RCA TUBE HANDBOOK HB-3

PHOTOTUBE SECTION

This section contains data on RCA phototubes having a variety of spectral responses, shapes, and sizes. It includes both gas and vacuum single-unit types as well as multiplier types for diversified applications.

For further Technical Information, write to Commercial Engineering, Tube Department, Radio Corporation of America, Harrison, N. J.

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PHOTOSENSITIVE-DEVICE CLASSIFICATION CHART

When choosing tube types, the equipment designer should refer to the RCA PREFERRED TYPES LIST and its companion list—TYPES NOT RECOMMENDED FOR NEW-EQUIPMENT DESIGN—both of which appear in the General Section

PHOTOTUBES

Response	Single-Unit		Twin-Unit		Multiplier
	Vacuum	Gas	Vacuum	Gas	
S-1	917 919 922 925 6570	1P40 1P41 868 918 921 923 927 928 930 6405/ 1640 6953		920	7102
S-3	926	1P29			
S-4	1P39 929 934 5653 7043	1P37 5581 5582 5583	5652	5584	1P21 931-A 6328 6472 7117
S-5	935				1P28
S-8					1P22
S-9	1P42				
S-10					6217
S-11					2020 5819 6199 6342-A 6655-A 6810-A 7264
Extended S-11					7046
S-13					6903
S-17					7029
S-19					7200
S-20					7265 7326

PHOTOTUBE CLASSIFICATION CHART

When choosing tube types, the equipment designer should refer to the RCA PREFERRED TYPES LIST and its companion list - TYPES NOT RECOMMENDED for NEW EQUIPMENT DESIGN - both of which appear in the General Section.

Response	S-1	S-3	S-4	S-5	S-8	S-9	S-10
SINGLE-UNIT PHOTOTUBES							
Vacuum Types	917⊕ 919⊕ 922□ 925▲	926□	1P39◆ 929 934 5653	935		1P42●	
Gas Types	1P40◆ 1P41● 868 918 921□ 923 924● 927 928* 930	1P29	1P37 5581 5582□ 5583				
TWIN PHOTOTUBES							
Vacuum Types			5652■				
Gas Types	920⊕		5584⊕				
MULTIPLIER PHOTOTUBES							
Vacuum Types			1P21† 931-A 5819●○ 6199●○ 6328 6342●○	1P28	1P22		6217●○

● End type for head-on operation.
⊕ Low-leakage type with anode-terminal cap.
▲ Short type.
■ Twin type having two composite anode-cathodes.
⊕ Twin type having two separate cathodes and two separate anodes.
† For applications involving very low light levels.
◆ For applications critical as to leakage under high-humidity conditions.
○ For applications involving large-area light sources.
◆ Low-leakage type with cathode-terminal cap.
□ Cartridge type.
* Non-directional.

DEFINITIONS
OF PHOTOTUBE TERMS

Current Amplification. Ratio of the output current to the photocathode current, at constant electrode voltages.

Cathode Luminous Sensitivity. The quotient of current leaving the photocathode by the incident luminous flux.

Cathode Radiant Sensitivity. The quotient of current leaving the photocathode by incident radiant energy of a given wavelength.

Luminous Sensitivity. The quotient of output current by incident luminous flux, at constant electrode voltages.

Radiant Sensitivity. The quotient of output current by incident radiant energy of a given wavelength, at constant electrode voltages.

Electrode Dark Current. The electrode current which flows when there is no radiant flux incident on the photocathode.

Equivalent Anode-Dark-Current Input. The quotient of the anode dark current by the luminous sensitivity.

Equivalent Noise Input. That value of incident luminous flux which when modulated in a stated manner produces an rms output current equal to the rms noise current within a specified bandwidth.

PHOTOTUBE SENSITIVITY AND SENSITIVITY MEASUREMENTS

GENERAL CONSIDERATIONS

The range of luminous-sensitivity limits given for a phototube on the data sheets of this Section is that which the tube will display when operated under low-current conditions.

If the tube is to be operated under conditions approaching its maximum-current rating, the equipment design should provide for a wider sensitivity range having a minimum value equal to one-half of that shown for low-current operation. The sensitivity of a phototube under such high-current conditions is dependent upon the tube type, as follows:

1. **Single-Unit and Twin Phototubes**

   a. **Gas Types:** For high-current operation, and particularly in applications in which the type is subjected to these higher values continuously, a drop in sensitivity below the values for low-current operation may be expected, the extent of the drop being affected by the severity of the operating conditions. After a period of idleness, a gas phototube usually recovers most of its initial sensitivity.

   b. **Vacuum Types:** Unlike gas phototubes, this class of phototubes shows negligible drop in sensitivity values for different degrees of illumination and over long periods of use. The output current of a vacuum phototube is a linear function of the exciting illumination under normal operating conditions. The frequency response is flat up to frequencies at which transit-time effects become the limiting factor.

2. **Multiplier Phototubes**

   Although RCA Multiplier Phototubes are vacuum types, a drop in sensitivity is to be expected from this class of phototubes when operated at high anode-current values. The extent of the drop is affected by the nature and severity of the operating conditions to which the tube is subjected. After a period of idleness, the multiplier phototube usually recovers a substantial percentage of this loss of sensitivity.

   Multiplier-phototube-sensitivity values are dependent on the respective amplification of each dynode stage. Hence, large variations in sensitivity can be expected between individual tubes of a given type. The overall amplification of a multiplier phototube is equal to the average amplification per stage raised to the nth power, where n is the number of stages. Thus, very small variations in amplification per stage produce very large changes in overall tube amplification.

   Because these overall changes are very large, it is advisable for designers to provide adequate adjustment of the supply voltage per stage so as to be able to adjust the amplification of individual tubes to the desired design value. It is suggested that an overall voltage-adjustment

(continued on next page)

range of at least 2 to 1 be provided. When the output current can be controlled by change in the illumination of the photocathode of the multiplier phototube, the required range of adjustment in the voltage per stage can be reduced.

SENSITIVITY MEASUREMENTS

The luminous-sensitivity values shown on the data pages of this Section are measured according to the following procedures:

1. Single-Unit and Twin Phototubes

a. Gas Types: The light source consists of a tungsten lamp operating at a filament color temperature of 2870°K. For the 0-cycle measurements, a light input of 0.1 lumen is used, unless otherwise specified. For the 5000- and 10000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean. For all measurements, a dc anode-supply voltage of 90 volts and a 1.0-megohm load resistor are employed. Under these conditions, the effect of tube capacitance is negligible.

b. Vacuum Types: The light source consists of a tungsten lamp operating at a filament color temperature of 2870°K. A steady light input of 0.1 lumen is used, unless otherwise specified, together with a dc anode-supply voltage of 250 volts and a 1-megohm load resistor.

2. Multiplier Phototubes

The light source consists of a tungsten lamp operating at a filament color temperature of 2870°K. A light flux of 10 microlumens from a rectangular aperture approximately 0.8" long and 0.2" wide is projected normal to the cathode in the direction noted on the basing diagram and outline. The load resistor has a value of 0.01 megohm. The applied voltages are specified on the individual data sheets.