Image Intensifier Tube

- Variant of 8606 Having Automatic Brightness Control
- Integral Oscillator and Voltage Multiplier
- Fiber-Optic Input and Output Faceplates
- Ruggedized Construction
- ERMA Photocathode
- P20 Phosphor Screen

The 4549 is available with ERMA spectral responses to provide the minimum photocathode sensitivities specified in the table below.

Spectral Response	Luminous – μA/lm	Radiant – mA/W	
		At 800 nm	At 850 nm
ERMA6-1	175	6	1
ERMA12-5	200	12	5
ERMA20-12	225	20	12
ERMA25-15	250	25	15

General Data

Spectral Response . . . . . S-20 with extended red response

Wavelength of Maximum Response . . . . $500 \begin{matrix} +\ 140 \text{ nanometers} \\ -\ 70 \text{ nanometers} \end{matrix}$

Photocathode:

- Material . . . . . Na-K-Cs-Sb (Multialkali)
- Minimum useful area . . . . . 11.1 cm^2 (1.70 in^2)
- Minimum useful diameter . . . . . 37.5 mm (1.47 in)
- Image surface:
  - Shape . . . . . Flat, Circular
  - Material . . . . . Fiber-Optics

Fluorescent Screen:

- Minimum useful area . . . . . 13.8 cm^2 (2.14 in^2)
- Minimum useful diameter . . . . . 42 mm (1.65 in)
- Phosphor . . . . . P20, Aluminized
  - Fluorescence and phosphorescence . . . . . Yellow-Green
  - Persistence . . . . . Medium to Medium Short
- Image surface:
  - Shape . . . . . Flat, Circular
  - Material . . . . . Fiber-Optics

Focusing Method . . . . . Electrostatic

Tube Dimensions:

Maximum overall length . . . . . 12.028 in (302.51 mm)

Maximum diameter . . . . . 3.747 in (95.10 mm)

Operating Position . . . . . Any

Weight (Approx.) . . . . . 4 lbs 8 oz (2.04 kg)

Maximum Ratings, Absolute-Maximum Values:

DC Input Voltage . . . . . 7.0 max. V

Ambient-Temperature Range:

Non-operating . . . . . -54° to +68° C

Operating . . . . . -54° to +52° C

Typical Performance Characteristics

Under conditions with 6.75 volts dc applied and at an ambient temperature of 22° C, unless otherwise noted.

	Min.	Typical	Max.	
Resolution:				
Center[b]	25	35	–	Line-Pairs/mm
Edge[c] (Peripheral)	23	30	–	Line-Pairs/mm
Maximum Screen Luminance (Brightness) See **Figure 3**	–	140	–	fL
Luminance Gain:[d]				
At 22° C	3.5×10^{4}	8×10^{4}	–	fL/fc
At -54° C	2.8×10^{4}	–	–	fL/fc
Equivalent Screen Background Input:				
Luminous[e]	–	–	2×10^{-11}	lm/cm^2
Photocathode Sensitivity:				
Radiant:				
At 470 nm[f]	–	4.6×10^{-2}	–	A/W
At 800 nm	6×10^{-3}	–	–	A/W
At 850 nm	1×10^{-3}	–	–	A/W
Luminous[g]	1.75×10^{-4}	2×10^{-4}	–	A/lm
Luminance Uniformity	–	–	3:1[h]	
Modulation Transfer Function (MTF):[i] (See **Figure 4**)				
For 2.5 Line-Pairs/mm	90	95	–	%
For 7.5 Line-Pairs/mm	55	60	–	%
For 16 Line-Pairs/mm	10	20	–	%

Paraxial Image Magnification (Cmx)[k]	0.82	–	1.0	
Edge Image Magnification[m]	1.0	–	–	
Image Alignment[n]	–	–	0.06	in
Image Stability in 30 Seconds[p]	–	–	0.005	in
Distortion[q]	–	–	21	%

Cathode and Screen Quality Tests

Cathode and screen quality are measured under the following conditions: The photocathode is fully illuminated with the light level adjusted to sharply define on the screen any dark spots, bright spots, streaks, or blemishes. The size and quantities of such spots, streaks, and blemishes are observed by means of a 10-power microscope fitted with a reticle and shall not exceed the size and quantities shown in Table I.

Table I

Size of dark spots, bright spots, streaks, or blemishes observed at screen. Note 1	Number of dark spots, bright spots, streaks, or blemishes		
	Area "A" Note 2	Area "B" Note 3	Area "C" Note 4
Greater than 0.015"	0	0	0
0.012" to and including 0.015"	0	1	2
0.009" to less than 0.012"	0	3	8
0.006" to less than 0.009"	0	12	24
0.003" to less than 0.006"	3	55	Min.
Less than 0.003"	Min.	Min.	Min.

Note 1 – Two spots separated by a distance of less than the maximum dimension of either spot are considered one spot with a size equal to the sum of the maximum dimensions of the two spots plus the distance separating them.

Note 2 – Area "A" is defined as the area within a 0.76 cm (0.30")-diameter circle concentric with the major axis of the tube.

Note 3 – Area "B" is defined as the area bounded by a 0.76 cm (0.30")-diameter circle and a 3.0 cm (1.2")-diameter circle both of which are concentric with the major axis of the tube.

Note 4 – Area "C" is defined as the area bounded by a 3.0 cm (1.2")-diameter circle and a 3.75 cm (1.47")-diameter circle both of which are concentric with the major axis of the tube.

Environmental Testing

The C33088P1 is designed to withstand military environmental requirements of 75 g's shock (peak amplitude), vibration at a frequency of 10 to 55 Hz at a double amplitude of 0.10", and temperature extremes of -54° C to +68° C. Military environmental test procedures can be supplied on request, and customer environmental requirements may be submitted for these devices if desired. Unless requested, environmental tests will not be performed.

b The resolution, both horizontal and vertical, is determined with a test pattern consisting of alternate black and white lines of equal width. Any two adjacent lines are designated a "line-pair."

c This minimum value applies at a distance of 11 mm from the major (optical) axis of the tube.

d Luminance Gain is defined as the quotient of screen brightness in footlamberts by the photocathode illumination in footcandles provided by a tungsten-filament lamp having a lime-glass envelope. The lamp is operated at a color temperature of 2854° K. The value of light input radiation on the photocathode image surface is in the range of 1×10^{-5} to 3×10^{-5} footcandle.

e Defined as the equivalent value of luminous flux from a tungsten-filament lamp operating at 2854° K that would be required to cause an increase in screen brightness equal to screen background brightness.

f For incident radiation at the wavelength of maximum response of the spectral sensitivity characteristic.

g Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. The lamp is operated at a color temperature of 2854° K. The light spot has a minimum diameter of 1.1".

h The light source is a tungsten-filament lamp having a lime-glass envelope. The lamp is operated at a color temperature of 2854° K. Luminance uniformity will not vary more than the ratio stated over a circular area 32.5 mm in diameter centered on the image screen. No distinct line of demarcation between light and dark areas is permitted. Alternatively, tubes will conform to MIL-E-55493 (EL) Uniformity Specification dated 26 November, 1968.

j A two-dimensional resolution pattern, providing constant illumination in the Y direction, and sinusoidal variation of intensity in the X direction is projected on the photocathode. Per cent image modulation M may then be defined as:

$$M = \frac{W - B}{W + B} \times 100$$

where W = maximum illumination in white line
B = minimum illumination in black line

Output image brightness is also a sinusoidal function of the distance across one direction of the pattern, and the output modulation is equal to or less than the input modulation. The modulation transfer function (MTF) is defined as the ratio of the output modulation to input modulation expressed as a function of the spatial frequency of the incident illumination pattern. MTF for the C33088P1 is measured using Modulation Transfer Function Analyzer Model No.K1-b, a product of Optics Technology, Inc., Belmont, CA, using the specified procedure for that instrument.

k Paraxial Image Magnification (Cmx) is defined as the ratio of the separation of two diametrically opposite image points on the screen to the separation of the two corresponding image points on the photocathode. The image points on the photocathode are separated by a distance of 2 mm and are located equal distances from the major axis of the tube.

m Under the same conditions as shown in footnote (k) except the test points on the photocathode are separated by 32 mm.

n The center of an image produced on the screen by focusing a test pattern on the optical axis of the photocathode will fall within a circle concentric with the optical axis of the screen having the specified diameter.

p The center of the image produced on the screen of the tube as specified in footnote (n) will not shift more than the specified value during 30 seconds of operation.

q A second magnification value (Emx) is obtained as stated in footnote (n) except the image points on the photocathode are separated by a distance of 32 mm. Per-cent distortion is defined by the equation

$$\text{Per-cent Distortion} = \frac{Emx - Cmx}{Cmx} \times 100$$

Operating Considerations

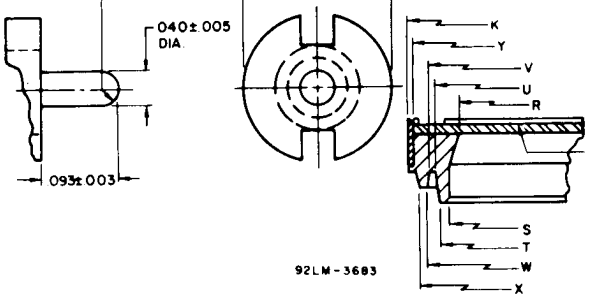
Magnetic shielding of these tubes may be required to minimize the effects of extraneous fields on tube performance. It is to be noted that ac magnetic fields are particularly objectionable in that they seriously impair tube resolution. If an iron or steel case is used, care should be taken to insure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

Response time for the automatic brightness control to adjust to incident illumination is dependent on the level of incident illumination but never exceeds a few seconds. Response time as a function of incident illumination is shown in **Figure 1.**

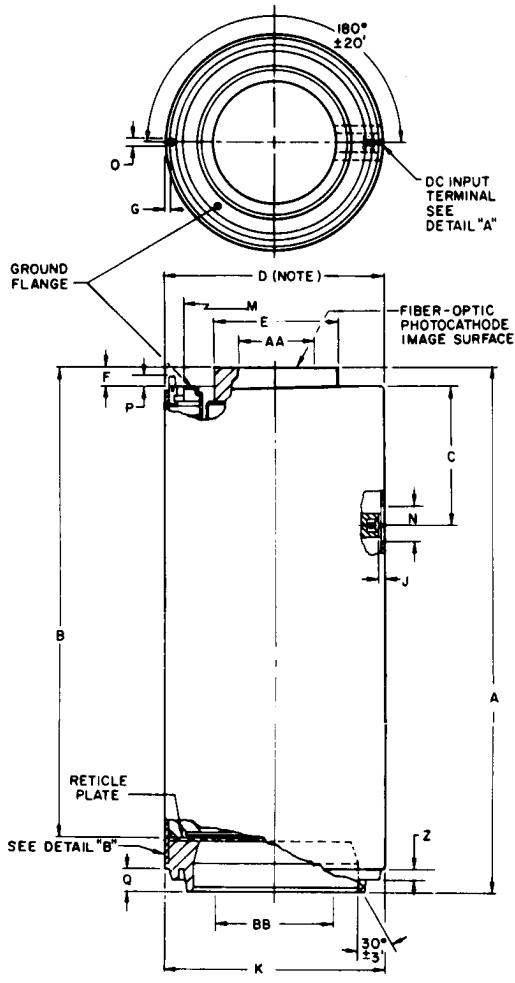
While the gain of the typical 8606 falls rapidly at input illumination levels above 10^{-3} footcandle and falls to unity at approximately 10^{-2} footcandle, the 4549 can operate at input illumination levels up to about 7 footcandles. Screen brightness as a function of incident illumination is shown in **Figure 3.**

The characteristic of **Figure 2** shows battery current as a function of incident illumination. At normal tube operating light levels battery drain is low allowing power conservation.

DIMENSIONAL OUTLINE DETAILS



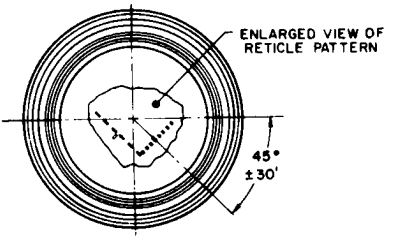
DIMENSIONAL OUTLINE



Note: Dimension applies within 1" of tube end.

DIMENSIONAL OUTLINE

BOTTOM VIEW



OUTLINE DIMENSIONS

Dimensions	Inches		mm	
	Min.	Max.	Min.	Max.
A	11.906	12.028	302.512	305.511
B	11.025	11.115	280.035	282.321
C	2.372	2.398	60.249	60.909
D	3.742 Dia.	3.747 Dia.	95.047 Dia.	95.174 Dia.
E	2.095 Dia.	2.105 Dia.	53.213 Dia.	53.467 Dia.
F	.237	.243	6.020	6.172
G	.082	.092	2.082	2.336
J	.093	.113	2.362	2.870
K	3.737 Dia.	3.747 Dia.	94.92 Dia.	95.10 Dia.
M	2.950 Dia.	3.050 Dia.	74.930 Dia.	77.470 Dia.
N	.620 Dia.	.630 Dia.	15.748 Dia.	16.002 Dia.
O	.120 Dia.	.123 Dia.	3.048 Dia.	3.124 Dia.
P	.208	.218	5.283	5.537
Q	.370	.380	9.398	9.652
R	2.51 Dia.	2.55 Dia.	63.75 Dia.	64.77 Dia.
S	2.781 Dia.	2.791 Dia.	70.637 Dia.	70.891 Dia.
T	2.979 Dia.	2.994 Dia.	75.666 Dia.	76.047 Dia.
U	3.083 Dia.	3.098 Dia.	78.308 Dia.	78.689 Dia.
V	3.245 Dia.	3.260 Dia.	82.423 Dia.	82.804 Dia.
W	3.297 Dia.	3.312 Dia.	83.743 Dia.	84.124 Dia.
X	3.500 Dia.	3.520 Dia.	88.900 Dia.	89.408 Dia.
Y	3.54 Dia.	3.58 Dia.	89.91 Dia.	90.93 Dia.
Z	.183	.193	4.648	4.902
AA	1.47 Dia.	–	37.5 Dia.	–
BB	1.65 Dia.	–	42 Dia.	–

The dimensions in millimeters are derived from the basic inch dimensions (1 inch = 25.4 mm)

RESPONSE TIME FOR SCREEN LUMINANCE (BRIGHTNESS) TO ADJUST TO INCIDENT ILLUMINATION

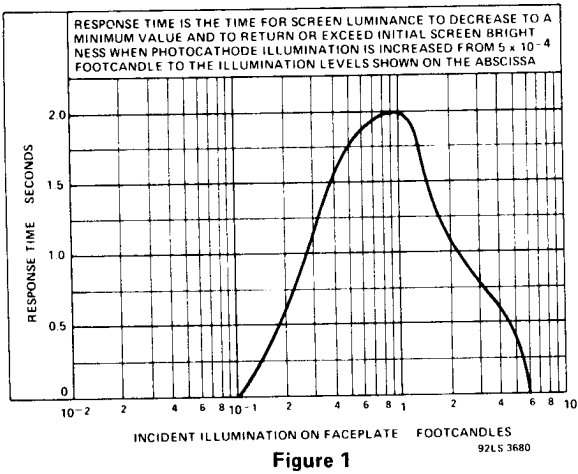


Figure 1

BATTERY CURRENT AS A FUNCTION OF INCIDENT ILLUMINATION

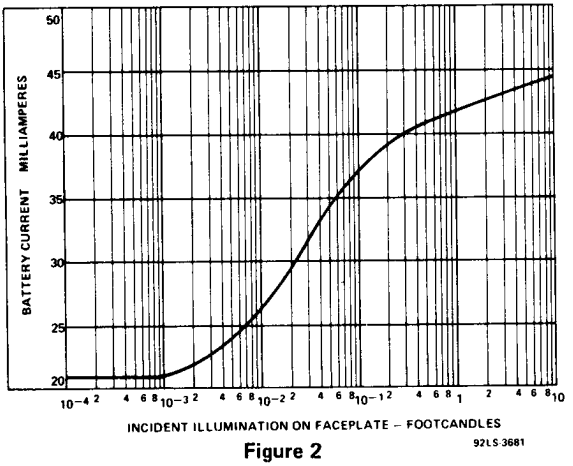
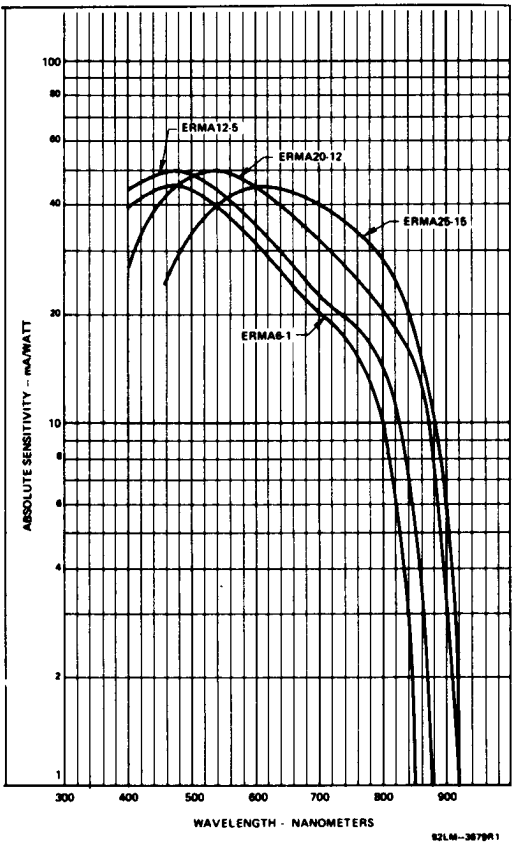


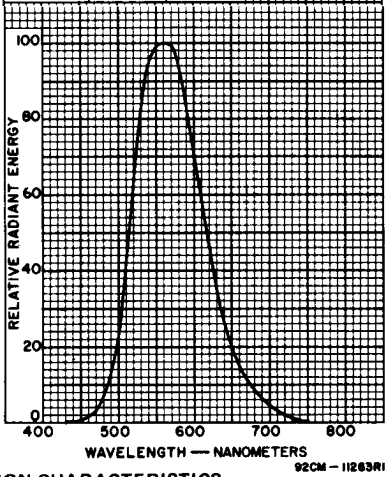
Figure 2

TYPICAL PHOTOCATHODE SPECTRAL RESPONSE CHARACTERISTICS

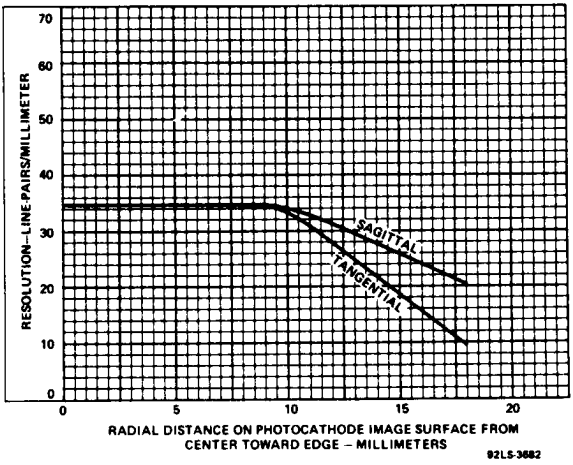


SPECTRAL ENERGY EMISSION CHARACTERISTIC (JEDEC PHOSPHOR P20)

COLOR	C.I.E. COORDINATES	
	X	Y
YELLOW–GREEN	0.426	0.546



TYPICAL RESOLUTION CHARACTERISTICS



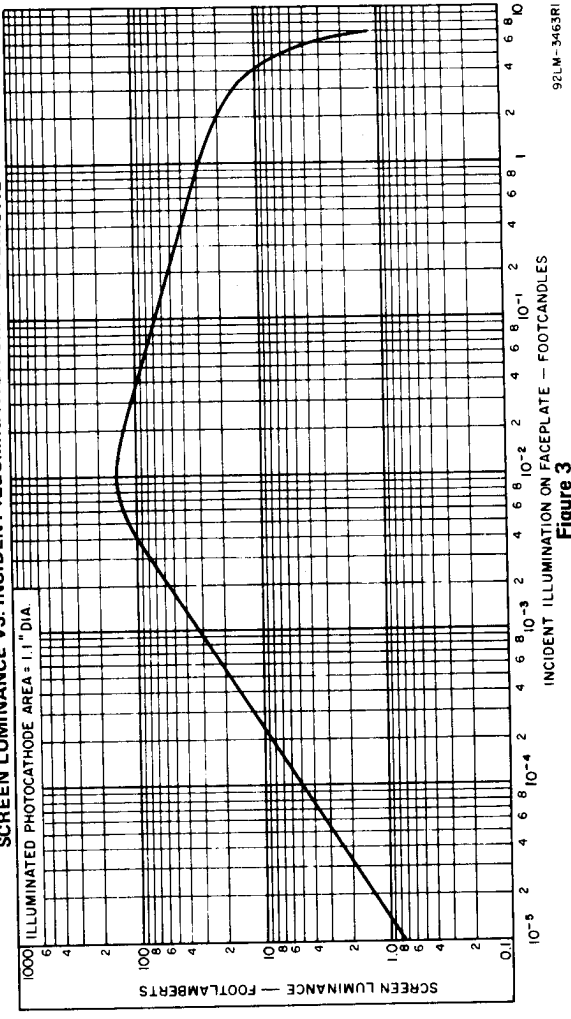

SCREEN LUMINANCE VS. INCIDENT ILLUMINATION CHARACTERISTIC
ILLUMINATED PHOTOCATHODE AREA = 1.1" DIA.
SCREEN LUMINANCE — FOOTLAMBERTS
1000
100
10
1.0
0.1
INCIDENT ILLUMINATION ON FACEPLATE — FOOTCANDLES
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
92LM-3463RI

Figure 3

TYPICAL MODULATION TRANSFER FUNCTION VS. FREQUENCY

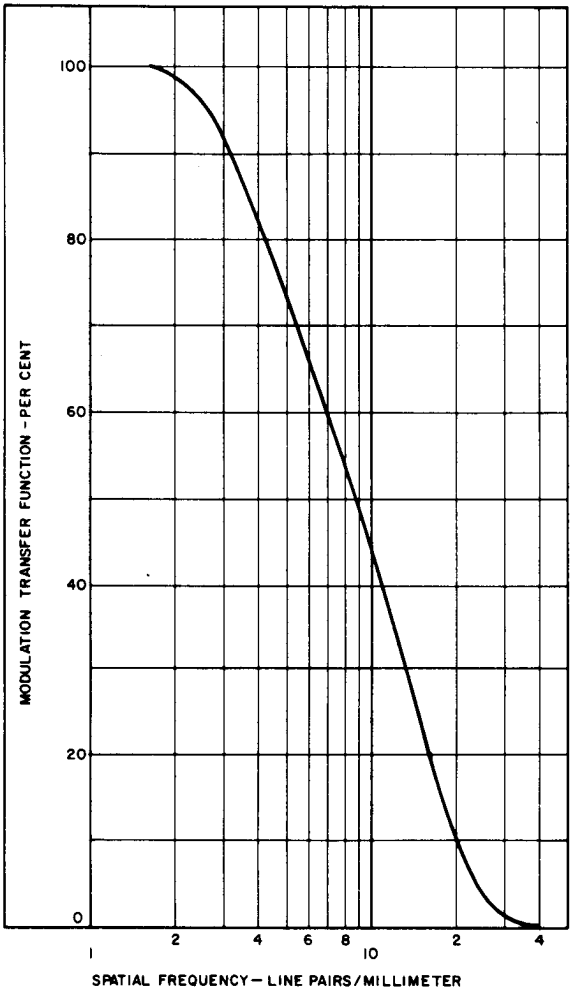


Figure 4

TYPICAL MAGNIFICATION AND DISTORTION CHARACTERISTICS