4449A

Image-Converter Tube

S-11 RESPONSE

For Use as a High-Speed Light Shutter in Extremely-High-Speed Photography

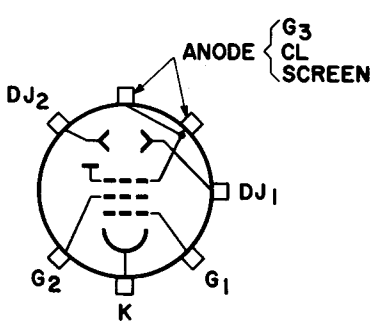
General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Photocathode, Semitransparent:	
Shape	Spherical, Circular
Window:	
Area	9.52 sq.cm (1.48 sq.in.)
Minimum diameter	3.48 cm (1.37 in.)
Index of refraction	1.48
Fluorescent Screen:	
Shape	Flat, Circular
Phosphor	P11[a], Aluminized
Fluorescence	Blue
Phosphorescence	Blue
Persistence[a]	Medium Short
Window:	
Useful deflection area (Approx.)	18 sq.cm (2.8 sq.in.)
Minimum diameter	7.1 cm (2.8 in.)
Index of refraction	1.48
Direct Interelectrode Capacitances (Approx.):	
Grid No.1 to all other electrodes	20 pf
Deflecting electrode DJ1 to deflecting electrode DJ2	1 pf
Deflecting electrode DJ1 to all other electrodes	6 pf
Deflecting electrode DJ2 to all other electrodes	6 pf
Focusing Method	Electrostatic
Deflection Method	Electrostatic
Overall Length	9.87" ± 0.06"
Diameter	3.97" ± 0.07"
Operating Position	Any
Weight (Approx.)	28 oz

Terminal Connections (See *Dimensional Outline*):

G_1 – Grid No.1
G_2 – Grid No.2
DJ1 – Deflecting Electrode No.1
K – Photocathode
DJ2 – Deflecting Electrode No.2
Anode – (Grid No.3, Collector, Screen)

DIRECTION OF LIGHT: PERPENDICULAR TO PHOTOCATHODE END OF TUBE



Maximum Ratings, *Absolute-Maximum Values:*

DC Anode Voltage[b]	15000 max.	volts
DC Grid-No.2 Voltage[b]	2200 max.	volts
Grid-No.1 Voltage[b]	190 max.	volts
Deflecting Electrode Voltage:		
DJ1 and DJ2[c]	±1500 max.	volts
Peak Photocathode Current[d]	0.02 max.	ampere
Photocathode Current Density:		
Peak[d]	0.002 max.	amp/cm^2
Average[e]	0.1 max.	μa/cm^2

Typical Operating Values:

Anode Voltage[b]	15000	volts
Grid-No.2 Voltage[b,f]	1500 to 1900	volts
Grid-No.1 Voltage:[b]		
Operating (Minimum)[f]	110 to 170	volts
Cutoff (Maximum)	-90	volts
Deflection Factor	1050 to 1250	volts/in.

Characteristics:

With conditions shown under Typical Operating Values and at an ambient temperature of 25° C

	Min.	*Typical*	*Max.*	
Photocathode Sensitivity:				
Radiant, at 4400 angstroms	–	0.04	–	amp/watt
Luminous, at 0 cps[g]	2×10^{-5}	5×10^{-5}	–	amp/lumen
Paraxial Image Magnification (Cmx)[h,j]	0.69	–	0.78	
Distortion[h,k]	–	–	0.03	
Paraxial Resolution[b,m]	25	–	–	line-pairs/mm
Edge Resolution[b,m,n]	15	–	–	line-pairs/mm
Radiant Power Gain,[p,q]	50	–	–	
Equivalent Background Screen Brightness Input[r]	–	–	5×10^{-12}	watts/sq.cm
Screen Uniformity Factor[s]	–	–	1.3	
Alignment	–	–	t	

[a] For P11 Spectral-Energy Emission Characteristic curve, see *front of Cathode-Ray Tube, Storage-Tube, & Monoscope Section.* See also accompanying *Operating Considerations.*

[b] Referred to photocathode.,

[c] Referred to anode.

[d] Over an interval not exceeding 1 microsecond.

[e] Averaged over any interval of 8 minutes maximum.

[f] Adjusted to minimize shadowing effects in the displayed image caused by the wires of grid No.1.

[g] For conditions where the light source is a tungsten-filament lamp having a lime glass envelope (Corning Glass Code No.0080, or equivalent). The lamp is operated at a color temperature of 2870° K. A light input of 0.01 lumen is used to irradiate a centered 1/2-inch diameter of the photocathode.

[h] Defined as the ratio of the separation of two diametrically opposite image points on the screen to the separation of the corresponding image points on the photocathode.

j Determined as follows: The image incident on the photocathode is perpendicular to the grid-No.1 wires and consists of 2 parallel lines on a bright background approximately 0.16" in length and separated by a distance of 0.160" ± 0.002". The image on the photocathode is focused and positioned so that the separation between the image lines is an equal distance on both sides of the geometric center of the photocathode. The line spacing on the screen is measured adjacent to the faint image of the center grid-No.1 wire.

k A second magnification value (Emx) is measured under the conditions established in (**j**) except that the lines are separated by a distance of 1.00" ± 0.01". Distortion (D) is defined by the equation:

$$D = \frac{Emx}{Cmx} - 1$$

m Determined with a resolution pattern consisting of horizontal and vertical bars. The limiting resolution value is measured adjacent to the faint image of the center grid-No.1 wire and applies to both vertical and horizontal resolution.

n Measured at the edge of a 1-inch diameter circle positioned concentric with the geometric center of the photocathode under the same conditions established in (**m**).

p Under the following conditions: Light incident on the photocathode is transmitted through a blue filter (Corning C. S. No.5-58 filter from Melt No.5113 polished to 1/2 stock thickness—Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp having a lime glass envelope. The lamp is operated at a color temperature of 2870° K. A 1/2-inch diameter of the photocathode is irradiated and the value of light flux incident on the filter is 0.1 lumen. A calibrated receiver having S-11 spectral response and masked to have a 1/2-inch-diameter aperture is positioned 12 inches from the screen of the 4449A. The output current (I_1) of the receiver is noted. The same receiver is then positioned to receive the radiant flux originally incident on the photocathode and its output current (I_2) is noted. Radiant power gain (G) is defined by the equation:

$$G = 2000 \times \frac{I_1}{I_2}$$

The coefficient 2000 is derived by assuming that the integrated light radiated by the screen is 79 per cent of that value that would be obtained if the light emitted by the screen has a cosine distribution.

q See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this Section.

r Defined as that value of incident radiation required to cause an increase in screen brightness equal to the screen background brightness.

s The ratio of the luminance values of the brightest area to the darkest area of the screen with the entire photocathode uniformly illuminated. The value of incident illumination on the photocathode is 1 footcandle and the light spot on the screen has a diameter of 0.10" ± 0.01".

t A trace produced on the screen, when the center of the photocathode is irradiated with a 0.025-inch diameter light spot and an ac voltage is applied to the deflecting electrodes, will not deviate more than 4° from the plane passing through the center of the recessed ball cap of grid No.1 and the major axis of the tube. The angle produced by the trace and the faint images of the grid wires, that are observed when the photocathode is uniformly illuminated, will be 90° ± 3°.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE is shown at front of this Section

OPERATING CONSIDERATIONS

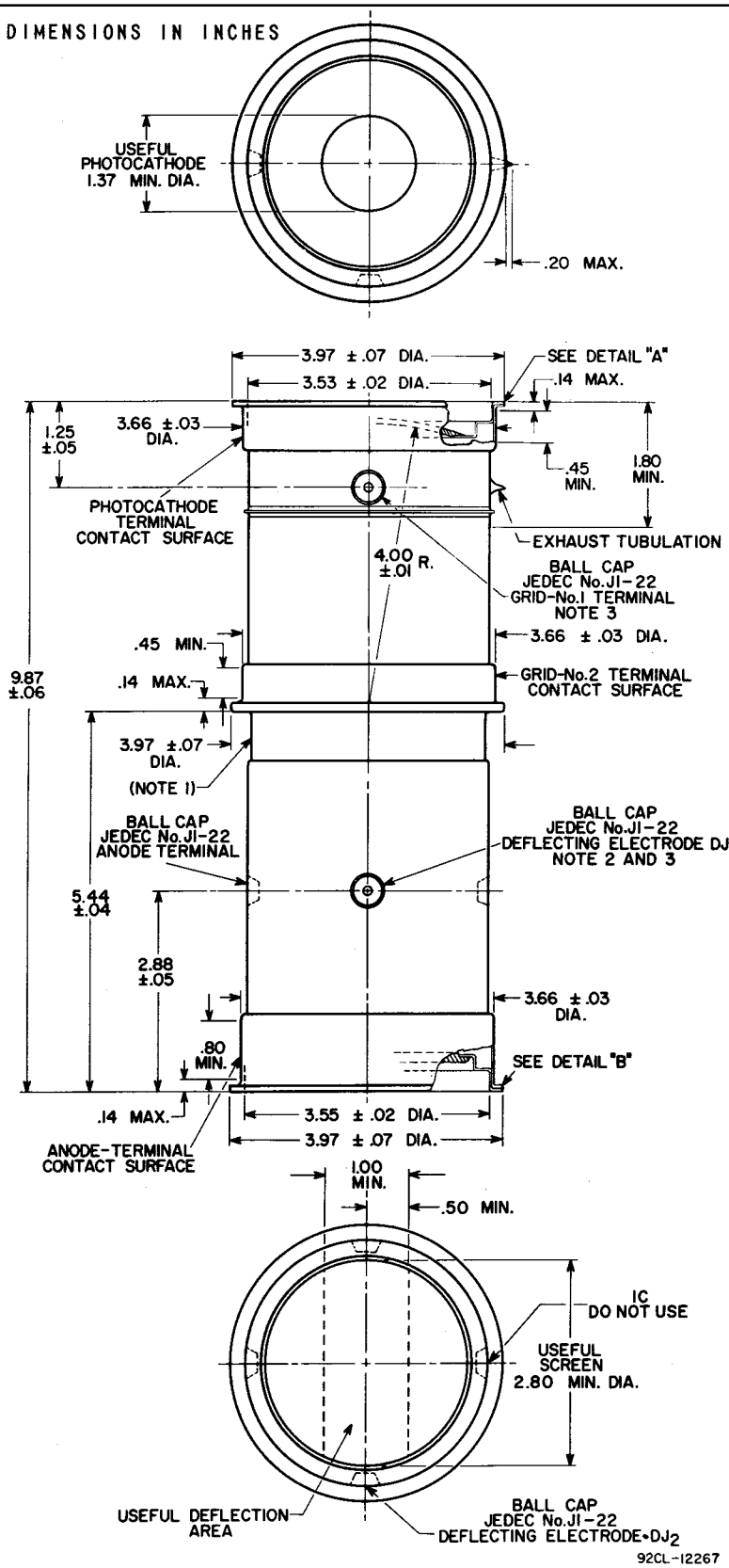
Magnetic shielding of the 4449A is required to minimize the effects of extraneous fields on tube performance; ac magnetic fields are particularly objectionable in that they seriously impair tube resolution. If an iron or steel case is used, care should be taken in its construction to insure that the case is completely demagnetized.

The *P-11 phosphor screen* employed by the 4449A emits high-intensity actinic blue fluorescence and has a persistence characteristic, within the range of 10 microseconds to 1 millisecond, that is dependent on the current density employed.

To *prevent degradation in the resolution of deflected images* care must be taken to assure that the deflecting voltage is free of ac ripple and that shielded semiflexible leads are used for making connection to the deflecting electrode terminals. Balanced deflection with respect to anode should be used.

Exposure Time. In practice, the shutter speeds attainable with the 4449A are limited by the ability of the external circuitry to supply to grid No.1 good rectangular-wave pulses of sufficiently short duration. With perfect pulse-forming circuits, the minimum exposure time of the 4449A is limited by electron transit time which, for an anode voltage of 15 kilovolts, is in the order of 10^{-9} seconds. Electrons are defocused if they are not beyond the influence of the gating (control) grid when its voltage returns to cutoff value at the end of the gating pulse.

The high voltage at which the 4449A is operated may be very dangereous. Great care should be taken in the design of apparatus to prevent the user from coming in contact with the high voltage. Precautions must include safeguards which eliminate all hazards to operating personnel. In the use of high-voltage tubes, such as the 4449A, it should always be remembered that high voltage may appear at normally low-potential points in the circuit because of capacitor breakdown or incorrect circuit connections. Before any part of the circuit is touched, the voltage-supply switch should be turned off and both terminals of any capacitors grounded.



For DETAIL "A" and "B" and notes, see back page.

NOTES FOR DIMENSIONAL OUTLINE

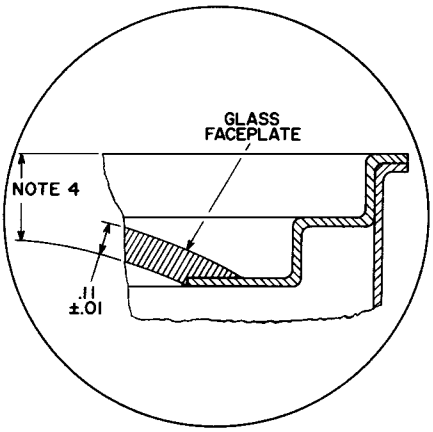
Note 1: Not to be used for mechanical support or electrical connection.

Note 2: The plane passing through the center of the recessed ball cap DJ2 and the major axis of the tube will not deviate more than 3° from the plane passing through the center of the recessed ball cap DJ1 and the major axis of the tube.

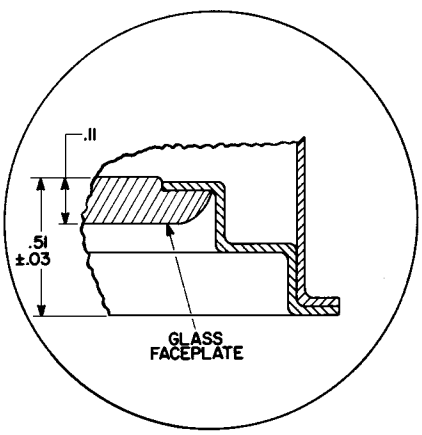
Note 3: The plane passing through the center of the recessed ball cap DJ1 and the major axis of the tube will not deviate more than 5° from the plane passing through the center of the recessed ball cap for grid No.1 and the major axis of the tube.

Note 4: This distance on the major axis of the tube is .33 ± .03.

DETAIL "A"



DETAIL "B"



DIMENSIONS IN INCHES