Amperex® ELECTRONIC CORPORATION
230 DUFFY AVENUE, HICKSVILLE, L. I., N. Y.

TUBE TYPE
8483

The 8483 is a camera tube of the vidicon type intended for use in either black-and-white or color TV cameras in industrial, medical and broadcast applications.

The high sensitivity of the photoconductive layer employed ensures high-quality pictures under normal room-lighting conditions or under the lighting conditions normally encountered in industrial applications.

Its heater consumption of only 0.6 watt makes the tube very suitable for all-transistorized cameras where heat dissipation must be kept at a minimum.

The resolution capability approaches 900 TV lines when the tube is operated with grids No. 3 and No. 4 at 750 volts and a magnetic-focusing field strength of approximately 70 gauss, and will be in excess of 600 TV lines when operated with grids No. 3 and No. 4 at approximately 285 volts and a magnetic focusing field strength of approximately 40 gauss.

GENERAL CHARACTERISTICS

MECHANICAL

Focusing method	magnetic
Delfection method	magnetic
Dimensions	see outline drawing
Base	small-button detetrar 8-pins (JEDEC No. E8-11)
Operating position[1]	any
Weight (approx.)	2.3 oz.

ELECTRICAL

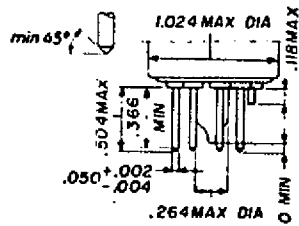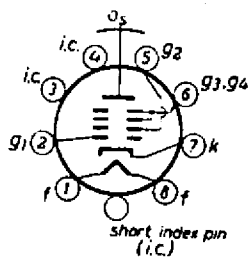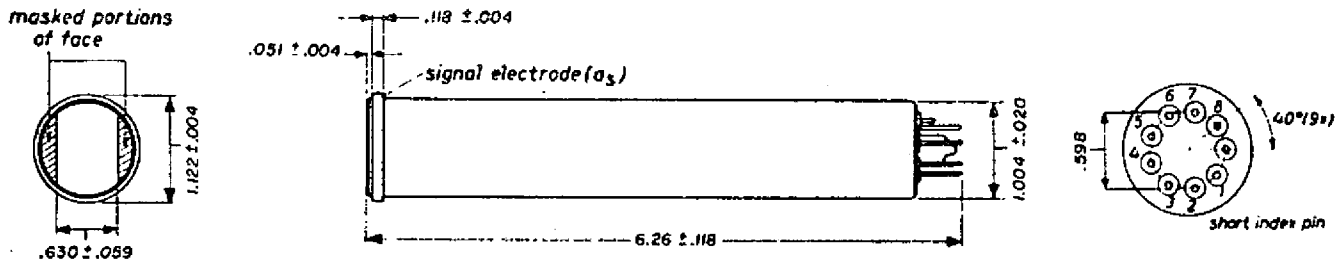|	
Heating	indirectly by AC or DC supply
Heater voltage	6.3 ($\pm$10%) volts
Heater current	90 ma
Capacitance	
Signal electrode to all other electrodes[2]	4.5 pf
Photoconductive layer	
Spectral response	see Figure 7
Useful diagonal of rectangular image (4 : 3 aspect ratio)	0.63 inch max.

Orientation of quality rectangle:
Proper orientation is obtained when the horizontal scan is essentially parallel to the straight sides of the masked portions of the face plate. The masking is for orientation only and does not define the proper scanned area of the photoconductive layer.

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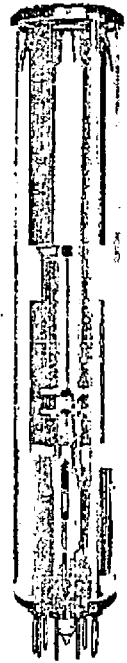
1. When operating at angles below the horizontal, care should be taken not to subject camera to undue shock.
2. This capacitance, which effectively is the output impedance of the 8483 is increased by about 3 pf when the tube is inserted into the deflection and focusing coil-assembly. The resistive component of the output impedance is in the order of 100 megohms.

Amperex

from JEDEC release #4532, Dec. 16, 1963

masked portions
of face

1.122 ±.004

.630 ±.059

.118 ±.004

.051 ±.004

signal electrode (a_s)

6.26 ±.118

1.004 ±.020

.598

40°(9°)

short index pin

a_s

i.c. ④   ⑤ g2

i.c. ③   ⑥ g3,g4

g1 ②   ⑦ k

f ①   ⑧ f

short index pin
(i.c.)

min 65°

1.024 MAX DIA

.118 MAX

.504 MAX

.366 MIN

.050 +.002 −.004

.264 MAX DIA

0 MIN

Mechanical Arrangement

ABSOLUTE MAXIMUM RATINGS

for scanned area of 3/8 inch x 1/2 inch (9.6 mm x 12.8 mm)[3,4]

Grid No. 3 and grid No. 4 voltage	800 volts
Grid No. 2 voltage	350 volts
Grid No. 1 voltage	
Negative bias	-125 volts
Positive bias	0 volt
Peak heater-cathode voltage	
Heater negative with respect to cathode	125 volts
Heater positive with respect to cathode	10 volts
Signal-electrode voltage[5]	100 volts
Peak signal-electrode current[6]	0.6 μa
Faceplate	
Illumination	500 Ft.-C.
Temperature[7]	80°C

OPERATING CONDITIONS AND PERFORMANCE

For scanned area of 3/8 inch x 1/2 inch (9.6 mm x 12.8 mm)
and faceplate temperature of 25-35°C.

PICK-UP FROM LIMITED-MOTION LIVE SCENES

Conditions	
Grid No. 3 and grid No. 4 (beam focus electrode) voltage[8]	250-300 volts
Grid No. 2 voltage	300 volts
Grid No. 1 voltage adjusted for sufficient beam current	
to stabilize highlights	
Minimum peak-to-peak blanking voltage	
when applied to grid No. 1	75 volts
when applied to the cathode[9]	20 volts
Field strength at center of focusing coil (approx.)[10]	40 gauss
Field strength of adjustable alignment coils[11]	0-4 gauss

3. The absolute maximum ratings are limiting values of operating and environmental conditions. The equipment designer should design so that, initially and throughout life, no absolute maximum value can be exceeded under the worst probable operating conditions. No claims for readjustments according to the tube manufacturers' warranty will be accepted for tube failures due to non-adherence to the above stipulations.

4. "Full-size scanning", (i.e., scanning of a 3/8 inch x 1/2 inch area of the photoconductive layer) should always be applied. The use of a mask having these dimensions is recommended. Underscanning, (i.e., scanning of an area less than 3/8 inch x 1/2 inch area) may cause permanent damage to the specified full-size area.

5. The signal-electrode voltage should never exceed 100 volts, either during heating-up or stand-by, or during operation. An excessive signal-electrode voltage may cause permanent damage to the photoconductive layer.

6. Video-amplifiers should be capable of handling signal-electrode currents of this magnitude without amplifier overload or picture distortion.

7. Absolute maximum for shelf-life and operation. Under difficult environmental conditions a flow of cooling air directed at the faceplate is recommended. When televising flames and furnaces appropriate infra-red filters should be applied.

8. Beam focus is obtained by the combined effect of the grid No. 3 voltage, which should be adjustable over the indicated range and a focusing coil having an average field strength of 40 gauss. Definition, focus uniformity and picture quality decrease with decreasing grid No. 3 voltage. In general, grid No. 3 should be operated above 250 volts.

9. In transistorized cameras cathode blanking will be preferable. The cathode impedance is in the order of 30 k ohms.

10. The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

11. The alignment coil assembly should be located on the tube so that its center is at a distance of approximately 3-11/16 inches from the face of the tube and be positioned so that its axis coincides with the axis of the tube, the deflecting yoke and the focusing coil.

PICK-UP FROM LIMITED MOTION LIVE SCENES (Cont.)

Performance

Signal-electrode voltage for dark current of 0.02 μa	
Range[12]	0-100 volts
Typical	40 volts
Grid No. 1 voltage for picture cut-off[13]	-30 to -100 volts
Signal output current, faceplate illumination 0.75 Ft.-C.	
Typical[14]	0.150 μa
Minimum	0.075 μa
Resolution capability in picture center (see Figure 8)[15]	600 TV lines
Decay: 1.32 Ft.-C. on layer, peak white signal of 0.1 μa, rest signal after dark pulse of 200 msec. (typical)	5 %
Average gamma of transfer characteristic for signal output currents between 0.01 and 0.3 μa	0.6
Visual equivalent signal-to-noise ratio (approx.)[16]	300 : 1

PICK-UP FROM FILM (MINIMUM-LAG OPERATION)

Conditions

As under "Pick-up from limited-motion live scenes" with the exception of:

Faceplate illumination (highlight)	47 Ft.-C.

Performance

As under "Pick-up from limited-motion live scenes" with the exception of:

Signal-electrode voltage for a dark current of 0.005 μa	10-20 volts
Signal output current (typical)	0.3 μa
Decay: peak white signal of 0.3 μa, rest signal after dark pulse of 200 msec. (typical)	1 %

OPERATION FOR MAXIMUM RESOLUTION

Conditions

As under "Pick-up from limited-motion live scenes" with the exception of:

Grid No. 3 and grid No. 4 voltage	750 volts
Field strength at center of focusing coil (approx.)[10, 17]	70 gauss

Performance

As in "Pick-up from limited-motion live scenes" with the exception of:

Resolution capability in picture center (approx.)	900 TV lines

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12. The deflection circuits must provide sufficient linear scanning for good black-level reproduction. The dark-current signal being proportional to the velocity of scanning, any change in this velocity will produce a black-level error.
13. With no blanking voltage on grid No. 1.
14. Defined as the component of the signal-electrode current after the dark current has been subtracted.
15. With a video-amplifier system having 7.5 Mc bandwidth (-3 db points).
16. Measured with a peak signal output current of 0.2 μa into a high-gain, cascode input type of amplifier with an own-noise of 0.002 μa rms and a bandwidth of 5 Mc. Because the noise in such a system is predominantly of the high-frequency type, the visual equivalent signal-to-noise ratio is taken as the ratio of the highlight video-signal current to the rms noise current multiplied by a factor of 3.
17. With this mode of operation beam-landing errors, resulting in parabolic shading and dark corners, increase. The deflecting and focusing coils should be designed to eliminate these errors. The increased-power requirements for these coils will increase the tube temperature, adequate provisions for cooling should be made.

PRINCIPLE OF OPERATION

SCHEMATIC ARRANGEMENT

The cutaway arrangement of the vidicon 8483 with its accessories is shown in Figure 1.
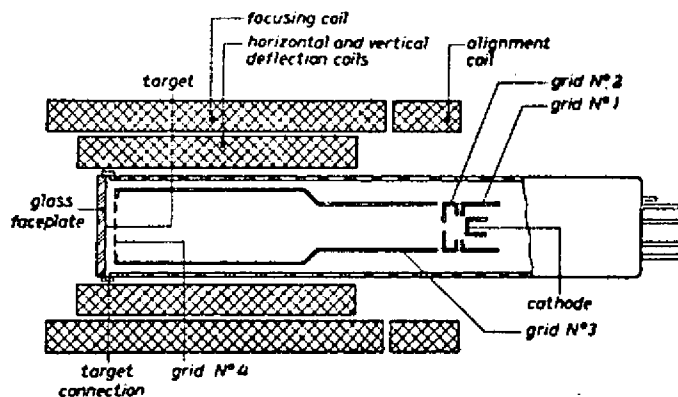

Figure 1. Cutaway Drawing - Electrode
and Coil Arrangement.

The vidicon may be assumed to consist of three sections, namely the electron gun, the scanning section, and the target section.

The electron gun contains a thermionic cathode, a grid, g_1, controlling the amount of beam, and a limiter anode, g_2, which accelerates the electrons and releases them in a fine beam through its diaphragm.

The scanning section. The electron beam released by g_2 enters the space enclosed by the cylindrical anode, g_3. By means of the combined action of the adjustable electrical field of g_3 (beam focus control) and a fixed axial magnetic field produced by the focusing coil, the electrons are focused in one loop on to the target.

The far end of the g_3 cylinder is closed with a fine metal mesh, g_4, electrically connected to g_3, which produces a uniform, decelerating field in front of the target. The focused beam is magnetically deflected by two pairs of deflection coils so that it scans the target. Proper alignment of the beam with the axial magnetic field is achieved by either an adjustable magnet, or, as shown in Figure 1, by two sets of alignment coils producing an adjustable transverse magnetic field.

The target section is illustrated in Figure 2. It consists of:

    a. an optically flat glass faceplate,
    b. a transparent conductive film on the inner surface of the faceplate, connected electrically
        to the external signal-electrode ring.
    c. a thin layer of photoconductive material deposited on the conductive film. In the dark this
        material has a high specific resistance, which decreases with increasing illumination.

The optical image to be televised is focused on the conductive film by means of a lens system.
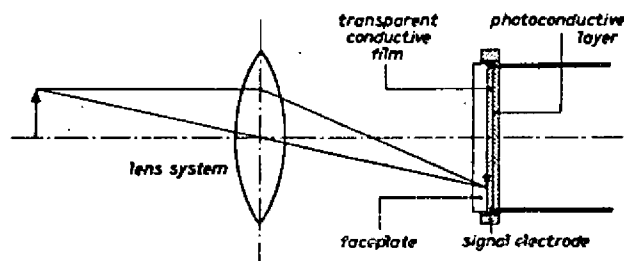

Figure 2. Target Section

OPERATION

The external signal-electrode ring is connected via a load resistor to a positive voltage in the order of 30 volts (see Figure 3).
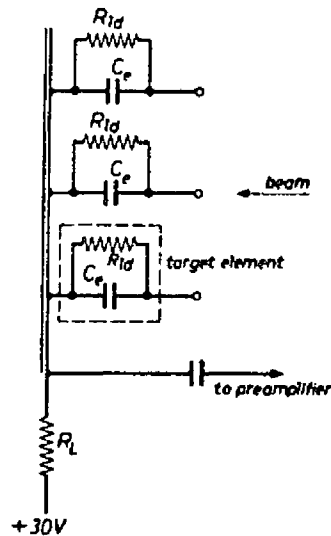

Figure 3.

The target may be assumed to consist of a large number of target elements, corresponding to the number of picture elements, each consisting of a small capacitor (C_e), connected on one side to the signal electrode via the transparent conductive film and shunted by a light-dependent resistor (R_{ld}, see Figure 3).

When the target is scanned by the beam its surface will be stabilized at approximately the cathode potential (low-velocity stabilization) and a potential difference will be established across the photoconductive layer. In other words, each elementary capacitor will be charged to nearly the same potential as applied to the electrode ring.

In the dark, the photoconductive material is a fairly good insulator, so that only a minute fraction of the charge of the elementary capacitors will leak away between successive scans. This charge will be restored by the beam; the resulting current to the signal electrode is termed "dark current".

When an optical image is focused on to the target, those target elements which are illuminated will become more conductive and will be partly discharged. As a consequence a pattern of positive charges corresponding to the optical image will be produced on the side of target facing the gun section.

When scanning this charge pattern the electron beam will deposit electrons on the positive elements until the latter are restored to their original cathode potential, causing a capacitive current to the signal electrode and hence a voltage across the load resistor R_L. This voltage (negative going for the highlights) is the video signal and is fed to the preamplifier.

A vidicon is called "stabilized" when the magnitude of the beam current applied is just sufficient to restore the scanned surface to cathode potential, so that all elementary capacitors, including those at the highlights in the image, are recharged successively.

During the retrace times the beam electrons should be prevented from landing on the target, since, otherwise the scan retraces will appear as dark lines in the picture obtained on the monitor. This may be achieved either by cutting off the beam with suitable negative blanking pulses on the control grid or by cutting off the target with adequate positive blanking pulses applied to the cathode.

EQUIPMENT DESIGN AND OPERATING CONSIDERATIONS

The signal-electrode connection is made by a spring contact, which bears against the metal ring at the face end of the tube. The spring contact may be provided as part of the focusing coil design.

The deflecting yoke and the focusing coil used with the 8483 must be so designed that the beam lands perpendicularly to the target at all points of the scanned area, to ensure high uniformity of sensitivity and focus.

The deflection circuits must provide constant scanning speeds in order to obtain good black-level reproduction. The dark-current signal being proportional to the velocity of scanning, any change in this velocity will produce a black-level error.

The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

The alignment coil assembly should be located on the tube so that its center is at a distance of approximately 3-11/16 inches from the face of the tube and be positioned so that its axis coincides with the axis of the tube, the deflecting yoke and the focusing coil.

The temperature of the faceplate should never exceed 80°C, either during operation or storage of the 8483. Operation at a faceplate temperature of 25 to 35°C is recommended.

The effect of the faceplate temperature on sensitivity and dark current of a typical 8483, measured with illumination level and signal-electrode voltage as fixed parameters, is illustrated in Figure 4.
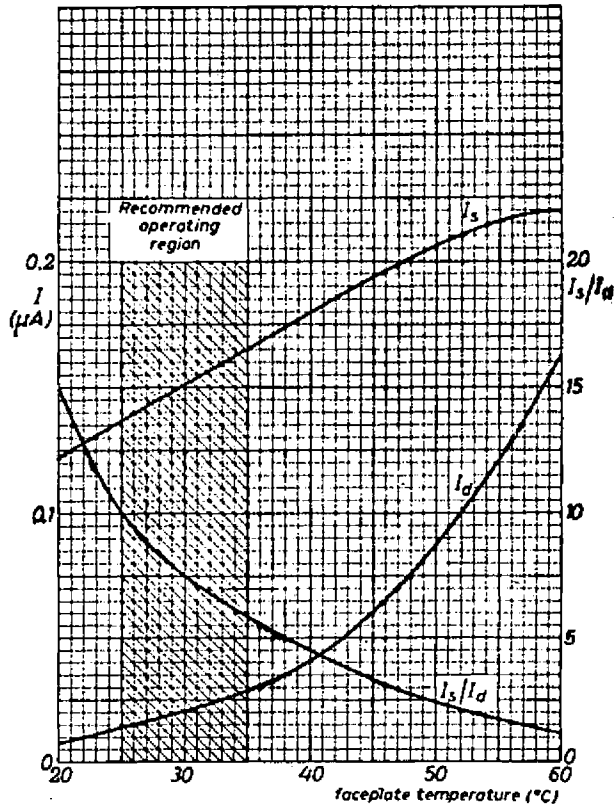

Typical Tube

Signal-electrode voltage and illumination level adjusted for a dark current (I_d) of 0.02 μa and a signal current (I_s) of 0.15 μa at a faceplate temperature of 30°C.

Figure 4. Dark Current vs. Faceplate Temperature

The temperature of the faceplate is determined by the heating effects of the incident illumination, the associated components, the environmental conditions and to a minor extent by the tube itself.

To reduce these heating effects and to permit operation in the preferred temperature range under conditions of high light levels, respectively high ambient temperatures, the use of an infra-red filter between object and camera lens, or a flow of cooling air directed across the faceplate, is recommended.

As the signal-electrode voltage is increased, the dark current and the sensitivity also increase (Figure 5).

Signal Output and Light-transfer Characteristics

The typical signal output as a function of a uniform 2870°K tungsten illumination on the photoconductive layer is shown in Figure 6.
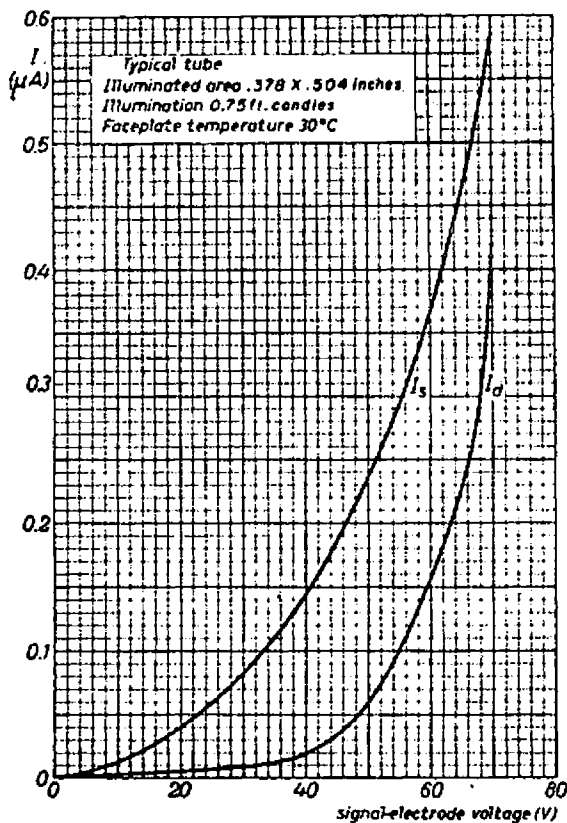

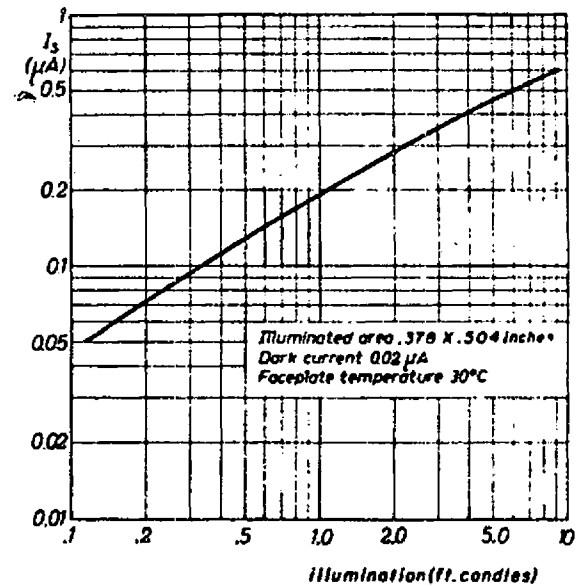Figure 5. Dark Current vs. Signal-Electrode Voltage

Figure 6. Average Signal Current vs. Illumination on the Photoconductive Layer

The average "gamma" of the light-transfer characteristic is approximately 0.6. This value is relatively constant over a signal output range of 0.01 to 0.3 μa.

Sufficient uniformity in the value of gamma is maintained to ensure satisfactory performance of color cameras, in which the signal output currents of three 8483's, with the aid of γ-correcting circuitry, must match closely over a wide range of scene illumination.

The spectral response of a typical 8483 is shown in Figure 7.

The resolution capability of the 8483 is illustrated in Figure 8.

In general the resolution decreases with decreasing grid No. 3 voltage. The voltage range will depend on the design of the focusing coil, which should be such as to provide a field strength within the range of 36 to 44 gauss. Definition, focus uniformity and picture quality decrease with decreasing grid No. 3 and No. 4 voltage. In general grid No. 3 and grid No. 4 should be operated above 250 volts.

As shown in Figures 8 and 9, a substantial increase in both limiting resolution and amplitude response of the 8483 may be obtained by increasing the operating voltage of grids No. 3 and No. 4 to 750 volts. With this mode of operation, the focusing field strength must be increased to approximately 70 gauss.

Since beam-landing errors increase with increasing grid No. 3 and grid No. 4 voltage, such operation will show a reduced signal output in the corners of the scanned area. When the 8483 is operated in this manner, the deflecting and focusing coils employed must be designed to eliminate beam-landing errors.

Compensation of beam-landing errors can be obtained by supplying modulating voltages of parabolic shape and of both horizontal and vertical scanning frequencies to the cathode and additionally, in order to prevent beam-modulation, to grid No. 1 and grid No. 2.
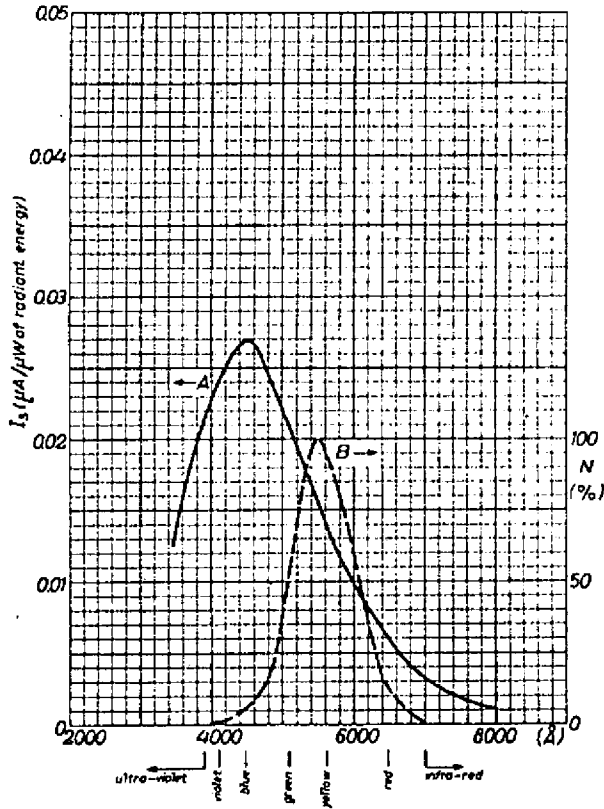

Figure 7. Spectral Sensitivity

A: Spectral sensitivity of 8483
Scanned area = 1/2 inch x
3/8 inch (12.8 mm x 9.6 mm)
Signal current I_s = 0.02 μa
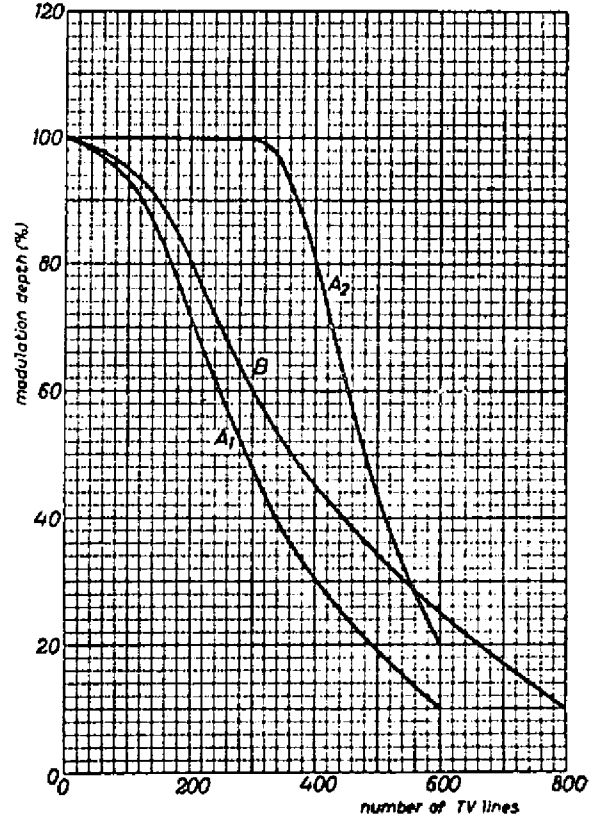
B: Relative spectral sensitivity
of the human eye (N).

Figure 8. Horizontal Square-wave Response of Typical 8483 Vidicon at Picture Center

Highlight signal current = 0.3 μa
Test pattern: transparent square-wave resolution
wedge.
A_1: Uncompensated $V_{g3, g4}$ = approx. 285 V, focusing field strength = 40 gauss
A_2: Compensated
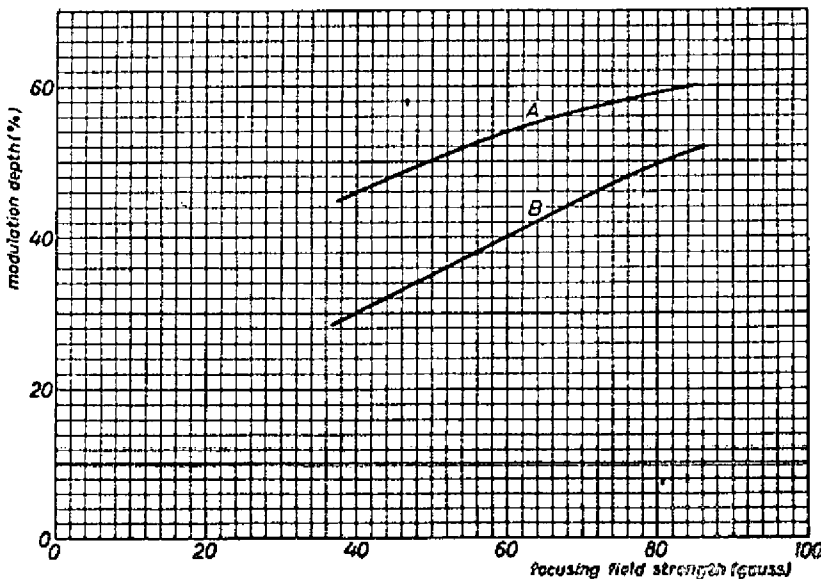B: Uncompensated: $V_{g3, g4}$ = 750 V, focusing field strength = approx. 70 gauss

Figure 9. Average Uncompensated Horizontal Square-wave Response at 400 TV Lines vs. Focusing Magnetic Field Strength

Curve A: Highlight signal
current = 0.1 μa
Dark current = 0.02 μa

Curve B: Highlight signal
current = 0.3 μa
Dark current = 0.02 μa

A suitable amplitude for this mixed parabolic waveform is approximately 4 volts peak-to-peak. The polarity should be chosen such that the potential of the cathode is lowered as the beam approaches the edges of the scanned area. The use of this modulating waveform also improves the center-to-edge focus of the vidicon.

Care must be taken that identical waveforms are applied to the relevant electrodes of each of the three tubes when using the 8483 in 3-color vidicon cameras to ensure good registration of all signals over the entire scanned area.

Operation with grid No. 3 and grid No. 4 voltage at 750 volts and a field strength of 70 gauss demands increased-power requirements for the deflecting and focusing coils which will increase tube temperature unless adequate provisions for cooling are made.

Scanning Amplitude

Full-size scanning of the area of the photoconductive layer should always be applied. To obtain this condition, first adjust the deflection circuits to overscan the photoconductive layer sufficiently so that the edges of the sensitive area can just be seen on the monitor, which itself should not be overscanned.

Then, after centering the image on the sensitive area (see Figure 10), reduce the scanning amplitudes in both directions by 15%.
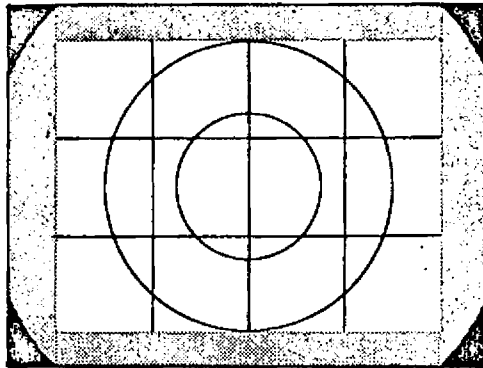

Figure 10. Positioning of the Image on
the Sensitive Area

In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. It should be noted that overscanning of the photoconductive layer produces a picture on the monitor that is smaller than normal.

Underscanning of the photoconductive layer, i.e., scanning of an area of less than 3/8 inch x 1/2 inch (9.6 mm x 12.8 mm) or failure of scanning for even the shortest duration should always be avoided, since this may cause permanent damage to the specified full-size area.