DISPLAY EXPANSION. Vertical gain shall be continuously adjustable over the range necessary to provide full-scale deflection when the monitor is operating extending from 120 mV to 1.5 V peak-to-peak. Additionally, full-scale deflections shall be available, through a switch, from video input voltages of 1.0 V, 0.5 V and 0.2 V, peak-to-peak (termed the X1, X2, and X5 vertical magnifier positions). The expansion accuracy shall be within ±1%.

(b) HORIZONTAL DISPLAY EXPANSION. A sweep magnifier shall be provided to expand any horizontal display sweep by factors of X1, X5, and X25. The X5 expansion accuracy shall be within ±3%. The X25 expansion accuracy shall be within ±5%.

(2) CALIBRATION SIGNALS. The monitor shall provide internal calibration signals of 0.714 V and 1.00 V ±1.0%. A control shall be provided which will permit display of either of the two internal calibration signals.

b. TEST ARRANGEMENTS

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Vertical Display Expansion of TV Waveform Monitor | 2-31 |
| 2 | Measurement of Horizontal Display Expansion of TV Waveform Monitor | 2-31a |
| 3 | Measurement of Internal Calibration Facilities in TV Waveform Monitor | 2-31 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1,2,3 |
| True RMS Voltmeter | B | 11 | 1,3 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF VERTICAL DISPLAY EXPANSION OF TELEVISION WAVEFORM MONITOR (Figure 2-31)

(a) Connect TV Test Signal Generator (A), or a calibrated square wave generator, to one terminated video input of the waveform monitor under test. Bridge True RMS Voltmeter (B), having an accuracy of ±0.25%, across the same input. Adjust the generator to supply a square wave input at any frequency between 1.0 kHz and 100 kHz; the square wave duty factor should be 0.5 ±3%, for which the peak-to-peak to rms ratio is 2.00.

(b) Adjust the input signal amplitude, in turn, to 0.12 V and 1.5 V, peak-to-peak, and adjust the monitor vertical gain to verify that a full-scale deflection amy be outlined.

(c) Apply a measured 0.2 V peak-to-peak input signal with the vertical magnifier switch set in the X5 position and observe the display to determine that a full-scale deflection is achieved. Repeat the test with 0.5 V and 1.0 V signals applied and the vertical magnifier switch in the X2 and X1 positions, respectively.

(2) MEASUREMENT OF HORIZONTAL DISPLAY EXPANSION OF TELEVISION WAVEFORM MONITOR (Figure 2-31a)

(a) Connect TV Test Signal Generator (A) to one terminated video input of the waveform monitor under test. Arrange the generator to provide a composite video signal with a sine wave in lieu of picture content. Adjust the sine wave signal to a frequency of 500 kHz at an amplitude of 1.0 V peak-to-peak.

(b) Set the monitor vertical gain magnifier to position X1, the horizontal magnifier to position X1 and the horizontal display to 0.125 H/cm.

(c) Observe the monitor display to determine the horizontal width occupied by 25 sine wave cycles. Set the horizontal magnifier to positions X5 and X25, in turn, and determine the display width occupied by 5 cycles and by 1 cycle, respectively. Compare the three measurements for compliance with specifications.

(3) MEASUREMENT OF INTERNAL CALIBRATION FACILITIES OF TELEVISION WAVEFORM MONITOR (Figure 2-31).

(a) Perform step (a) of Procedure (1) above.

(b) Set the vertical magnifier switch to the X1 position. Adjust the input amplitude to 1.0 V peak-to-peak, as verified by the Precision Voltmeter (B), and adjust the monitor vertical gain control for precise full-scale deflection.

(c) Switch the monitor internal calibration control to the 1.0 V position and measure the vertical deflection. Determine the percentage variation from the deflection established with the external 1.0 V signal and compare with specifications.

(d) Reset the monitor for external calibration and measure the vertical deflection with the external square wave signal adjusted precisely to 0.714 V peak-to-peak. Switch the monitor to display the internal 0.714 V calibration signal and measure the vertical deflection. Again determine the percentage variation from the deflection established with the external 0.714 V signal and check for compliance with specifications.

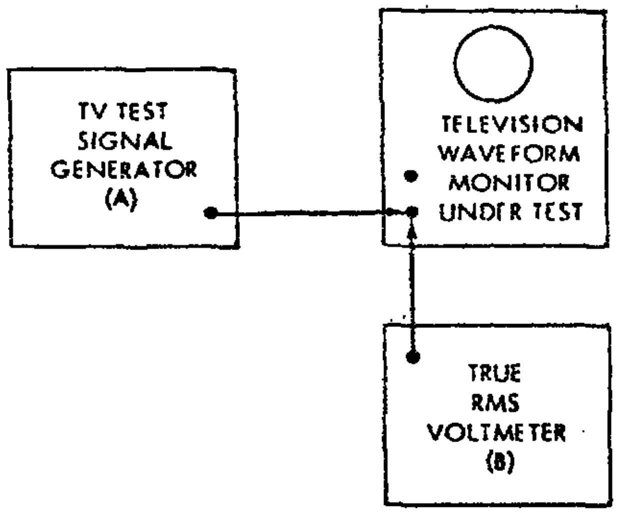



Figure 2-31. Measurement of Vertical Display Expansion and Internal Calibration of Television Waveform Monitor.

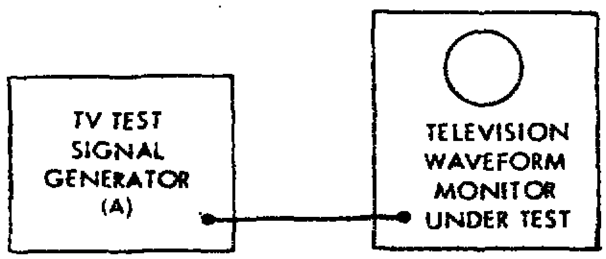



Figure 2-31a. Measurement of Horizontal Display Expansion of Television Waveform Monitor.

2.5.2.4 FIELD SHIFT (TV WAVEFORM MONITOR)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of field selection capability of a television waveform monitor as specified in the following paragraph:

FIELD SHIFT. A control shall be provided to allow selection of either an odd or an even field when viewing the two-field or delayed sweeps. Random noise or power interruptions shall not shift either field.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Field Shift of Television Waveform Monitor | 2-32 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | -- | 13 | 1 |

d. PROCEDURE. See subparagrpah 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF FIELD SHIFT OF TELEVISION WAVEFORM MONITOR (Figure 2-32)

(1) Connect TV Test Signal Generator (A) to one terminated video input of the waveform monitor under test. Setup the generator to supply a composite video signal at an amplitude of 1.0 V peak-to-peak using a sine wave as picture content.

(2) Set the monitor for two-field display and set the field switch in the "odd" position. Measure the horizontal interval displayed between the sixth equalizing pulse following the vertical synchronizing pulse interval and the first subsequent horizontal synchronizing pulse. This interval should be 0.5H (31.75 μsec).

(3) Repeat step (2) above with the field switch in the "even" position. The interval should now measure 1.0H (63.5 μsec).

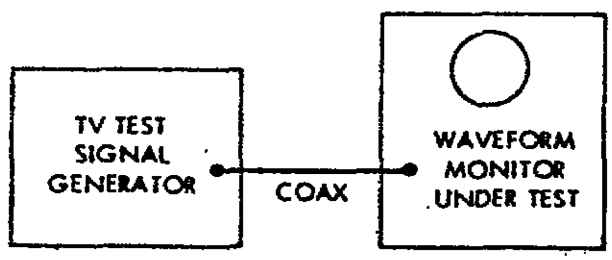



Figure 2-32. Measurement of Field Shift of Television Waveform Monitor.

2.5.2.5 LINE SELECTOR (TV WAVEFORM MONITOR)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of line selector performance of a television waveform monitor as specified in the following paragraph:

LINE SELECTOR. A line-selector circuit shall be incorporated that will allow detailed analysis of television line waveforms. Any portion of an odd or an even field shall be selectable for examination. The monitor shall provide an output signal containing both the input video signal and line brightening pulse having a level of 0.1 V that may be fed to a picture monitor to identify the line or lines displayed on the waveform monitor.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Line Selector Performance of TV Waveform Monitor | 2-33 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Monochrome Camera Chain | A | 7 | 1 |
| Monochrome Picture Monitor | B | 22 | 1 |
| Resolution Chart | C | 5 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF LINE SELECTOR PERFORMANCE OF TELEVISIONS MONITOR (Figure 2-33)

(1) Align and focus Monochrome Camera Chain (A) upon Resolution Chart (C) and connect the composite output of the camera chain to either of the video inputs of the waveform monitor under test. Connect Monochrome Picture Monitor (B) to the picture monitor output terminal of the waveform monitor.

(2) Adjust the line selector control of the waveform monitor to present the video waveform of any one of the 525 lines on the oscilloscope display. Observe the picture monitor to identify the selected line that is intensified by the line brightening pulse from the waveform monitor. Examine the displayed waveform to determine that it corresponds to the picture information on the identified line on the picture monitor.

(3) Repeat step (2) above for additional lines of different picture content.

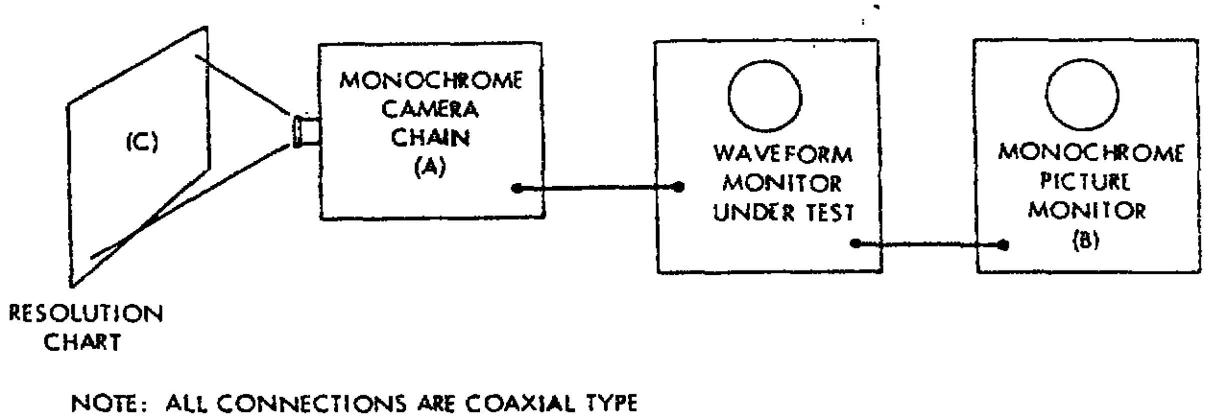



Figure 2-33. Measurement of Line Selector Performance of TV Waveform Monitor.

2.5.2.6 VIDEO DIFFERENTIAL DISPLAY (TV WAVEFORM MONITOR)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of video differential display of a televsion waveform monitor as specified in the following paragraph:

VIDEO DIFFERENTIAL DISPLAY. A video differential display shall appear on the waveform monitor when the signal input selector switch is in the "Video Input One and Two Differential" position ("A-B" position). The display observed shall be the instantaneous algebraic amplitude difference of two video inputs. The displayed amplitude shall be accurate to within ±1% of the amplitude of the largest input signal.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Video Differential Display of Television Waveform Monitor | 2-34 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1 |

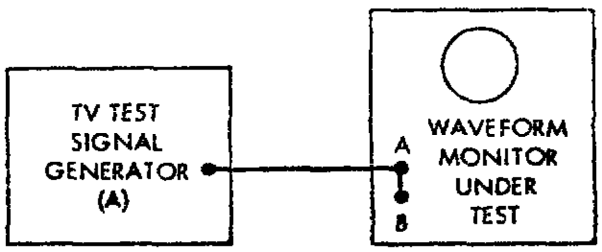
d. PROCEDURE.

See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF VIDEO DIFFERENTIAL DISPLAY OF TELEVISION WAVEFORM MONITOR (Figure 2-34)

(1) Arrange TV Test Signal Generator (A) to produce a 10-step staircase signal with horizontal and vertical blanking intervals. Connect output to waveform monitor video input "A," bridge through to input "B" and terminate at input "B." Set generator output level at 1.0 V peak-to-peak.

(2) Set the monitor input control for "A-B" differential display. The resultant display should be a straight line trace. Measure the peak-to-peak voltage amplitude of any deviation from a straight line and calculate the deviation as a percentage of the 1.0 V peak-to-peak input signal. Compare the percentage deviation with specifications.




NOTE: CONNECTIONS ARE COAXIAL TYPE

Figure 2-34. Measurement of Video Differential Display of TV Waveform Monitor.

## 2.5.3 TV SYNCHRONIZING GENERATOR

### 2.5.3.1 BAR-DOT PATTERN GENERATOR (TV SYNCHRONIZING GENERATOR)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of the output signals from the bar-dot pattern generator of a television synchronizing generator as specified in the following paragraph:

BAR-DOT PATTERN GENERATOR. A bar-dot signal output, with or without synchronizing pulses, shall be available. In the Bar mode, the generator shall produce a test "grating" pattern corresponding geometrically to a standard linearity chart. In the Dot mode, the dot display shall appear at locations corresponding to the intersections of the vertical and horizontal bars. Controls shall be provided to position the bars so that they may be used with a standard linearity chart to check picture geometry.

Modes shall be switchable from the front panel. The signal characteristics shall be as follows:

(1) Output Voltage: 0.5 to 4.0 V peak-to-peak, when terminated in a load impedance of 75 ohms ±5%.

(2) Output Polarity: Black Negative.

(3) Bar Width: No greater than 1% of picture height.

(4) Tilt: 1% maximum.

(5) Pulse Rise and Decay Time: 0.2 μsec maximum.

(6) Output Source Impedance: 75 ohms ±5%.

(7) Synchronization from internal crystal or 60 Hz line, selectable.

The bar-dot signal shall appear at a separate output, independent of the setting of the synchronizing generator mode switch.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
| --- | --- | --- |
| 1 | Measurement of Output Signal of a Bar-dot Pattern Generator of a Television synchronizing Generator | 2-35 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
| --- | --- | --- | --- |
| Monochrome Picture Monitor | A | 22 | 1 |
| Wideband Oscilloscope | B | 3 | 1 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) Connect Monochrome Picture Monitor (A) video input to the terminated output of the bar-dot generator. Synchronize the monitor

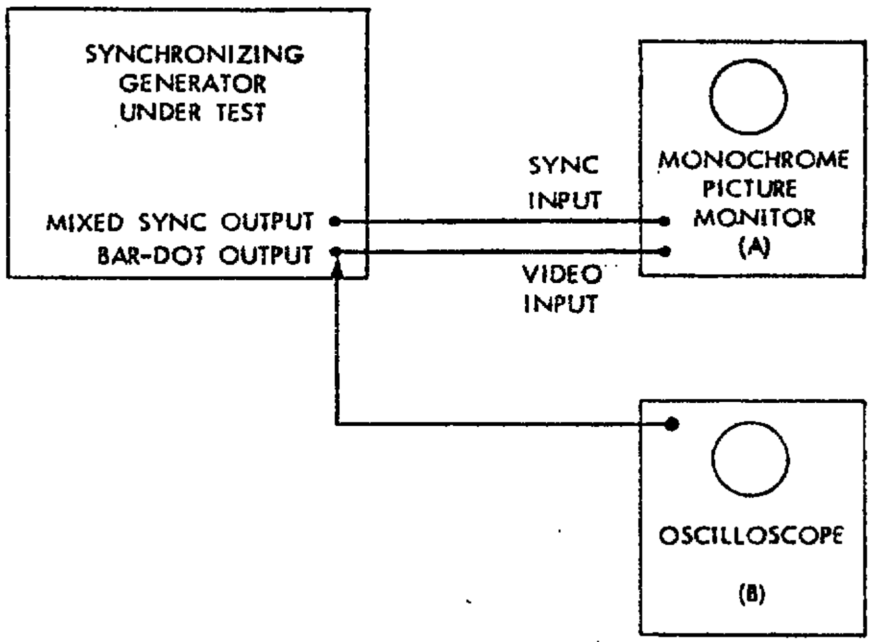
externally from the mixed synchronizing output of the synchronizing generator under test. Connect wideband Oscilloscope (B) to the output of the bar-dot generator.

(2) Set the bar-dot generator to produce the bar grating pattern. Vary the number of horizontal and vertical bars and observe whether these can be adjusted to produce a pattern of bar intersections that will coincide with the circles on a standard linearity chart.

(3) Using the wideband oscilloscope, measure the bar grating signal for voltage, polarity, tilt, and pulse width, rise time and decay time. Perform these measurements for both composite and noncomposite operation, in turn.

(4) Set the bar-dot generator to produce the dot pattern. Observe whether the dots can be set to appear at the cross points of the grating pattern. Perform the same measurements as in step (3) above for both composite and noncomposite operation.

(5) Compare the measured values of (3) and (4) above with requirements of the referenced paragraphs.




NOTE: CONNECTIONS ARE COAXIAL TYPE

Figure 2-35. Measurement of Output Signal of Bar-Dot Pattern Generator of a TV Synchronizing Generator.

2.5.3.2 SYNCHRONIZING SIGNAL OUTPUT (TV SYNCHRONIZING GENERATOR)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of the basic synchronizing output signals of a television synchronizing generator as specified in the following paragraph:

OUTPUTS. The basic synchronizing generator shall have four pulse signal outputs, two color subcarrier outputs, and a bar-dot pattern output (Figure 2-36a)

(1) Horizontal Drive

(2) Vertical Drive

(3) Blanking (horizontal and vertical)

(4) Composite Synchronizing

(5) Color Subcarrier (two 3.579545 MHz outputs)

(6) Bar-Dot Signal

(7) Selectable inputs from 60 Hz line, internal color crystal, or external composite picture.

The pulse signals shall conform to characteristics depicted in Figure 2-24h for monochrome synchronizing generator waveforms.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Basic Synchronizing Output Signal of a Television Synchronizing Generator | 2-36 |
| 2 | Synchronizing Generator Inputs and Outputs | 2-36a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Procedure |
|---|---|---|---|
| Oscilloscipe, Wideband | A | 3 | 1 |

d. PROCEDURE See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF BASIC SYNCHRONIZING OUTPUT SIGNALS OF A TELEVISION SYNCHRONIZING GENERATOR (Figure 2-36)

(1) Set the generator to the "crystal control" operating mode. Terminate each generator output in 75 ohms ±5%.

(2) Calibrate wideband Oscilloscope (A) for amplitude measurement accuracy.

(3) Connect the oscilloscope to the four basic "monochrome" outputs, in turn. Referring to Figure 2-24h verify that the output waveforms conform to the depicted values in the following respects:

(a) Peak-to-peak voltage and adjustment range, if specified.

(b) Number of pulses.

(c) Pulse widths (in terms of "H" or "V," at 10% and 90% amplitudes).

(d) Rise and decay times (in terms of "H" or "V").

(e) Pulse overshoot.

(4) Employ the time mark generator of the oscilloscope and measure the time interval between pulses or groups of pulses, where specified, in terms of "H" or "V."

(5) Arrange the oscilloscope for dual trace operation at a sweep rate harmonically related to the horizontal or vertical rate, as required. Apply the horizontal drive signal to one trace input. Apply to the second trace input, in turn, the vertical drive signal, the mixed blanking signal and mixed synchronizing signal and verify that the time coincidence of the pulse leading edges conforms to the referenced figure.

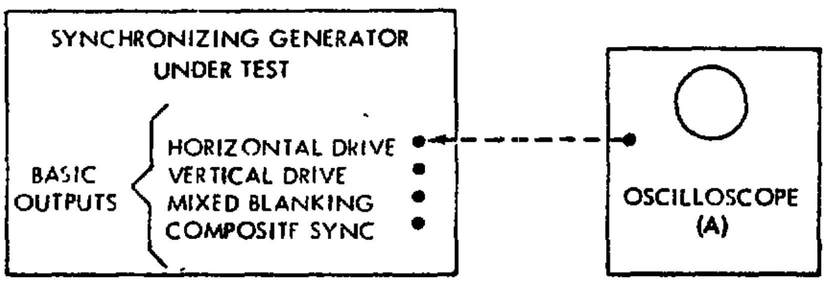



Figure 2-36. Measurement of Basic Synchronizing Output Signals of a TV Synchronizing Generator.

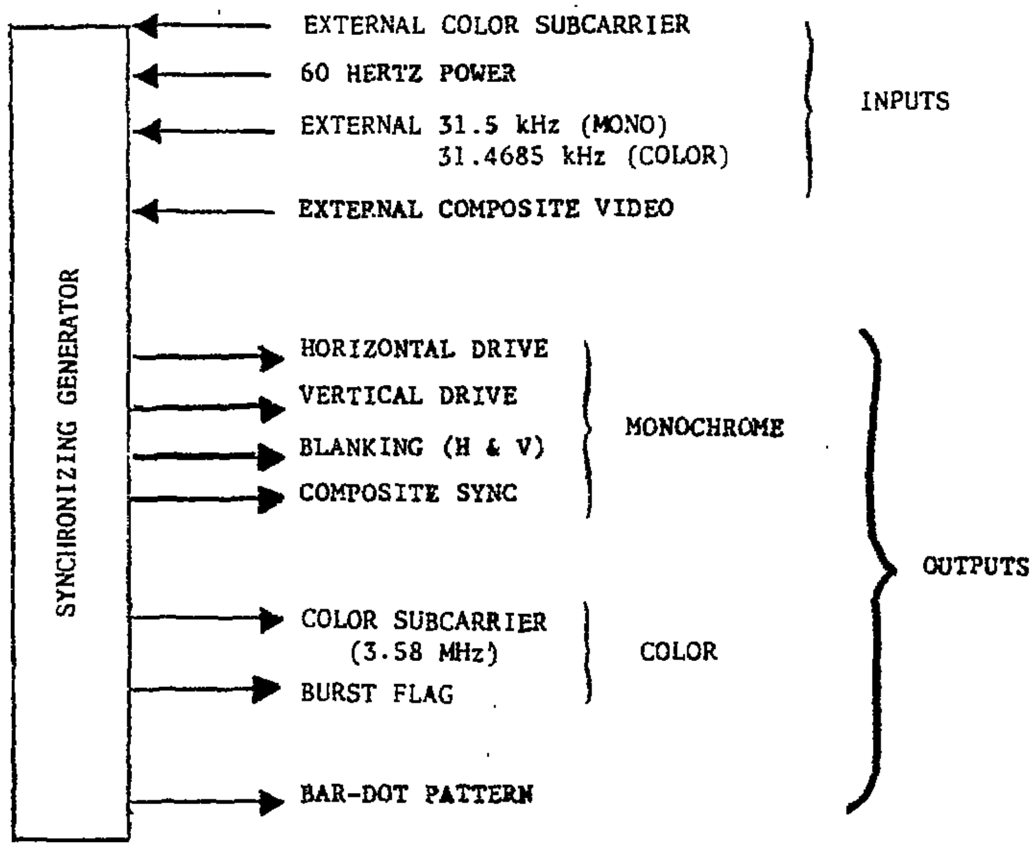



Figure 2-36a. Synchronizing Generator Inputs and Outputs.

2.5.3.3 OPERATING MODES (TV SYNCHRONIZING GENERATOR)

a. APPLICABILITY. The test arrangements in subparagraph b. below are applicable to the measurement of synchronizing generator performance in different operating modes as specified in the following paragraph:

OPERATING MODES. Four modes of operation shall be provided. Where oven warming time is a limiting factor, a separate switch shall be provided to permit continuous operation of the oven without regard to the position of the main "on-off" control of the synchronizing generator.

(1) Line Lock. Lock, or an in-step progression with time, shall be established between the horizontal drive output signal and the power line frequency within 5 sec after activation of this mode. Thereafter, a horizontal drive output signal shall be generated at a pulse rate 262.5 times the line frequency.

(2) Crystal Control. It shall be possible, within 5 sec after activation in this mode, to establish a horizontal drive output stream having a frequency of 15,750 pulses per second (pps). The variation in frequency shall not exceed ±0.1 pps.

(3) Color. The synchronizing generator shall be able, within 5 sec after activation in this mode, to lock step with a 31.468528 kHz signal supplied from a color subcarrier generator and shall generate a horizontal drive output having a pulse rate of 15,734.264 pps, ±0.044 pps.

(4) Genlock. The synchronizing generator shall be able to lock onto an incoming composite video signal within 5 sec, and subsequently to generate standard synchronizing waveforms in accordance with the standards delineated in Figure 2-24h.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Line Lock, Crystal Control, and Color Lock of a TV Synchronizing Generator | 2-37 |
| 2 | Measurement of Genlock Operation of a TV Synchronizing Generator | 2-37a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Electronic Counter | A | 54 | 1 |
| Monochrome Picture Monitor | B | 22 | 1,2 |
| TV Test Signal Generator | C | 13 | 2 |
| Waveform Monitor | D | 21 | 2 |
| Stopwatch | E | 62 | 1,2 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF LINE LOCK, CRYSTAL CONTROL, AND COLOR LOCK OF A TELEVISION SYNCHRONIZING GENERATOR (Figure 2-37)

(a) Connect the video input of Monochrome Picture Monitor (B) to the bar-dot generator output of the synchronizing generator under test. Connect the horizontal drive output of the synchronizing generator to Electronic Counter (A).

(b) Set the synchronizing generator to the "Crystal Control" mode and adjust the bar-dot pattern generator to produce a grating pattern on the picture monitor display. Switch the synchronizing generator to "Line Lock" operation and measure with Stopwatch (E) the time required for the grating pattern to stabilize on the monitor display. After stabilization, measure with the electronic counter the pulse rate of the horizontal drive signal and the power line frequency in hertz. Determine whether the pulse rate is the required 262.5 times the power line frequency.

(c) Switch the synchronizing generator to "Crystal Control" operation and measure with the stopwatch the time required for the grating pattern to restabilize on the monitor display. After stabilization, measure the horizontal drive pulse rate with the electronic counter and calculate the percentage deviation from the desired 15,750 pps.

(d) Switch the synchronizing generator to the "Color Lock" operating position and measure with the stopwatch the time required for the grating pattern to restabilize on the monitor display. After stabilization, measure the horizontal drive pulse rate with the counter and determine the percentage deviation from the desired 15,734.264 pps.

(2) MEASUREMENT OF GENLOCK OPERATION OF A TELEVISION SYNCHRONIZING GENERATOR (FIGURE 2-37a)

(a) Apply from TV Test Signal Generator (D) a composite video signal to the "Genlock" input terminal of the synchronizing generator under test. The picture content of the composite signal can be any convenient type, such as a sine or square wave, and the peak-to-peak amplitude of the composite signal should be set to 1.0 V.

(b) Set the synchronizing generator to the "Crystal Control" mode and adjust the bar-dot pattern generator to produce a grating pattern on the display of Monochrome Picture Monitor (B) connected to the pattern generator output. Switch the synchronizing generator to "Genlock" mode and measure with Stopwatch (E) the time required for the grating pattern to restabilize on the monitor display.

(c) Connect Waveform Monitor (D) or a suitable oscilloscope to the mixed synchronizing output of the synchronizing generator and examine the signal waveform for conformance with the requirements of subparagraph 2.5.3.2,a.

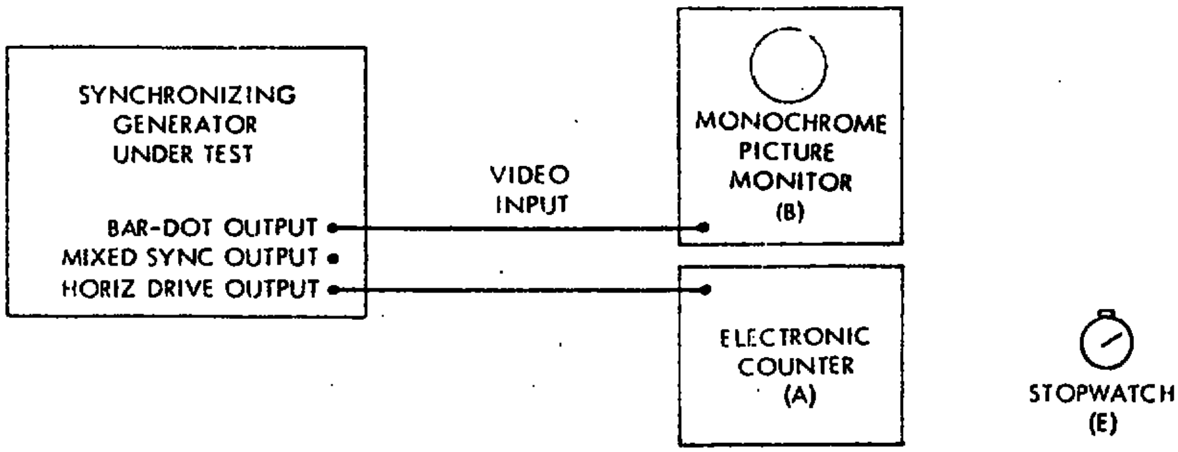



Figure 2-37. Measurement of Line Lock, Crystal Control and Color Lock Operation of a TV Synchronizing Generator.

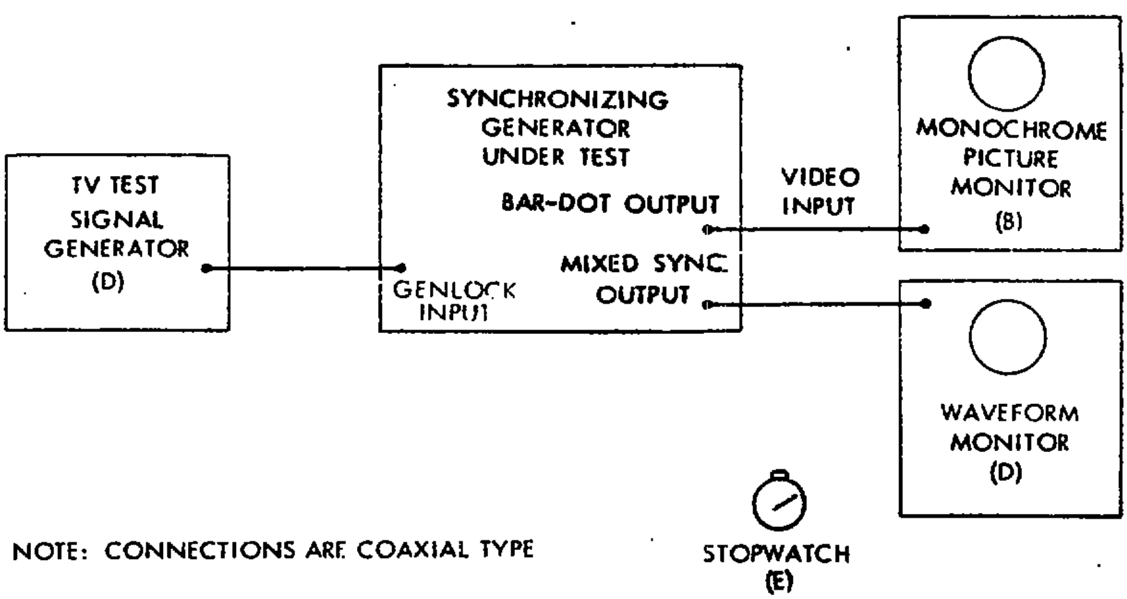



Figure 2-37a. Measurement of Genlock Operation of TV Synchronizing Generator.

2.5.4 TV VIDEO SWITCHER

2.5.4.1 SWITCHING INTERVAL (TV VIDEO SWITCHER)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of vertical interval switching, lap switching and gap switching of a video switcher as specified in the following paragraphs:

(1) VERTICAL INTERVAL. Vertical interval switching, when specified, shall be accomplished during the vertical blanking interval of the video signal and within 4.0 μsec after start of the switching cycle. The switching cycle shall be initiated through operation of control panel pushbuttons. Transients resulting from switching action shall not exceed 10% of the synchronizing voltage level.

(2) LAP SWITCHING. Switching of video signals, when specified, shall be accomplished within 3.0 msec after start of the switching cycle. This cycle shall be initiated by momentary contact. When switching is effected between two inputs having equal video levels, the output level shall remain constant within ±2% during the switching cycle. The amplitude of switching transients shall not exceed 10% of the synchronizing voltage level.

(3) GAP SWITCHING. Gap switching of video signals, when specified, shall be accomplished within 2.0 msec after start of the switching cycle. The switching cycle shall be initiated by momentary contact.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Switching Interval of a Video Switcher | 2-38 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| TV Test Signal Generator | A | 13 | 1 |
| TV Test Signal Generator | B | 13 | 1 |
| Storage Oscilloscope | C | 24 | 1 |
| Delay Line | D | 25 | 1 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF VERTICAL INTERVAL SWITCHING OF VIDEO SWITCHER (Figure 2-38)

(a) Provide Storage Oscilloscope (C) (or an oscilloscope plus photographic camera) suitable for measuring a single sweep display actuated by an external trigger voltage. Connect the oscilloscope directly to one of the video switcher outputs.

(b) From TV Test Signal Generator (A), provide a composite video signal consisting of 0.3 volt, peak-to-peak, or synchronizing signal plus 0.2 V setup and apply this signal to any one input (to be called "A") of the video switcher. From TV Test Signal Generator (B) apply a 2 MHz sine wave signal at an amplitude of 0.5 V peak-to-peak to another input of the switcher (to be called "B").

(c) Connect point "T" of the switcher to the external trigger terminal of the oscilloscope ("T" is a connection to the switcher internal circuitry capable of supplying a trigger signal that is time coincident with the signal that causes switching action; the method of obtaining this signal is to be determined by the switcher manufacturer). Adjust the oscilloscope for a 500 μsec sweep.

(d) Switch the output to input "B" preliminarily and arrange the oscilloscope for single sweep operation. Then switch to input "A" and observe the stored sweep (or sweep photograph). Determine whether the switching action occurred during the vertical interval, as indicated by the appearance of the blanking baseline and any of the six horizontal synchronizing pulses which appear at the end of the vertical interval.

(e) Set the oscilloscope for a sweep duration in the vicinity of 20 μsec or greater. Insert Delay Line (D) between the switcher output and the oscilloscope, to provide approximately 0.5 μsec signal delay and thus permit the entire switching waveform to be observed. With the oscilloscope set for single sweep operation, and input "A" initially connected through the switcher to the test output, switch input "B" to the test output. Examine the stored trace to determine the duration of the switching period. The switching time is measured from the point of departure from the blanking baseline to the point where the sine wave signal has reached a stable amplitude level. The trace of the 2 MHz sine wave may be used to measure time; an accuracy within ±0.5 μsec is adequate. Measure the amplitude of any switching transients on the stored trace and check for compliance with specifications.

(f) Repeat steps (d) and (e) above with the external connections to inputs "A" and "B" reversed, and the switching sequence correspondingly changed.

(g) Perform the above tests for several different input-output combinations.

(2) MEASUREMENT OF LAP SWITCHING OF VIDEO SWITCHER (Figure 2-38)

(a) Connect Storage Oscilloscope (C) to the switcher as in Procedure 1, steps (a) and (c) above, and insert 0.5 μsec Delay Line (D) between the switcher output and the oscilloscope.

(b) From TV Test Signal Generator (A), apply to switcher input "A" a composite video signal of 0.5 V amplitude peak-to-peak, consisting of 0.2 V setup and 0.3 V synchronizing signal. From TV Test Signal Generator (B), apply to switcher input "B" a similar signal of 0.7 V amplitude peak-to-peak consisting of 0.4 V setup and 0.3 V synchronizing signal. The two input signals should be synchronous.

(c) Set the switcher to connect input "A" to the test output and adjust the oscilloscope for a 5 msec single sweep.

(d) Switch input "B" to the test output and measure the stored trace. The switching interval consists of the time required for the video level to change from 0.5 V to 0.7 V. Also, measure the amplitude of any switching transients. Compare data with the referenced specifications.

(e) Repeat (a) through (d) above for other input/output combinations.

(3) MEASUREMENT OF GAP SWITCHING OF VIDEO SWITCHER (Figure 2-38)

Perform the steps of Procedure (2) above, except as follows:

(a) Set the oscilloscope for 4 msec sweep period.

(b) Measure the gap switching interval as the time during which the signal is not visable in the display.

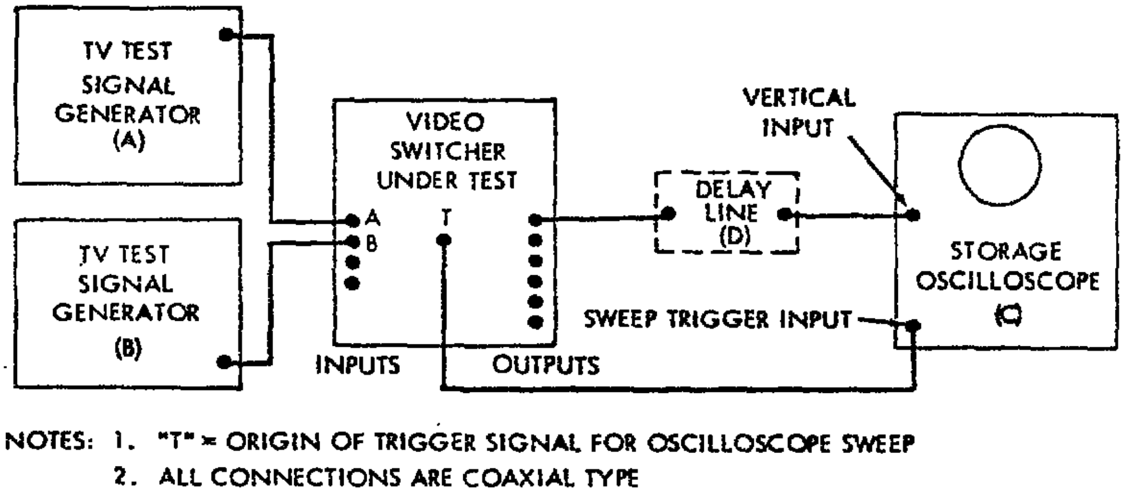



Figure 2-38. Measurement of Switching Interval of Television Video Switcher.

2.5.5 TV OPTICAL MULTIPLEXER

2.5.5.1 TRANSMITTANCE (TV OPTICAL MULTIPLEXER)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of the transmittance (or optical efficiency) of an optical multiplexer as specified in the following paragrpah:

TRANSMITTANCE. The transmittance of any optical path shall be at least 85% for white light and shall not differ more than ±5% from the transmittance of any other path. For any optical path, the transmittance at any wavelength shall not differ by more than ±2% from the transmittance at any other wavelength within the visible spectrum, although this specification amy be relaxed for monochrome-only systems.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Transmittance of Optical Multiplexer | 2-39 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Collimated Light Source | A | 31 | 1 |
| Foot-Candle Meter | B | 19 | 1 |
| Set of 6 Color Filters | C | 60 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF TRANSMITTANCE OF OPTICAL MULTIPLEXER (Figure 2-39)

(1) Measure the length of each optical path of multiplexer $d_1$ from the normal projector lens position to the normal camera lens position. Determine the diameter, $d_2$, of the projection lens accommodated by the multiplexer.

(2) In an area that can be completely darkened, set up Collimated Light Source (A) and Foot-Candle Meter (B), separated by distance $d_1$. With ambient light shut off, set the intensity of the collimated light source to a level convenient for measurement on the foot-candle meter and arrange that the diameter of the light beam does not exceed $d_2$. Record the meter reading in foot-candles.

(3) Similarly, record the meter readings with each of six Color Filters (C) inserted, in turn, in the path of the light beam. The color filters should cover the full gamut of saturated colors.

(4) Following these bench measurements, move the collimated white light source to the multiplexer and place it in a position normally occupied by a projector lens. Place the foot-candle meter in a position normally occupied by a camera lens. Repeat each of the previous measurements with the light source emitting the same light intensity as in step (2) above.

(5) Compare the meter readings taken in steps (2) and (3) with those of step (4) and establish the percentage transmittance of white light through the multiplexer. Also determine the percent of transmittance for each of the colors derived from the six filters.

(6) Perform the above measurement for each of the optical paths available in the multiplexer. Determine the maximum percentage variation in transmittance between all optical paths for white light. Also, for any single path, establish the maximum percentage variation of transmittance for beams of different colors (wavelength). Compare with tolerances permitted by specifications.

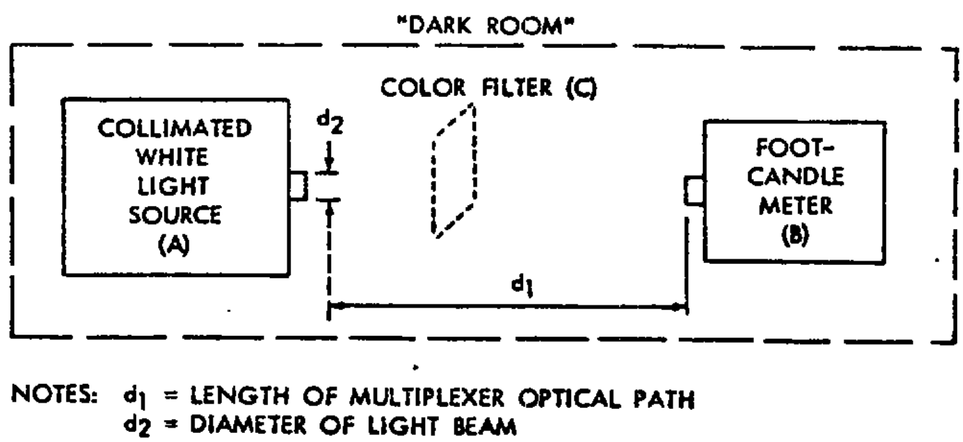



Figure 2-39. Measurement of Transmittance of Optical Multiplexer.

2.5.5.2 SPURIOUS IMAGES (TV OPTICAL MULTIPLEXER)

a. APPLICABILITY. The test arragement in subparagraph b. below is applicable to the measurement of spurious images of a TV optical multiplexer as specified in the following paragraph:

SPURIOUS IMAGES. Design of the optical system shall be such as to minimize reflections which would cause "ghosts" or displaced images. Total secondary reflections on any optical path employing front-surface mirrors shall be less than 0.3% of the level of the primary image. On paths which include other than front-surface mirrors, secondary reflections shall be less than 1.0% of the level of the primary image.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Spurious Images of a TV Optical Multiplexer | 2-40 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Resolution Chart Slide | A | 5a | 1 |
| Waveform Monitor | B | 21 | 1 |
| Monochrome Picture Monitor | C | 22 | 1 |
| 35mm Slide Projector | D | 9 | 1 |
| Monochrome Field and Slide Camera Chain | E | 32 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF SPURIOUS IMAGES OF TV OPTICAL MULTIPLEXER (Figure 2-40)

(1) Set up 35mm Slide Projector (D) to project Resolution Chart Slide (A) through the optical multiplexer under test to Monochrome Film and Slide Camera Chain (E). Connect the camera chain output on a bridge-through basis to Waveform Monitor (B) and terminate in Monochrome Picture Monitor (C). Adjust all controls for optimum display of the resolution chart on the picture monitor.

(2) Examine the picture monitor carefully for "ghosts" and displaced images. If present, set the waveform monitor for line selector operation and measure the amplitude of the spurious waveforms. Also measure the amplitude of a normal black-to-white transition for purposes of comparison. Calculate the ratio of the spurious signal to the normal signal and express in terms of percentage. Determine whether the multiplexer optical path includes front-surface mirrors, or other types, and check specifications for compliance with the tolerance pertaining to the mirror type in use.

NOTE: If there is any doubt that an observed spurious image is originating in the optical multiplexer, remove the multiplexer from the optical path and project the chart directly into the camera chain and observe whether the spurious image is still present or has disappeared.

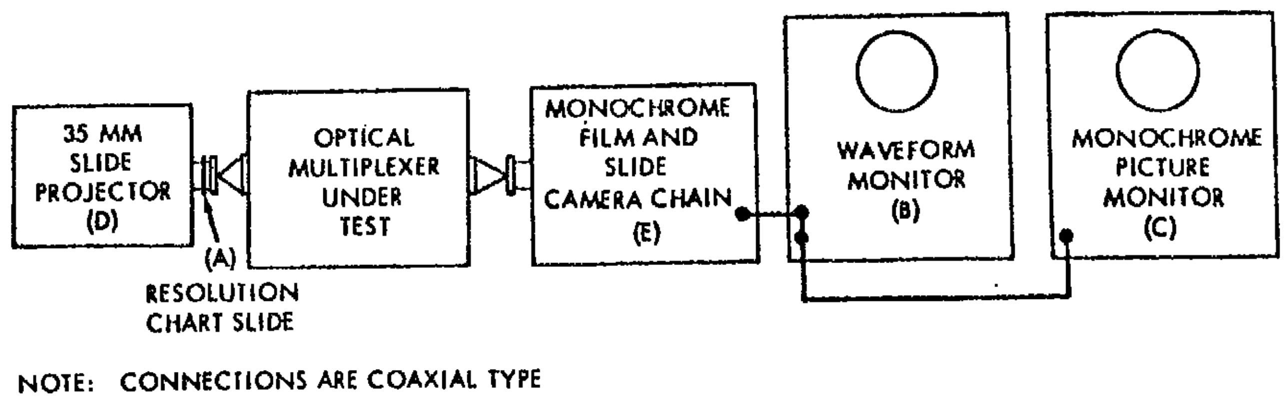



Figure 2-40. Measurement of Spurious Images of TV Optical Multiplexer.

2.5.5.3 OPTICAL ACCURACY (TV OPTICAL MULTIPLEXER)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of optical accuracy of television special multiplexers as specified in the following paragraph:

The optical element surfaces and positions in the multiplexer and the associated field lenses shall be sufficiently accurate to preserve the full television picture quality available from standard projectors, and monochrome film and slide camera chains. The resolution of the multiplexer and camera combination shall not be degraded more than 5 percentage points below the values established for the camera alone. The multiplexer shall introduce no geometric distortion which would cause the multiplexer-camera combination to fail to meet the geometric distortion criteria specified for the camera alone.

b. TEST ARRANGEMENT*

c. TEST EQUIPMENT REQUIRED*

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF OPTICAL ACCURACY OF OPTICAL MULTIPLEXER

*The test arrangements and test equipment specified for measuring horizontal resolution and geometric distortion of monochrome film and slide camera chain, described in sections 2.3.1.1 and 2.3.1.5 (applicable to paragraph a (3) in section 2.3.1.1 and subparagraph a (2) in section 2.3.1.5) are required in subparagraph d.

(1) Perform the measurements of horizontal resolution on a monochrome film and slide camera chain, as specified in the applicable part of section 2.3.1.1.

(2) Mount the same camera and projector, used in step (1), for operation through the optical multiplexer, employing the lenses normally used in multiplex operation. Remeasure the horizontal resolution through the system and compare with the resolution data recorded in step (1) above. Calculate the percentage reduction in resolution, if any, and check for compliance with specification.

(3) Repeat step (2) above for each projector-camera path.

(4) Perform the measurements for geometric distortion on a monochrome film and slide camera chain, as specified elsewhere in Appendix A. Repeat the measurements with the optical multiplexer in the optical path. Compare the results of both measurements with the referenced specifications.

2.5.6 VIDEO MIXING AMPLIFIER

2.5.6.1 FADE AND CROSSFADE LINEARITY (VIDEO MIXING AMPLIFIER)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of fade linearity and crossfade linearity of a video mixing amplifier as specified in the following paragraphs:

(1) FADE LINEARITY. The change in gain of either input channel shall be proportional to the change in angular displacement of the fade control lever, over its active range, within a tolerance of ±3%.

(2) CROSSFADE LINEARITY. System output shall remain constant ±5% during crossfades between busses with the same signal on each when the fade levers are locked for simultaneous operation.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
| --- | --- | --- |
| 1 | Measurement of Fade and Crossfade Linearity of a Video Mixing Amplifier | 2-41 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
| --- | --- | --- | --- |
| Sine Wave Oscillator | A | 2 | 1 |
| Vacuum Tube Voltmeter | B | 27 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF FADE AND CROSSFADE LINEARITY OF A VIDEO AMPLIFIER (Figure 2-41)

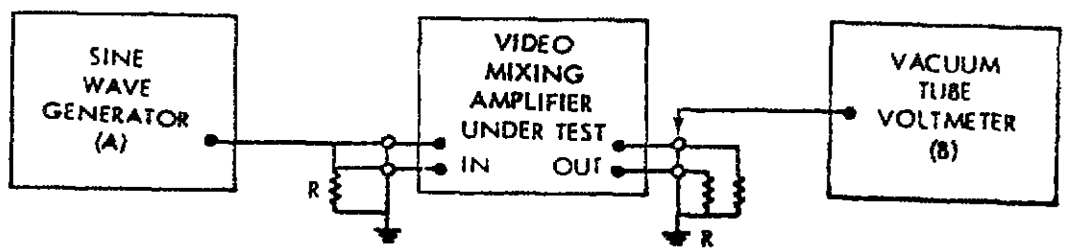
(1) Connect Sine Wave Oscillator (A) to both inputs of the mixing amplifier under test and terminate in 75 ohms ±2%. Adjust the oscillator to provide a 1.0 kHz sine wave at a level of 1.0 V peak-to-peak, at the amplifier inputs. Set gain of both amplifier channels to unity. Terminate both amplifier outputs in 75 ohms +2% and connect Vacuum Tube Voltmeter (B) across one of the outputs.

(2) Measurements shall be made at 10 equidistant angular measuring intervals, starting at a lever position corresponding to zero

gain and ending at a lever position corresponding to maximum gain. The measuring points should be established within an accuracy of ±0.5% of the total lever arc thus described.

(3) With one channel fade lever at zero, measure the output voltage for each calibrated position of the fade lever of the second channel. Repeat this test with the channels interchanged. Examine the data to determine whether the change in gain of each channel is proportional to the change in angular displacement of the corresponding fade lever. Calculate the maximum deviation from fade linearity in percent.

(4) Measure crossfade linearity by simultaneously moving the video mixing control levers (locked) with one video signal increasing while the other is decreasing and observing the output voltage. If the output does not remain constant, measure the maximum change and compare the percentage change with the allowable tolerance.




NOTES: 1. R = 75 OHMS ±2%
2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-41. Measurement of Fade and Crossfade Linearity in a Video Mixing Amplifier.

## 2.5.7 VIDEO EQUALIZING AMPLIFIERS

### 2.5.7.1 EQUALIZATION (VIDEO EQUALIZATION AMPLIFIER)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of the equalization capabilities of a video equalization amplifier as specified in the following paragraphs:

(1) FREQUENCY EQUALIZATION. The equalization amplifier shall compensate, within ±1.0 dB over a frequency range from 30 Hz to 10 MHz, for the frequency response characteristics of RG-11/U cable, or other 75-ohm coaxial cables having signal transmission characteristics which closely approximate those of the RG-11/U except in respect to attenuation per unit length. The amplifier shall be capable of providing equalization which is continuously adjustable up to the amount required to compensate for at least 3000 ft of RG-11/U cable.

(2) OVERSHOOT CORRECTION. The amplifier shall, for the same lengths and types of cable, and concurrently with frequency equalization, compensate within ±2% for overshoot on a square wave input signal having a rise time of 0.05 μsec, as measured at the amplifier output.

(3) TILT CORRECTION. The amplifier shall, for the same lengths and types of cable, provide concurrent correction within 1% for tilt on square wave signals in the frequency range from 60 Hz to 100 kHz, as measured at the amplifier output.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Equalization in Video Equalization Amplifier | 2-42 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Sine Wave Generator | A | 2 or 13 | 1 |
| Square Wave Generator | B | 4 or 13 | 1 |
| Oscilloscope, Wideband | C | 3 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF EQUALIZATION OF VIDEO EQUALIZATION AMPLIFIER (Figure 2-42)

(1) Connect Sine Wave Generator (A) and Square Wave Generator (B) or item 13 through an impedance matching network designed to match the 75-ohm input impedance of the video equalization amplifier over a frequency range from 30 Hz to 10 MHz. The generators shall have been previously calibrated. The square wave signal should have a rise time of approximately 0.05 µsec, overshoot not exceeding 1% and a tilt not exceeding 0.5%.

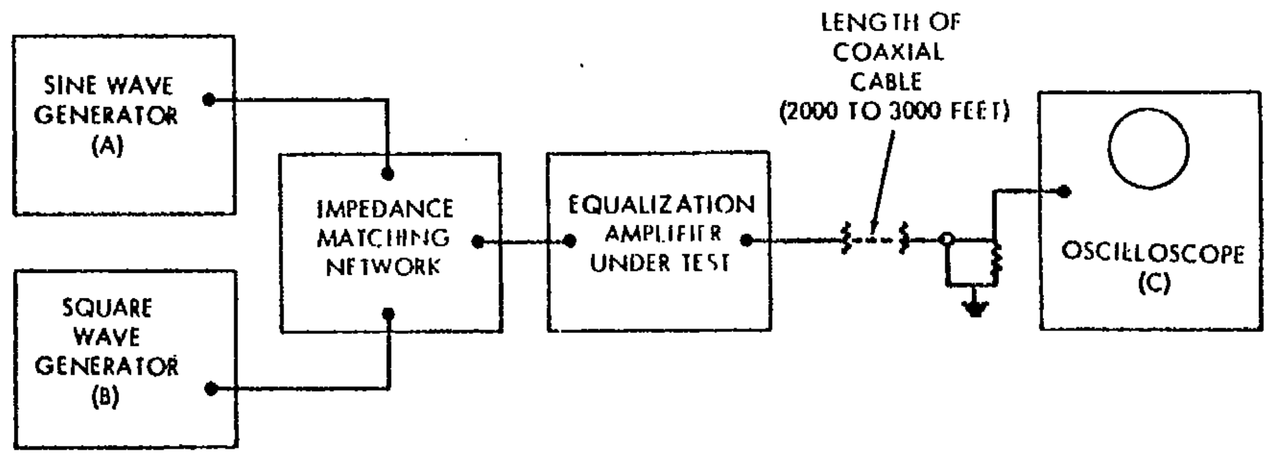
(2) Connect the output of the equalization amplifier to a section of cable consisting of approximately 300 ft of RG-11/U, RG-12/U or RG-13/U, or approximately 2000 ft of RG-59/U cable. Terminate the cable in 75 ohms ±2% resistive. Arrange wideband Oscilloscope (C) to measure the waveforms at the cable output.

(3) With the oscilloscope monitoring the cable output, apply square wave signals in the range from 60 Hz to 10 MHz, as required, and

adjust the equalization amplifier for optimal compensation of the overshoot, tilt, and attenuation characteristics of the test cable section. Thereafter, these controls will not be disturbed for the remainder of the test.

(4) Adjust the square wave output to zero. Measure the amplifier-plus-cable frequency response by setting the sine wave generator to produce a 1.0 V peak-to-peak 1.0 kHz signal across the cable terminating resistor and observing the voltage on the oscilloscope as the generator is set to the following frequencies: 30 Hz, 60 Hz, 100 Hz, 250 Hz and 500 Hz; 1 kHz, 2 kHz, 5 kHz, 10 kHz, 50 kHz, 100 kHz and 500 kHz; and 1 MHz, 2 MHz, 4 MHz, 6 MHz, 8 MHz and 10 MHz. Convert the observed level variations to decibel form and compare to specifications.

(5) Adjust the sine wave output to zero. Set the square wave generator to provide a 50 kHz, 1.0 V peak-to-peak, signal across the cable terminating resistor. Measure tilt and overshoot on the oscilloscope with square wave signals at frequencies of 60 Hz, 50 kHz and 100 kHz. Compare observations with the specified values.




NOTES: 1. THE IMPEDANCE MATCHING NETWORK SHALL PRESENT A 75 OHM LOAD ±2% TO THE EQUALIZATION AMPLIFIER FROM 30 HERTZ TO 10 MEGAHERTZ.
2. R = 75 OHMS ±2%
3. THE LENGTH OF COAXIAL CABLE SHALL BE APPROXIMATELY 3000 FEET OF RG-11/U, RG-12/U or RG-13/U CABLE, OR APPROXIMATELY 2000 FEET OF RG-59/U CABLE.

Figure 2-42. Measurement of Equalization of a Video Equalization Amplifier.

## 2.5.8 PULSE DISTRIBUTION AMPLIFIERS

### 2.5.8.1 OUTPUT SIGNAL SHAPING (PULSE DISTRIBUTION AMPLIFIER)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of the pulse reshaping capability of a pulse distribution amplifier as specified in the following paragraph:

OUTPUT PULSE SHAPE. The pulse distribution amplifier will reshape and/or regenerate the input signal and provide output signals with rise and decay times not exceeding 100 ns and an overshoot of less than 2%.

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Output Signal Shaping of Pulse Distribution Amplifier | 2-43 |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Square Wave Generator | A | 4 | 1 |
| Oscilloscope, Wideband | B | 3 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF OUTPUT SIGNAL SHAPING OF PULSE DISTRIBUTION AMPLIFIER (Figure 2-43)

(1) Connect Square Wave Generator (A) to the terminated input of the pulse distribution amplifier under test. Adjust the generator to deliver a square wave of 4.0 V peak-to-peak amplitude and rise and decay times of 50 ns, at a repetition rate of 100 kHz.

(2) Connect wideband Oscilloscope (B) to each terminated amplifier output, in turn, and measure the output square wave rise time, decay time and overshoot. Compare the data with the specifications.

(3) Repeat steps (1) and (2) above with an input signal having rise and decay times of 250 ns.

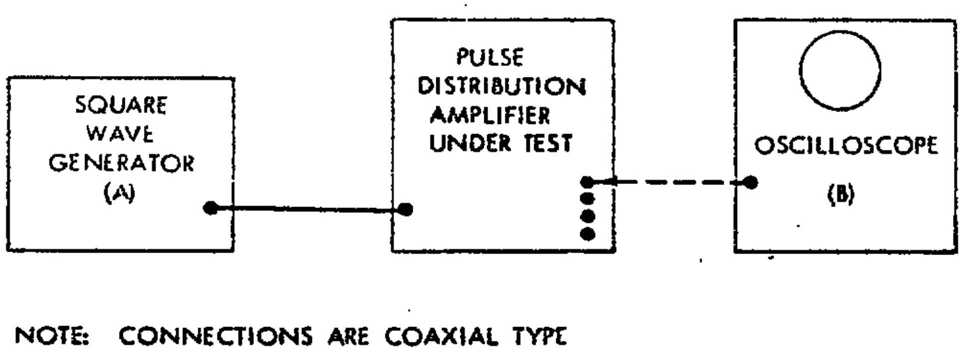



Figure 2-43. Measurement of Output Signal Shaping of Pulse Distribution Amplifier.

(2) WIPE TRANSITION. Black level and video output level for each channel shall be maintained within ±1.0 IRE unit during wipes and keying. Switching time for changeover between video signals shall not exceed 50 ns irrespective of video content or wipe mode. When a split-screen signal is viewed on a monitor there shall be no observable jitter along the boundary between the two video pictures.

(3) WIPE CONTROL. Wiping action shall be linear in respect to movement of wipe control levers and shall start and finish within 90% of lever travel. Control shall be stable at any position of travel and shall be noise-free in operation.

(4) SPECIAL EFFECTS KEYING. The special effects keying circuitry shall permit the insertion of one video waveform into another with simultaneous keying-out of the original video information in that portion of the raster where the insertion is to occur. Keying in and out sensitivity shall be capable of resolving two IRE units.

(5) SPLIT-SCREEN POSITIONING CONTROL. The split-screen positioning control shall permit positioning an inserted video image in any area of displayed picture.

(6) NON-ADDITIVE MIXING. When operated, shall allow the whitest portions of two signals to take precedence in fades. An optional feature shall be available by which delayed horizontal and vertical drive signals may be used at the camera to move the apparent position of the subject in the raster without requiring camera movement.

The montage positioning control shall operate freely in any direction and shall be capable of being locked in any position. Steady control motion shall result in smooth action by the image throughout the range of its movement with the electrical effect operating in the same direction as the control device.

## 2.5.9 TV SPECIAL EFFECTS GENERATORS

### 2.5.9.1 SPECIAL EFFECTS CONTROL (TV SPECIAL EFFECTS GENERATOR)

a. APPLICABILITY. The test arrangement in subparagraph b. below is applicable to the measurement of special effects control performance of a television special effects generator as specified in the following paragraphs:

(1) SPECIAL EFFECTS. The following video wipe features (Figure 2-44) shall be available as a minimum:

(a) Horizontal

(b) Vertical

(c) Corner

(d) Diagonal

(e) Circular

Provision shall be made for subsequent additional wipe forms through the use of optional plug-in modules. These shall include, but shall not be limited to:

(a) Rectangular

(b) Triangular

(c) Diamond

(d) Sawtooth

(e) Multiple Geometric

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Special Effects Control of Television Special Effects Generator | 2-44a |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Monochrome Camera Chain | A | 7 | 1 |
| TV Test Signal Generator | B | 13 | 1 |
| Waveform Monitor | C | 21 | 1 |
| Monochrome Picture Monitor | D | 22 | 1 |
| Resolution Chart | E | 5 | 1 |

d. PROCEDURE. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

MEASUREMENT OF SPECIAL EFFECTS CONTROL OF TELEVISION SPECIAL EFFECTS GENERATOR (Figure 2-44a)

(1) Connect to one terminated video program input of the special effects generator under test a Monochrome Camera Chain (A)

focused upon a Standard Resolution Chart (E). Connect TV Test Signal Generator (B) to the second video input and to the video keying input of the special effects generator. The TV test signal generator should be arranged to supply an electronically generated 10-step staircase signal. Both input signals should be adjusted to supply an input level of 0.7 V peak-to-peak, noncomposite. Connect one output of the special effects generator on a bridge-through basis to Waveform Monitor (C) and terminate in Monochrome Picture Monitor (D).

(2) Operate each of the special effects controls to verify that each of the specified effects can be produced by normal action of the controls.

(3) Verify the keying in and keying out sensitivity by observing the presence of the steps of the staircase signal while the control is being adjusted and measure resolving capability in IRE units on the Waveform Monitor.

(4) Use the waveform monitor to measure the video output level and the black level, in IRE units, at line rate for various wipe modes and keying levels. Also measure the transition times in nanoseconds for these wipes and levels.

(5) Observe on the monitors the boundaries between the two video pictures for various split screen and video key montage signals and note the presence or absence of jitter. Examine for stability at both line and field rates on the waveform monitor.

(6) Compare observations and measurements with specifications.

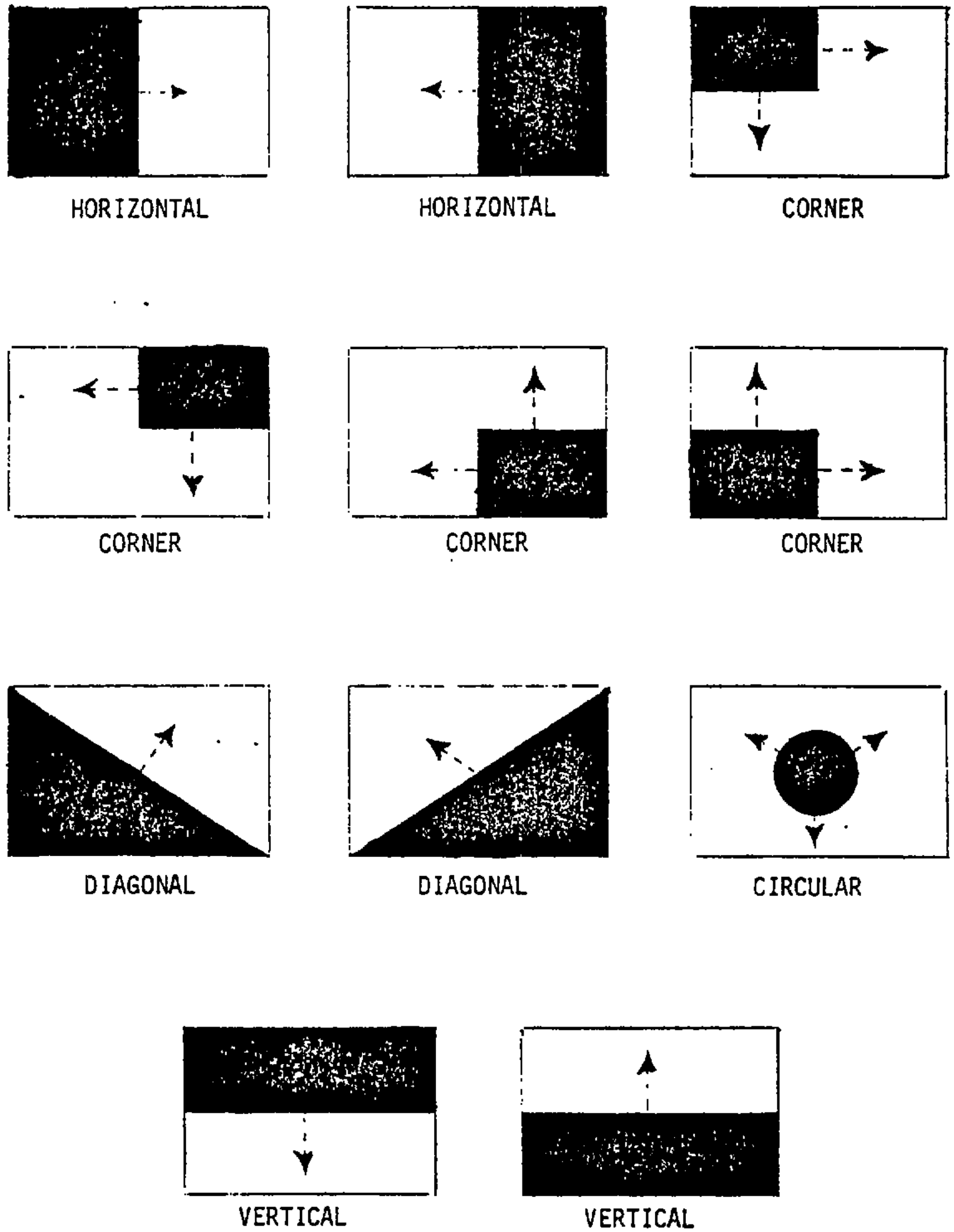



Figure 2-44. Video Wipe Patterns.

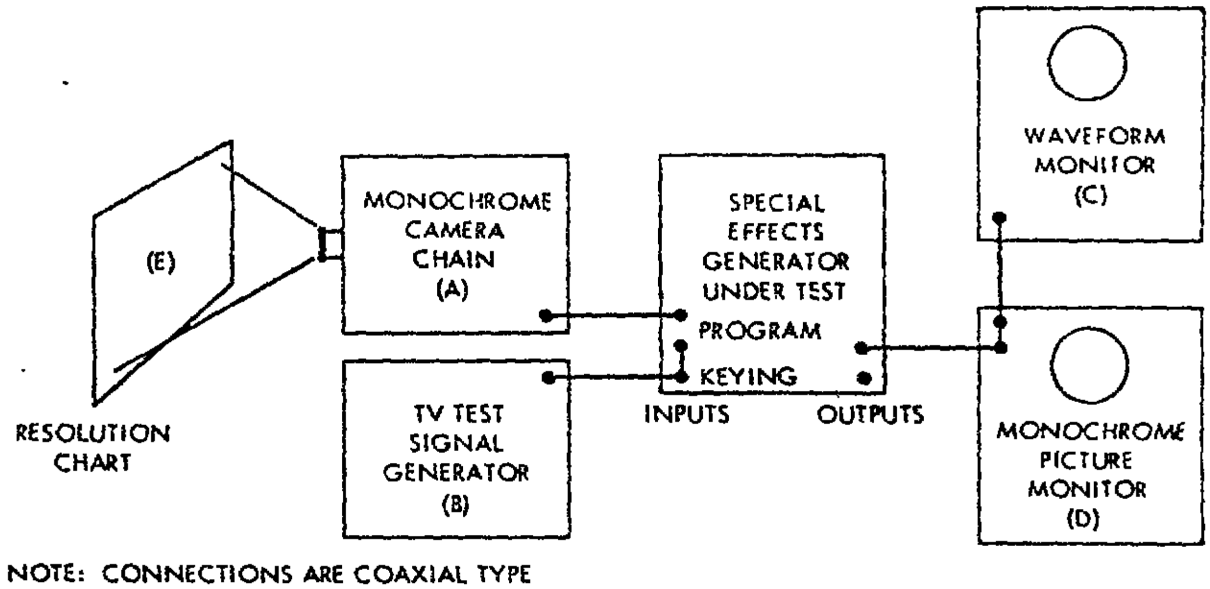



Figure 2-44a. Measurement of Special Effects Control of TV Special Effect Generator.

## 2.5.10 TV FILTERS

### 2.5.10.1 INPUT VOLTAGE AND FREQUENCY RESPONSE (TV FILTERS)

The measurements in this section are concerned with the sine wave and square wave frequency responses of two specialized television filters and with the ability of the filters to maintain their specified characteristics over extended periods of operation. The filters are of the passive, low-pass variety; one has a nominal upper cutoff frequency ($f_c$) of 4.2 MHz, the other a nominal upper $f_c$ of 10.0 MHz.

a. APPLICABILITY. The test arrangements in subparagrpah b. below are applicable to the measurement of input voltage performance and frequency response of television filters as specified in the following paragrpahs:

(1) SQUARE WAVE RESPONSE. Undershoot and overshoot, when measured with a square wave having a period of $20/f_c$ sec and a rise and decay time of $1/2\ f_c$ sec between 10% and 90% amplitude points, shall not exceed 7% of the peak-to-peak signal. The undershoot shall not differ from the overshoot by more than 1% of the peak-to-peak signal.

(2) INPUT LEVEL. The filter shall operate continuously with composite video signal inputs whose values range from 0 to 5.0 V peak-to-peak. This performance shall be achieved under the conditions when as much as half of the total spectrum power falls above $f_c$. No dielectric breakdown shall occur when an input signal of 10k pps at 20 V peak-to-peak, having a half-amplitude pulse duration of 1.0 μsec, is applied for 1 minute to the input of the filter while the output is terminated in a 75-ohm resistance.

(3) FREQUENCY RESPONSE. Filter frequency response shall be as follows:

| Frequency | Insertion Loss |
|---|---|
| 100 kHz | not in excess of 3 dB. |
| Between 30 Hz and kHz | within ±0.5 dB of the insertion loss measured at 100 kHz. |
| At 1.2 $f_c$ | at least 3 dB greater than the insertion loss measured at 100 kHz. |
| At 1.3 $f_c$ | at least 6 dB greater than the insertion loss measured at 100 kHz. |
| At 1.6 $f_c$ | at least 20 dB greater than the insertion loss measured at 100 kHz. |

b. TEST ARRANGEMENT

| Arrangement | Description | Relevant Figure |
|---|---|---|
| 1 | Measurement of Square Wave Response of TV Filters | 2-45 |
| 2 | Measurement of Input Voltage Performance of TV Filters | 2-45a & 2-45b |
| 3 | Measurement of the Sine Wave Frequency Response of TV Filters | 2-45c |

c. TEST EQUIPMENT REQUIRED

| Test Unit | Schematic Reference | Item No. in Appendix A | Used in Test Arrangement |
|---|---|---|---|
| Square Wave Generator | A | 4 | 1 |
| Oscilloscope, Wideband | B | 3 | 1,2 |
| Pulse Generator | C | 29 | 2 |
| Sine Wave Generators (2) | D1, D2 | 2 | 2,3 |
| Vacuum Tube Voltmeter | E | 27 | 3 |

d. PROCEDURES. See subparagraph 2.1.1.1 for precautions that must be observed in carrying out all test procedures.

(1) MEASUREMENT OF SQUARE WAVE RESPONSE OF TV FILTERS (Figure 2-45).

This test requires the measurement of "overshoot" and "undershoot," the transient responses that accompany abrupt changes in signal amplitude. Overshoot is measured as the percentage by which the first transition peak following the signal transition exceeds the flat top amplitude of the transition. Undershoot is measured as the percentage by which the transient peak immediately preceding the signal transition (and in the opposite direction) exceeds the flat top amplitude of the signal transition.

(a) Terminate the filter input and output in 75 ohms ±2%. Connect Square Wave Generator (A) to the filter input and adjust period to $20/f_c$ sec (where $f_c$ is the filter cutoff frequency in hertz) and rise and decay time to $1/2\ f_c$ sec between 10% and 90% amplitude points.

(b) Connect wideband Oscilloscope (B) to the filter output. The oscilloscope should be flat in frequency response from 30 Hz to twice the filter cutoff frequency.

(c) Set the square wave input to a convenient level and measure the overshoot and undershoot. Compare observed percentages with the specified limits.

(2) MEASUREMENT OF INPUT VOLTAGE PERFORMANCE OF TV FILTERS

(a) Power Test (Figure 2-45a)

1. Terminate the filter input and output in 75 ohms ±2%.

2. Connect two Sine Wave Generators, $(D_1)$ and $(D_2)$, to the input of the TV filter under test and apply simultaneously sine wave signals at 0.8 $f_c$ and 1.3 $f_c$. Adjust each sine wave signal to a level of 2.5 V peak-to-peak, as measured by Oscilloscope (B). Connect the oscilloscope to the filter output and monitor the performance periodically during a test period of three hours to observe any changes.

3. Perform the square wave response test per Procedure (1) above, both before and after the power test, to indicate any degradation of filter characteristics.

(b) Pulse Test (Figure 2-45b)

1. Terminate the filter input and output in 75 ohms ±2%.

2. Set Pulse Generator (C) to provide a signal of 10k pps, having a half-amplitude pulse duration of 1.0 μsec. Connect

generator to the filter input and adjust input level to 20 V peak-to-peak for a period of one minute. Monitor the filter output signal for signs of breakdown using Oscilloscope (B).

(3) Repeat step 2 above at least five times.

(3) MEASUREMENT OF SINE WAVE FREQUENCY RESPONSE OF TV FILTERS (Figure 2-45c)

(a) Terminate the filter input and output in 75 ohms ±2%.

(b) Connect Sine Wave Generator (D) to the filter input. Provide high impedance Vacuum Tube Voltmeter (E) to measure both input and output voltages at the following range of frequencies:

1. For filters with cutoff frequency of 4.2 MHz measure at 30 Hz, 60 Hz, 100 Hz and 500 Hz; 1 kHz, 2 kHz, 5 kHz, 10 kHz, 100 kHz and 420 kHz; and 1 MHz, 2 MHz, 3.58 MHz, 4.2 MHz, 5.04 MHz 5.46 MHz and 6.72 MHz.

2. For filters with cutoff frequency of 10 MHz, measure at 30 Hz, 60 Hz, 100 Hz and 500 Hz; 1 kHz, 2 kHz, 5 kHz, 10 kHz, 100 kHz and 500 kHz; and 1 MHz, 2 MHz, 3.58 MHz, 5 MHz, 8 MHz, 10 MHz, 12 MHz, 13 MHz, and 16 MHz.

(c) Calculate the insertion loss of the filters at each of the designated frequencies and compare with the specified values.

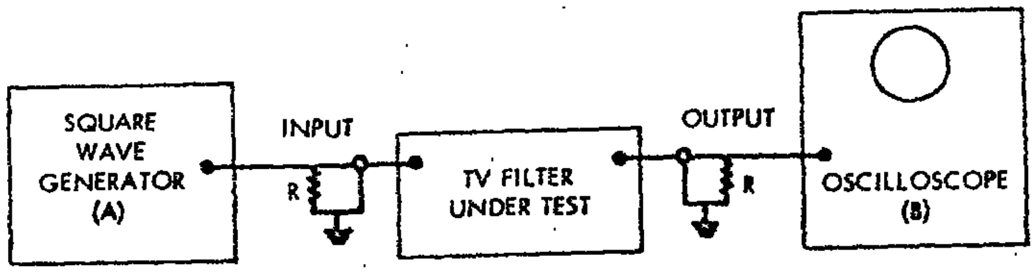
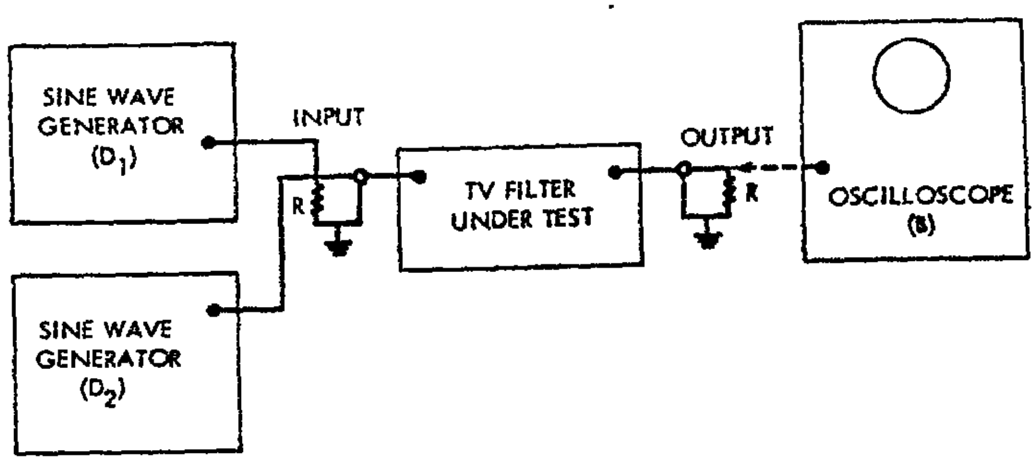



Figure 2-45. Measurement of Square Wave Response of Television Filters.




NOTES: 1. R = 75 OHMS ± 2%
2. ALL CONNECTIONS ARE COAXIAL TYPE

Figure 2-45a. Measurement of Input Voltage Performance of Television Filters (power test).

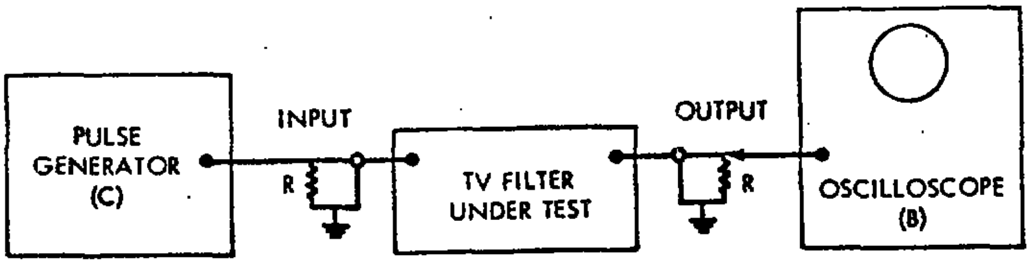



Figure 2-45b. Measurement of Input Voltage Performance of Television Filters (pulse test).

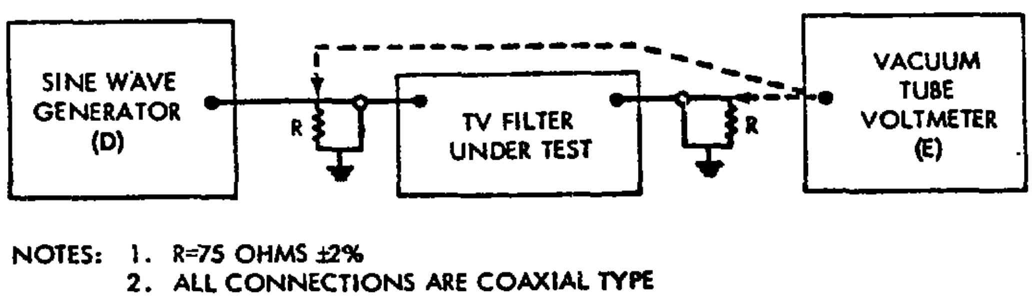



Figure 2-45c. Measurement of Sine Wave Frequency Response of Television Filters.

3.0 TELEVISION WAVEFORM MONITOR (PERFORMANCE CHARACTERISTICS)

The television waveform monitor shall consist of a self-contained CRT oscilloscope designed for the monitoring and measuring of video waveforms. It shall display any portion of a composite or noncomposite television signal waveform conforming to the monochrome signal standard.

3.1 INPUTS

3.1.1 VIDEO INPUT

3.1.1.1 QUANTITY OF INPUTS. Two input terminals shall be provided, each designed for high inpedance bridging of 75-ohm coaxial lines.

3.1.1.2 INPUT IMPEDANCE. The input impedance shall be at least 50k ohms resistive.

3.1.1.3 INPUT LEVEL (PEAK-TO-PEAK). The monitor shall operate with input voltages ranging from 120 mV to 1.5 V. No damage to the waveform monitor shall occur when a signal having an amplitude of 10 V is applied to the input.

3.1.2 SYNCHRONIZING INPUT

3.1.2.1 QUANTITY OF INPUTS. There shall be one synchronizing input for high impedance bridging of 75-ohm coaxial lines.

3.1.2.2 INPUT IMPEDANCE. The input impedance shall be at least 50k ohms resistive.

3.1.2.3 INPUT LEVEL (PEAK-TO-PEAK). The monitor shall operate with mixed synchronizing input levels ranging from 250 mV to 6.0 V. No damage to the waveform monitor shall occur when a signal having an amplitude of 10.0 V is applied to the input.

3.1.3 CALIBRATION INPUT

3.1.3.1 INPUT IMPEDANCE. The input impedance shall be at least 1.0 megohm resistive.

3.1.3.2 INPUT LEVEL (PEAK-TO-PEAK). The external calibration signal shall have a maximum amplitude of 2.0 V.

3.2 OUTPUT

3.2.1 OUTPUT IMPEDANCE. The output impedance shall be 75 ohms ±5% resistive.

3.2.2 OUTPUT LEVELS

3.2.2.1 VIDEO

a. The nominal video output level shall be 1.0 V peak-to-peak with a 75 ohm ±5% resistive load.

b. Line Brightening Pulse. The line brightening pulse shall have a level of 0.1 V peak-to-peak superimposed on the video output.

3.2.2.2 HUM AND NOISE. The rms value of hum and noise shall be at least 60 dB below a signal output level of 1.0 V peak-to-peak.

3.2.2.3 DC ON OUTPUT. No dc voltage shall appear on any output under conditions of no signal input when measurements are made with a dc voltmeter having an input impedance of 20k ohms per volt.

3.3 FREQUENCY RESPONSE

3.3.1 DISPLAYS. The monitor shall provide a selection of any one of four amplitude versus frequency response characteristics. These shall be as follows:

a. Flat - Within ±0.1 dB from 60 Hz to 5 MHz and within ±0.3 dB from 5 MHz to 10 MHz.

b. IRE - Flat ±0.1 dB from 60 Hz to 3.0 MHz and at least 20 dB down at 3.58 MHz and above (1958 Standard IRE 23S-1).

c. Low - Not more than 3.0 dB down at 400 kHz and at least 14 dB down at 500 kHz and above.

d. Chroma - 3 ±0.5 dB down at ±400 kHz from center frequency of 3.58 MHz and proceeding on down at frequencies greater than 400 kHz from the center frequency.

3.3.2 INPUT/OUTPUT. The frequency response shall be flat within ±1.0 dB from 30 Hz to 10 MHz.

3.4 GAIN

3.4.1 VERTICAL DISPLAY EXPANSION. Vertical gain shall be continuously adjustable over the range necessary to provide full-scale deflection when the monitor is operating from an input signal having an amplitude level within a range extending from 120 mV to 1.5 V peak-to-peak. Additionally, full-scale deflections shall be available through a switch from video input voltages of 1.0 V, 0.5 V and 0.2 V peak-to-peak (termed the X1, X2, and 5 vertical magnifier positions). The expansion accuracy shall be within ±1%.

3.4.2 HORIZONTAL DISPLAY EXPANSION. A sweep magnifier shall be provided to expand any horizontal display sweep by factors of X1, X5, and X25. The X5 expansion accuracy shall be within ±3%. The X25 expansion accuracy shall be within ±5%.

3.5 SWEEP DISPLAYS. The monitor shall provide the following displays of a composite or noncomposite video input signal:

a. Two-field Display

b. Two-line Display

c. Calibrated 0.125 H/cm Display (H = 63.5 μsec)

d. Calibrated 0.25 H/cm Display

e. Delayed Line 0.125 H/cm Display

f. Delayed Line 0.25 H/cm Display

3.6 VIDEO DIFFERENTIAL DISPLAY. A video differential display shall appear on the waveform monitor when the signal input selector switch is in the "Video Input One and Two Differential" position ("A-B" position). The display observed shall be the instantaneous algebraic amplitude difference of two video inputs. The displayed amplitude shall be accurate to within ±1% of the amplitude of the largest input signal.

3.7 CALIBRATION SIGNALS. The monitor shall provide internal calibration signals of 0.714 V and 1.00 V ±1%. A control shall be provided which will permit display of either of the two internal calibration signals.

3.8 CONTROLS

3.8.1 INPUT SIGNAL SELECTION. The monitor shall be capable of selecting and providing displays of each of the following input signals:

a. Video Input Number One,

b. Video Input Number Two,

c. Video Input One and Two Differential or

d. Calibration Signal.

3.8.2 LINE SELECTOR. A line-selector circuit shall be incorporated that will allow detailed analysis of television line waveforms. Any portion of an odd or an even field shall be selectable for examination. The monitor shall provide an output signal containing both the input video signal and line brightening pulse having a level of 0.1 V that may be fed to a picture monitor to identify the line or lines displayed on the waveform monitor.

3.8.3 FIELD SHIFT. A control shall be provided to allow selection of either an odd or an even field when viewing the two-field or delayed sweeps. Random noise or power interruptions shall not shift either field.

3.8.4 DISPLAY CONTROLS. The brightness of the CRT display and of the illumination of the graticule shall be adjustable from front panel controls. A front panel control of focus shall also be available.

3.8.5 LOW-FREQUENCY TILT. Low-frequency tilt to a 60 Hz square wave input signal shall be less than 1% of peak-to-peak amplitude.

3.8.6 POWER SUPPLY REGULATION. A primary source voltage variation of ±10% from the nominal level of 120 V shall not result in a variation greater than 1.0% in the high voltage supplied to the CRT.

3.8.7 DC RESTORATION. A dc restorer shall be provided for stabilization of the blanking pulse backporch at a constant level ±4 IRE units during changes in average picture level from 10% to 90%. The presence of a color burst shall not be distorted, clipped or degraded. A switch shall be provided for bypassing the dc restorer circuit. The capability of the monitor to provide sine wave and square wave displays at approximately 60 Hz shall not be impaired by operation of the dc restorer.

3.8.8 DUTY CYCLE. The television waveform monitor shall be capable of intermittent or continous operation without requiring readjustment.

3.8.9 CATHODE RAY TUBE (CRT). The CRT display device shall be a flat-faced, rectangular tube of 5-inch dimension. It shall have a viewing area of at least 6 x 10 centimeters.

3.8.10 GRATICULE. A graticule, marked in IRE units for composite video signal monitoring, shall be provided with the equipment. The edge lighting of the graticule shall be adjustable in intensity. Additionally, green filtering shall be provided.

3.8.11 MTBF. The television waveform monitor shall have a mean time between failures (MTBF) of 12,000 hours or greater.

## 4.0 TELEVISION DISPLAY EQUIPMENT

Television display equipment shall convert standard television electrical signals into visual displays that accurately reproduce the images obtained from picture generation equipment. The display devices may include direct viewing CRT's or projection systems that present the optical images on front or rear projection screens.

## 4.1 COMMON CHARACTERISTICS

The following characteristics are applicable to monochrome picture monitors, monochrome television projectors and camera viewfinders.

### 4.1.1 VIDEO INPUTS

Television display equipment shall accept composite or non-composite video input signals having form factors as described in Section 1.

#### 4.1.1.1 INPUT IMPEDANCE

a. Bridging Inputs. Video inputs shall be suitable for high impedance bridging with two parallel-connected coaxial input connectors for each video input. The input impedance shall be 50k ohms minimum. Connection between the parallel-connected video inputs shall be accomplished in a manner that will minimize any discontinuitites introduced into 75-ohm coaxial cable by reactive components of the equipment load.

b. Terminating Input. Video input terminals shall be internally terminated in 75 ohms ±2% when activated by a switch.

#### 4.1.1.2 INPUT LEVELS (NORMAL)

a. Composite. The nominal level of a composite picture signal shall be 1.0 V peak-to-peak. The equipment shall meet performance specifications with input levels between 0.25 V and 1.5 V peak-to-peak.

b. Noncomposite. The nominal level of a noncomposite picture signal shall be 0.7 V peak-to-peak. The equipment shall meet performance specifications with input levels ranging from 0.25 V to 1.5 V peak-to-peak.

4.1.1.3 INPUT LEVELS (SURGE)

There shall be no damage to equipment when input levels up to and including 10.0 V peak-to-peak are applied to the video input(s).

4.1.1.4 COAXIAL CONNECTORS

All television equipment coaxial connectors provided for connection to external coaxial cables shall be of the improved BNC type having metal-to-metal clamping.

4.1.2 SYNCHRONIZING INPUTS

Television display equipment shall have provisions for operating from noncomposite video signals and shall accept external synchronizing signals having form factors as described in Figure 2-24h. A manual on/off switch shall be provided to select internal or external synchronization.

4.1.2.1 INPUT IMPEDANCE

a. Bridging Input. Synchronizing inputs shall be suitable for high impedance bridging with two parallel-connected coaxial inputs. The input impedance shall be 50k ohms minimum.

b. Terminating Input. Synchronizing input terminals shall be internally terminated in 75 ohms ±5% when activated by a switch.

4.1.2.2 INPUT LEVELS (NORMAL)

The nominal input level of the synchronizing signal shall be 4.0 V peak-to-peak. The equipment shall meet performance specifications with input levels ranging from 2.0 V to 6.0 V peak-to-peak.

4.1.2.3 INPUT LEVELS (SURGE)

There shall be no damage to equipment when input levels up to and including 10.0 V peak-to-peak are applied to the synchronizing input(s).

4.1.3 VIDEO RESPONSE

4.1.3.1 FREQUENCY RESPONSE

Monochrome Signal. The frequency response to a monochrome signal, between the video input terminal(s) and the driven element(s) which control the electron beam(s), shall be flat ±1 dB from 30 Hz to 10 MHz.

4.1.3.2 LOW-FREQUENCY TILT

The low-frequency tilt to a 60 Hz square wave input signal shall not exceed 1%, as measured at the output of any video channel.

4.1.3.3 DIFFERENTIAL GAIN

The differential gain of any video amplifier at any frequency within the video passband shall not exceed 2%.

4.1.3.4 HUM AND NOISE

The weighted rms value of hum and noise contributed by the display equipment shall be at least 65 dB below the normal peak-to-peak video signal level at the driven element(s) that control the electron beam(s). Weighting shall be accomplished by a network having an insertion loss equal to 10 log $[1 + (\omega\tau)^2]$dB, where $\omega = 2\pi f$, f is in MHz and $\tau = 0.11$ µsec.

### 4.1.4 DC RESTORATION

A dc restorer shall be provided at the output of the final video amplifier(s) of the display equipment. On/off switching shall be provided to remove or insert dc restoration.

### 4.1.5 DISPLAY CHARACTERISTICS

#### 4.1.5.1 SCAN SIZE

The normal scan shall provide a display in which all four corners of the raster are visible. The width and height controls shall have sufficient range to vary the raster size from -10% to +20% without exceeding the specified tolerance for geometric distortion.

#### 4.1.5.2 ASPECT RATIO

The width-to-height ratio of the normal picture shall be 4:3.

#### 4.1.5.3 INTERLACE

The displacement of any scanning line from a center position between lines of the alternate field shall not exceed 10% of the distance between the lines of the alternate field.

### 4.1.5.4 GEOMETRIC DISTORTION

The combined effects of all distortions shall not displace any point on the raster from its correct position by more than a specified percentage of the picture height. The percentage tolerance for monochrome equipment shall be ±1%.

### 4.1.5.5 GRAY SCALE REPRODUCTION

Nine shades of gray and the white background shall be distinguishable in the visual display of a Standard Resolution Chart at the normal brightness level.

APPENDIX A

TEST EQUIPMENT FOR MEASUREMENTS (TELEVISION EQUIPMENT)

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 1 | Not Assigned | |
| 2 | Sine Wave Oscillator | Frequency Range--30 Hz 16 MHz.<br>Output--0 to 10 V, peak-to-peak, into 75 ohms load.<br>Distortion--less than 1%.<br>Frequency Calibration Accuracy--better than 1%.<br>Two or more parallel output terminals.<br>Capability for television blanking addition desirable. |
| 3 | Oscilloscope | The oscilloscope may consist of one wideband high gain unit with appropriate plug-in auxiliary modules, or several different units, each meeting a portion of the stated requirements.<br>Frequency Response--Flat ±0.1 dB 30 Hz to 10 MHz.<br>Rise Time--5 ns max.<br>Sensitivity--10 MV/cm or better.<br>Television line selection capability.<br>Internal Voltage Calibrator--1% accuracy. |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| | | Time Marker Generator--0.1 μsec, 1.0 μsec, 10 μsec.<br>Dual Trace Capability. |
| 4 | Square Wave Generator | Frequency Range--60 Hz to 1.0 MHz.<br>Output Level--0.V to 20 V, peak-to-peak.<br>Low-Frequency Tilt--less than 0.5%.<br>Overshoot--less than 1%.<br>Rise Time--50 ns nominal. |
| 5 | Std Resolution Chart | Standard Chart (available from EIA). |
| 5a | Std Resolution Chart | 35mm Film Slide of Standard Chart (positive). |
| 5b | Std Resolution Chart | Opaque Reduction of chart, 15" x 20". |
| 5c | Std Resolution Chart | Opaque Reduction of chart, 11.25" x 15". |
| 5d | Std Resolution Chart | Opaque Reduction of chart, 7.5" x 5". |
| 5e | Std Resolution Chart | Opaque Reduction of chart, 3.75" x 5". |
| 5f | Std Resolution chart | With EIA Gray Scale overlay strips |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 5g | Std Resolution Chart | 35mm Film Slide of standard chart (negative). |
| 6 | 800 Line Resolution Chart | 800 line wedges at center and corners. |
| 6a | 800 line Resolution Chart | 35mm film slide of chart (positive). |
| 6b | 800 Line Resolution Chart | 35mm film slide of chart (negative). |
| 7 | Monochrome Camera Chain | Resolution--center 800 lines, corners 700 lines, vertical 400 lines. Performance to conform to section 3.0. |
| 8 | Not Assigned | |
| 9 | 35mm Television Slide Projector | High quality commercial projector (with low distortion lens system). |
| 10 | Grating Pattern Generator (also see item #13) | Produces horizontal and vertical bar signals causing a grating pattern on TV displays. Location of bar intersections must correspond precisely with the centers of the "tolerance circles" on a standard Linearity Chart. |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 11 | True RMS Voltmeter | Frequency Response--Flat (±.25 dB) 30 Hz to 10 MHz.<br>Accuracy--±0.25% of full scale.<br>Impedance--over 50k ohms.<br>Multirange--0.1 MV to 10 V full acale.<br>Should respond to rms value of any waveform. |
| 12 | Foot-Lambert Meter | FL Range 5 to 200 full scale.<br>Accuracy ±3% of full scale. |
| 13 | TV Test Signal Generator | |

This is a generic term applied to one generator, or a combination of several individual assemblies required to produce the specialized waveforms employed in television testing. A typical commercial generator can supply such signals as: variable stairstep, stairstep modulated with color subcarrier, multifrequency burst, window (with or without synchronizing signals and with adjustable average picture level); it is also capable of accepting external signals such as sine wave, square wave, sine squared pulses and standard sync, and adding sync or blanking when necessary. The "generator" shall be capable of supplying the following type of signals in the 30 Hz to 10 MHz range:

Composite or Noncomposite
Color Burst
Stairstep
Stairstep modulated with 3.58 MHz
Color Subcarrier
Sine-squared pulses

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| | | Square Wave (with or without blanking)<br>Window<br>Multiburst Frequency<br>Flat White Field<br>Synchronizing Signals<br>Grating |
| 14 | Not Assigned | |
| 15 | Synchronizing | Provides following signals in accordance with Figures 2 - 24h.<br>Horizontal Drive<br>Vertical Drive<br>Blanking (mixed)<br>Composite Synchronizing<br>Color Subcarrier |
| 16 | Vidicon Camera (Alternate, item #7) | Resolution--Center: 800 lines, corners: 700 lines, vertical; 400 lines.<br>Performance to conform to Section 3.0. |
| 17 | Oscilloscope (Alternate, item #3) | Frequency Response--Flat ±0.25 dB 30 Hz to 10 MHz.<br>Line selector capability.<br>Rise Time--0.01 μsec. |
| 18 | Time Mark Generator | Provides time marks for oscilloscope traces at 0.05 and 1.0 μsec. |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 19 | Foot-candle Meter | Multirange--1.0 fc to 200 fc full scale. |
| 20 | Not Assigned | |
| 21 | Waveform Monitor | Performance to conform to Section 3.0 |
| 22 | Monochrome Picture Monitor | Performance to conform to Section 4.0 |
| 23 | Phase Meter | Frequency Range--30 Hz to 10 MHz.<br>Accuracy--±0.2 degree. |
| 24 | Storage Oscillo-scope | Frequency Response--Flat<br>±0.25 dB 30 Hz to 10 MHz.<br>30 Hz to 10 MHz.<br>Writing Speed--at least 400 cm/msec. |
| 25 | Delay Line | Delay 0.5 μsec (fixed or variable).<br>Delay vs Frequency--1%, 1.0 V to 10 MHz. |
| 26 | DC Voltmeter | 20k ohms per volt movement.<br>Multirange--1.0 V to 300 V.<br>Accuracy--±3%. |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 27 | Vacuum Tube Voltmeter | Frequency Response--Flat ±0.25 dB from 30 Hz to 16 MHz. |
| 28 | Oscilloscope, Dual Trace | Same requirements as item 3. |
| 29 | Pulse Generator | Output Voltage--20 V Peak-to-peak.<br>Pulse duration--1.0 μsec.<br>Repetition Rate--20k per second.<br>Output Impedance--75 ohms ±2%. |
| 30 | Not Assigned | |
| 31 | Collimated White Light Source | Typical--"Opaque" projector with tungsten lamp and high reflectrance flat white material as visual source. |
| 32 | Monochrome Film and Slide Camera Chain | Performance to conform to Section 3.0 |
| 33 | Not Assigned | |
| 34 | Not Assigned | |
| 35 | Terminating Resistor | 75 ohms ±1%, one watt, non-inductive. |
| 36 | Not Assigned | |
| 37 | Not Assigned | |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 38 | Not Assigned | |
| 39 | Not Assigned | |
| 40 | Not Assigned | |
| 41 | Not Assigned | |
| 42 | Not Assigned | |
| 43 | Not Assigned | |
| 44 | Not Assigned | |
| 45 | Standard Linearity Chart | EIA Standard. |
| 45a | 35mm Slide of Chart | |
| 46 | Projection Screens | 6 ft. x 8 ft.<br>9 ft. x 12 ft.<br>12 ft. x 16 ft.<br>15 ft. x 20 ft.<br>24 ft. x 32 ft. |
| 47 | Not Assigned | |
| 48 | Not Assigned | |
| 49 | Not Assigned | |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| 50 | Camera, film | Low geometric distortion lens, Lens speed f/3.2 or better. Film fast black and white, ASA $\geq$ 400. |
| 51 | Filter, Low-Pass | Flat ±1 dB -30 Hz to 500 Hz, down 20 dB or greater at 1000 Hz and above. Impedance--over 10k ohms. |
| 52 | Logarithmic Reflectance Chart | Standard "paste-on" EIA Reflectance Chart (4" x 18" scale, mounted on 18" x 24" card). |
| 53 | Neutral-Density Filters (Sets) | Light Attenuation filters of 1%, 10%, 20%, 30%, 50%, 60% and 90% transmittance:<br>(1) Suitable for insertion in camera optical path between visual source and camera lens (Glass mounted).<br><br>(2) Set of 35mm slides in cardboard or glass mounting, suitable for insertion in TV slide projector. |
| 54 | Electronic Counter | Frequency Accuracy--1 part in $10^7$. |

| Item No. | Test Unit | Minimum Performance Requirements |
|---|---|---|
| | | Capability of counting number of pulses occurring during periods from 60 msec to 1½ sec. Frequency Range--0 to 10 MHz. |
| 55 | Not Assigned | |
| 56 | Not Assigned | |
| 57 | Filter, High-Pass | Flat ±1 dB from 2 kHz to 10 MHz, down to 20 dB to greater at 1 kHz and below. Impedance--over 10 k ohms. |
| 58 | Not Assigned | |
| 59 | Test Films | 16mm and 35mm test films in both monochrome and color. |
| 60 | Color Filters (Set) | Red, green blue, magenta, cyan, and yellow saturated filters. Dimensions sufficient to filter light beam from collimated light source (item 31). |
| 61 | "Variac®" Adjustable auto transformer | Capable of providing 120 V ±20% from 120 V input, 60 Hz, at 2 amperes minimum. |
| 62 | Stopwatch | 1/10" increments. |