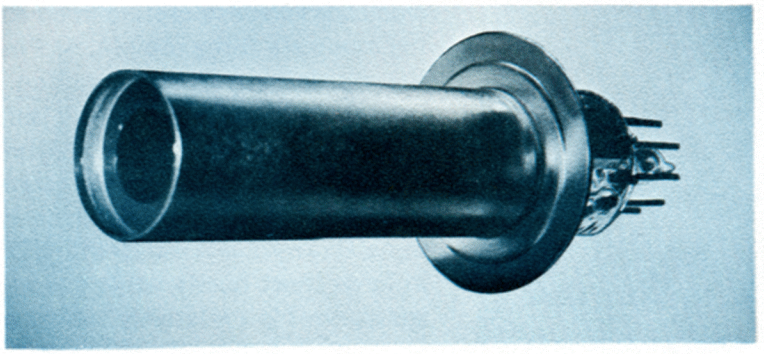
Channeltron® Ultraviolet Photon Counter Tube

Model No. BX 760



DESCRIPTION

The Bendix BX 760 Ultraviolet Photon Counter Tube* is a small high gain, very low-noise Bendix photomultiplier tube which employs a Channeltron® electron multiplier to provide electron gain. This tube has been especially designed for counting single photoelectron events resulting from far ultraviolet radiation; it is unique in that it exhibits a typical dark count rate of less than one count per ten seconds at room temperature when care is taken to minimize extraneous noise sources. The noise from the channel electron multiplier which amplifies the photoelectron current is extremely low. (1—3) This factor coupled with the very low thermionic emission from cesium iodide results in a noise count of the magnitude one would expect from cosmic background radiation.

FEATURES

The tube employs a front-surface (opaque) cesium iodide photocathode deposited on the inner surface of the extended cone Channeltron electron multiplier. The photocathode surface is externally processed; thus, the possibility of cesium contaminating the tube is eliminated, assuring a solar blind characteristic. A bias potential applied to the cone results in a unity collection coefficient when the tube is operated in the pulse counting mode. The combined characteristics of the sapphire window and cesium iodide photocathode give the tube a useful working range from 1900 Å to 1450 Å. The capped anode connection reduces the number of electrical leads required.

APPLICATIONS

The combination of high gain, narrow pulse height distribution, very low dark count rate, and the cesium iodide photocathode make the Bendix BX760 ideal for detecting weak ultraviolet fluxes in the presence of high visible radiation; e.g., such sources as flames, corona discharges, rocket exhaust, explosions, and other UV generators in a high ambient background. The BX 760 is also an excellent atomic absorption line detector in the 1450 Å to 1900 Å range, and it can serve as a secondary standard in this range for measuring weak ultraviolet fluxes. The minimum measurable photon flux (photons per second) of the Bendix BX 760 is better by two orders of magnitude than any other known device sensitive to these wavelengths. Operated as a pulse counter, the measured count is practically insensitive to applied voltage variations and delivers an unambiguous high level pulse using simple post-electronics.

SPECIAL FEATURES

- **CsI Front Surface Photocathode**
- **Sapphire Window**
- **Channeltron® Electron Multiplier**
- **Solar Blind**
- **Very Low Dark Noise Without Cooling**
- **Insensitive To Voltage**
- **Narrow Pulse Height Distribution**
- **Only Three Active Terminals**
- **Relatively Insensitive To Magnetic and Electrostatic Fields**

*Patent No. 3128408

Bendix Research Laboratories

Typical Operation

FIG. 1

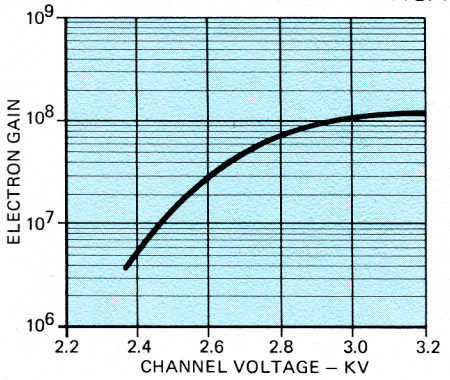


FIG. 2

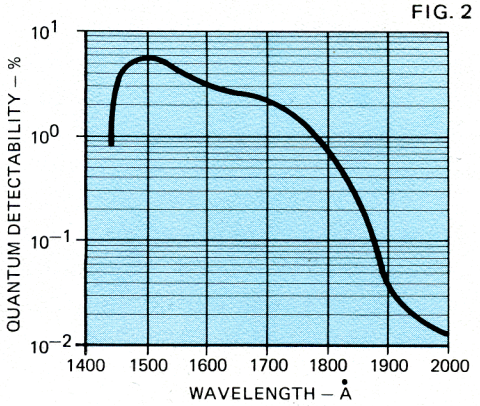


FIG. 3

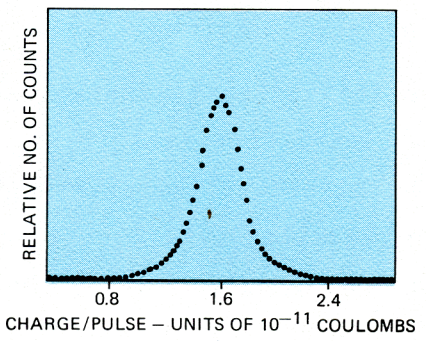
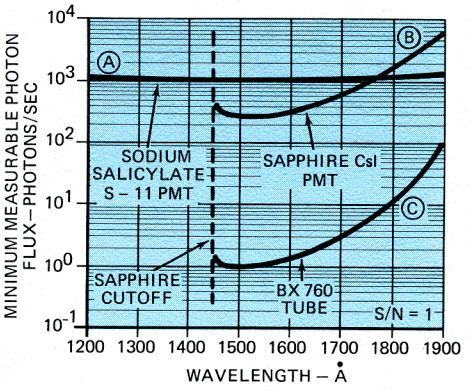


FIG. 4



The advantages of counting photoelectrons versus operating in an analog mode are three fold: (4, 5) First, the multiplier gain as a function of voltage is very stable once a sufficient gain level is attained. Second, leakage current can be separated from true signal current, since the signal current arrives at the anode in large short bursts while the leakage current is a relatively steady signal. Third, extremely low level signals can be conveniently counted over an extended period of time, in contrast with other electrometer-type instruments which are cumbersome and inflexible.

When the BX 760 tube is operated at high gain in the "uniform mode," the distribution of output pulse charge amplitudes for individual input photoelectron events departs from the quasiexponential curve characteristic of an ordinary photomultiplier and becomes a narrow peaked distribution centered at about 10^{-11} coulomb (Figure 3). Such a charge pulse, when detected with ordinary pulse counting circuitry, will insure output counts for over 99 percent of all pulses at an output discrimination threshold of 10^{-12} coulomb. The graphs show the extremely high count efficiency and stability this mode of operation provides, even for large changes in electron multiplier voltage.

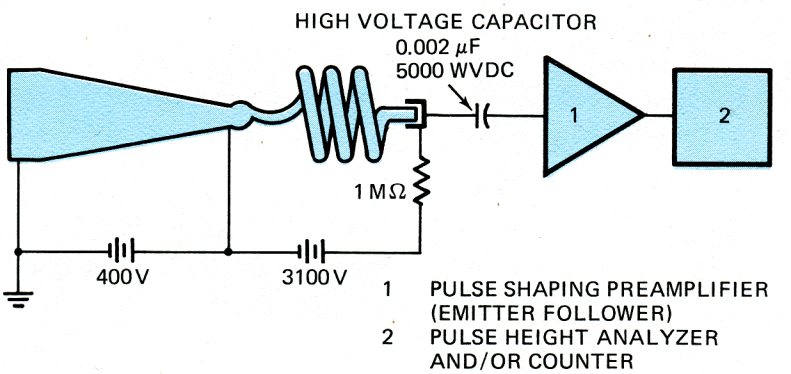
In Figure 4, the minimum detectable photon flux of the BX 760 tube is compared to those of two other common detectors used at these wavelengths. Typical values of dark count and sensitivity were used in this calculation—gain is not relevant since all calculations are referred to the photocathode. Since there is a degree of arbitrariness about setting discrimination levels in discrete dynode photomultiplier tubes (curves A and B), the typical D-C dark current was divided by the D-C gain to obtain equivalent dark electrons per second from the photocathode. Using a typical value of sensitivity, these can be converted to an equivalent number of photons per second at each wavelength. These are the values plotted in Figure 4.

An important point to note in using the BX 760 is that high sensitivity is obtained at the expense of the high count rate capability. When operated at a high gain, the tube should not be exposed to count rates in excess of 10^5 per second for long periods of time, although it will stand momentary exposures of 10^6 counts per second.

AVAILABILITY

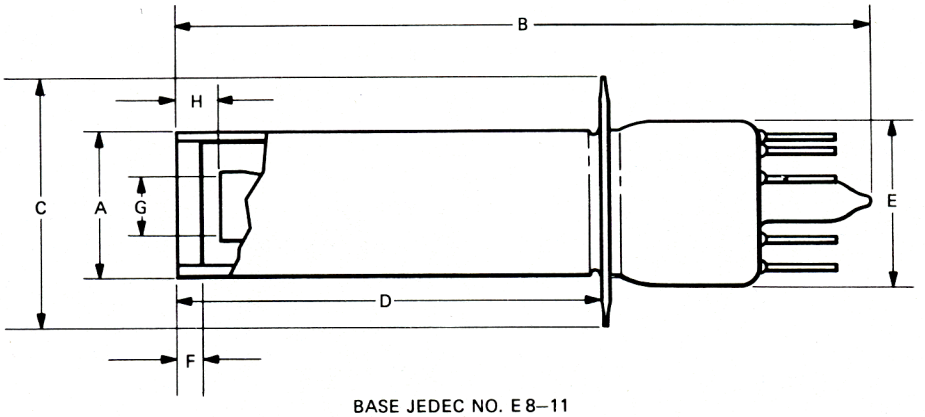
At this time, the tube is in pilot production and is currently available from Bendix Research Laboratories. Delivery is available from stock to 60 days.

FIG. 5



1 PULSE SHAPING PREAMPLIFIER (EMITTER FOLLOWER)
2 PULSE HEIGHT ANALYZER AND/OR COUNTER

Specifications



BASE JEDEC NO. E 8–11

BX 760 DIMENSIONS

A = 0.900 ± 0.005″
B = 4.55 ± 0.10″
C = 1.60 + 0.010″
– 0.150″
D = 2.76 ± 0.04″
E = 1.00 ± 0.040″
F = 0.125″ (Nominal)
G = 0.500 ± 0.005″
H = 0.225 ± 0.025″

INPUT WINDOW

Material	Sapphire
Thickness	0.125″ (Nominal)

PHOTOCATHODE

Material	CsI
Usable Diameter	0.500 ± 0.005″
Spectral Response (With Sapphire Window)	1450 Å to 1900 Å

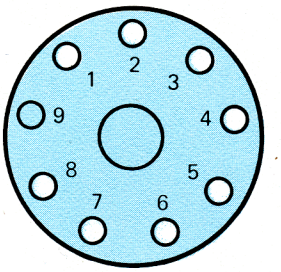
GENERAL

Weight	55 ± 10 Grams
Typical Operating Voltages:	
Cone Bias	400 Volts
Channeltron Multiplier	3100 Volts

TYPICAL PERFORMANCE CHARACTERISTICS

Wavelength of Maximum Response	1500 Å
Quantum Efficiency at Maximum Response Wavelength	5%
Quantum Efficiency at 2537 Å	3×10^{-6}
Quantum Efficiency at 3160 Å	Less Than 4×10^{-7}
Luminous Sensitivity (Tungsten Lamp at 2870°K)	Less Than 9000 Counts/Second-Lumen
	(Less Than 2 Counts/Second-Lumen With 4000 Å Cutoff Corning No. 3341 Visible-Pass Filter)
Dark Counts at 3100 Volts	Less Than 1 Count per 10 Seconds
Output Charge per Photoelectron at 3100 Volts	10^{-11} Coulomb

BASING DESIGNATION



1. CHANNEL OUTPUT
2. DO NOT USE
3. DO NOT USE
4. CONE INPUT
5. CHANNEL BIAS
6. DO NOT USE
7. DO NOT USE
8. DO NOT USE
9. SHORT PIN

SOCKET – CINCH TYPE 8VT OR EQUIVALENT

ACCESSORY EQUIPMENT

Miniature electronic circuitry designed to optimize the special advantages of the BX 760 ultraviolet Photon Counter Tube is available from the Bendix Research Laboratories. The following circuitry is available packaged for various environments, including space applications:

FOR PHOTON COUNTING APPLICATIONS

- **Power Supplies**
- **Charge Pulse Amplifiers**
- **Gating Circuits**

A complete capability for supplying custom optical assemblies is also available. Your inquiries are invited regarding these products, as well as specific electro-optical packages tailored to your needs.

For additional information contact:

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General Science and Technology Laboratory
Bendix Research Laboratories
20800 10½ Mile Road
Southfield, Michigan 48075
(Area Code 313: 353–3500)

REFERENCES

1. D. S. Evans, "Low Energy Charged-Particle Detection Using Continuous Electron Multiplier," Rev. Sci. Instr., Vol. 36, No. 3, p. 375, March 1965
2. W. C. Wiley and C. F. Hendee, "Electron Multipliers Utilizing Continuous Strip Surfaces," IRE Trans. Nucl. Sci., Vol. NS–9, 3, p. 103, June 1962
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