

### 3" Diameter Circular Envelope Position-Sensitive PMT with Crossed Wire Anodes For Nuclear Medical Instruments, High Energy Physics Experiments



#### Introduction

The R2486 series have a bialkali photocathode, a 12-stage coarse mesh dynode structure, and multiple anode wires crossing one another in the X and Y directions. Output signals from each anode can be divided through external resistive chains and derived from X and Y electrodes as the position signals. This crossed-wire anode construction features high spatial resolution, high position linearity, and easy signal processing for scintillation imaging. A 5-inch diameter type R3292 is also available.

#### The R2486 series enables the acquisition of 2-dimensional information with a single tube.

Until now, the task of obtaining 2-dimensional information required the use of an arrangement of multiple PMTs. This approach was costly and required complex hardware. The R2486 series were developed as position-sensitive PMTs to enable this information acquisition with a single tube.

#### Applications

- Compact Gamma Camera
- Animal PET
- Radiation Imaging

#### Voltage divider circuit and resistive chains for signal processing simplify connection to measuring instruments.

The following versions are available to handle various applications.

1. R2486: Flying lead type (Fig. 9)
2. R2486-01: Provided with high-voltage divider circuit; enables direct reading of signals from each anode through an IC socket. (Fig. 10)
3. R2486-02: Provided with high-voltage divider circuit and resistive chains for signal processing, simplifying connection to external devices. (Fig. 11)
4. R2486-03: Variant type of R2486-02 having HA coating and  $\mu$ -metal shielding. (Fig. 12)
5. R2486-04: Variant type of R2486-03 with the aluminum case. (Fig. 13)

# POSITION-SENSITIVE PHOTOMULTIPLIER TUBES R2486 SERIES

## GENERAL

Parameter		Description/Value	Unit
Spectral Response		300 to 600	nm
Wavelength of Maximum Response		420	nm
Photocathode Material		Bialkali	—
Window	Material	Borosilicate glass	—
	Shape	Plano-plano	—
	Thickness	3.0 ± 0.3	mm
	Index of Refraction at 420 nm	1.5	—
Dynode	Structure	Coarse mesh	—
	Number of Stages	12	—
Anode Number of Wires		16 (X) + 16 (Y)	—
Effective Area		φ50	mm

## MAXIMUM RATINGS

Parameter		Value	Unit
Supply Voltage Between Anode and Cathode		1300	V dc
Average Anode Current <sup>(A)(H)</sup>		0.1	mA
Ambient Temperature	R2486	-80 to +50	°C
	R2486-01, -02, -03, -04	-30 to +50	

## CHARACTERISTICS (Typ. at 25 °C)

Parameter		Value	Unit
Cathode Sensitivity	Luminous <sup>(B)</sup>	80	μA/lm
	Radiant at 420 nm	72	mA/W
	Blue Sensitivity index (CS 5-58) <sup>(C)</sup>	9.0	—
	Quantum Efficiency at 390 nm (peak)	23	%
Anode Sensitivity <sup>(D)</sup>	Luminous	40	A/lm
	Radiant at 420 nm	36 × 10 <sup>3</sup>	A/W
Gain <sup>(D)</sup>		5.0 × 10 <sup>5</sup>	—
Anode Dark Current <sup>(E)</sup>		20	nA
Time Response <sup>(D)</sup>	Rise Time <sup>(F)</sup>	5.5	ns
	Electron Transit Time <sup>(G)</sup>	17	ns

## NOTES

- (A): Averaged over any interval of 30 seconds maximum.
- (B): The light source is a tungsten filament lamp operated at a distribution temperature of 2856K. Supply voltage is 150 volts between the cathode and all other electrodes connected together as an anode.
- (C): The value is cathode output current when a blue filter (Corning CS No. 5-58 polished to 1/2 stock thickness) is interposed between the light source and the tube under the same condition as Note (B).
- (D): Measured with the same light source as Note (B) and with the anode-to-cathode supply voltage and voltage distribution ratio shown in Table 1.
- (E): Measured with the same supply voltage and voltage distribution ratio as Note (D) at 30 minutes after removal of light.
- (F): The rise time is the time for the output pulse to rise from 10 % to 90 % of the peak amplitude when the entire photocathode is illuminated by a delta function light pulse.
- (G): The electron transit time is the interval between the arrival of a delta function light pulse at the entrance window of the tube and the time the output pulse reaches the peak amplitude. In measurement the entire photocathode is illuminated.
- (H): In the case of R2486

**Table 1: Voltage Distribution Ratio and Supply Voltage**

Electrodes	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	Dy11	Dy12	P
Distribution Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Supply Voltage: 1250 V dc, K: Cathode, Dy: Dynode, P: Anode

Figure 1: Typical Spectral Response

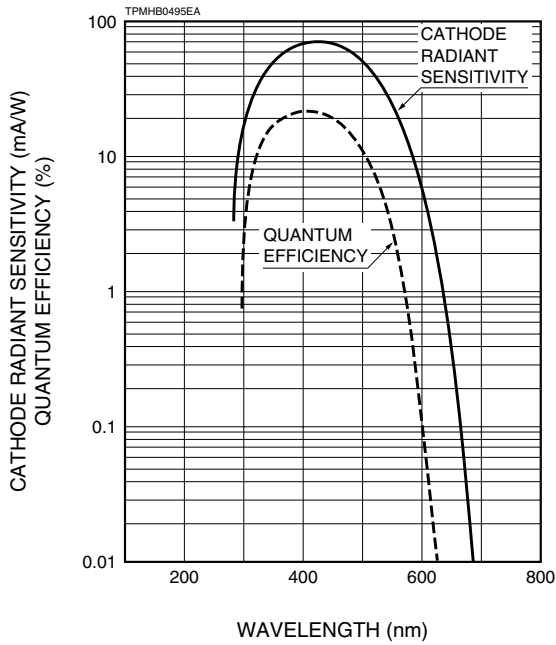


Figure 2: Typical Gain

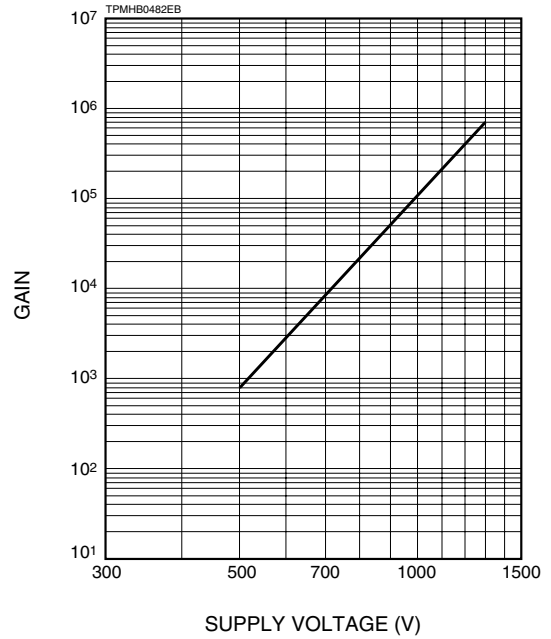


Figure 3: Example of Spatial Resolution

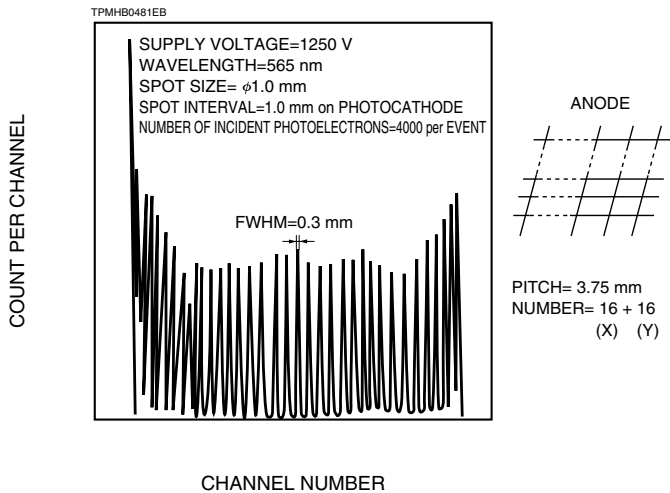
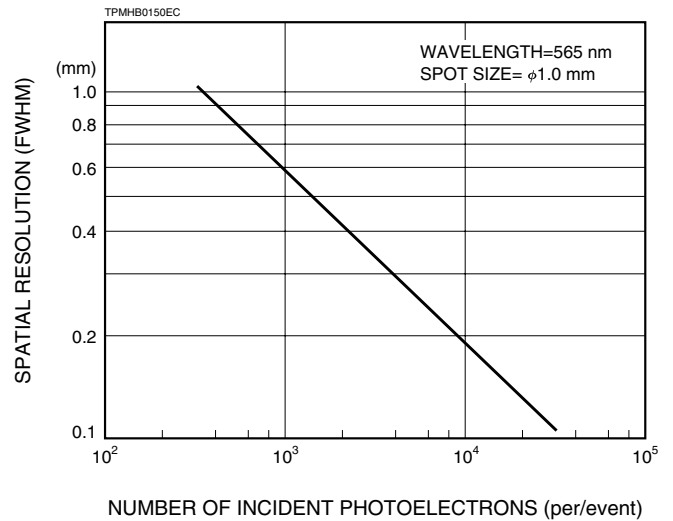


Figure 4: Example of Spatial Resolution as a Function of Incident Photoelectrons



**NOTE:**

The above data is measured with spot light source.  
The spot size is 1 mm in diameter, and the wavelength is 565 nm.  
The light is operated in pulse mode so that light intensity of 4,000 photoelectrons is obtained.  
The light source is scanned with 1 mm step on the photocathode, the output signal is calculated and plotted in accordance with the position of the light source.  
The fluctuation of the position signal is 0.3 mm at FWHM.

# POSITION-SENSITIVE PHOTOMULTIPLIER TUBES R2486 SERIES

Figure 5: Spatial Resolution

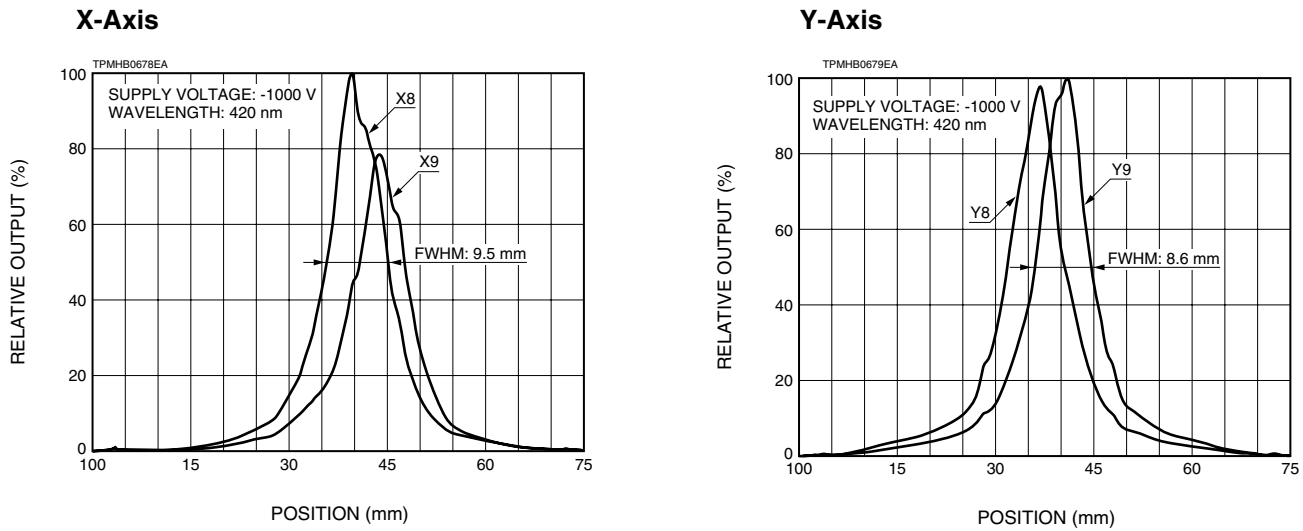


Figure 6: Test Condition of Spatial Resolution

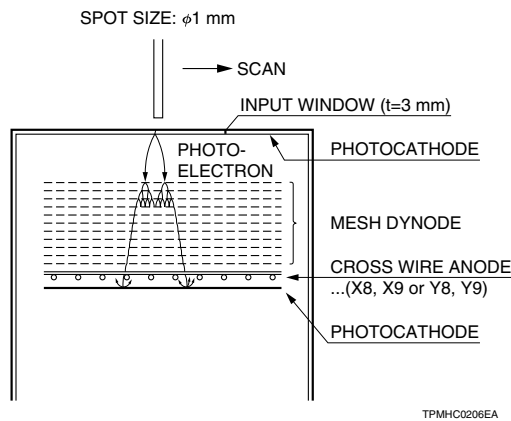
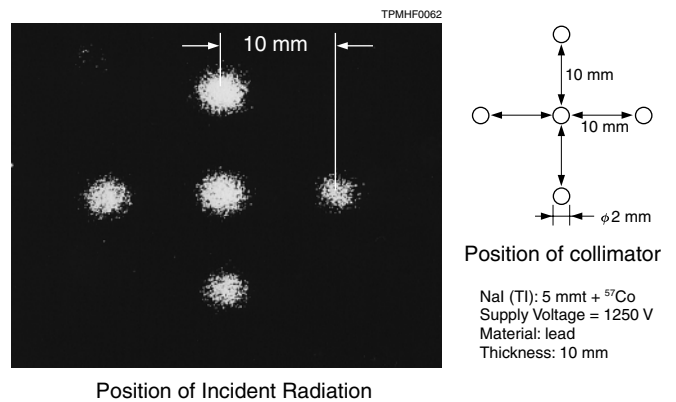


Figure 7: Example of Scintillation Imaging



## OPERATING EXAMPLE

The R2486-02 can be connected to commercially available general-purpose measuring instruments. The figure below shows a typical connection example.

Ortec Position-Sensitive Detector Analyzer (NIM Module) can be connected to the R2486-02.

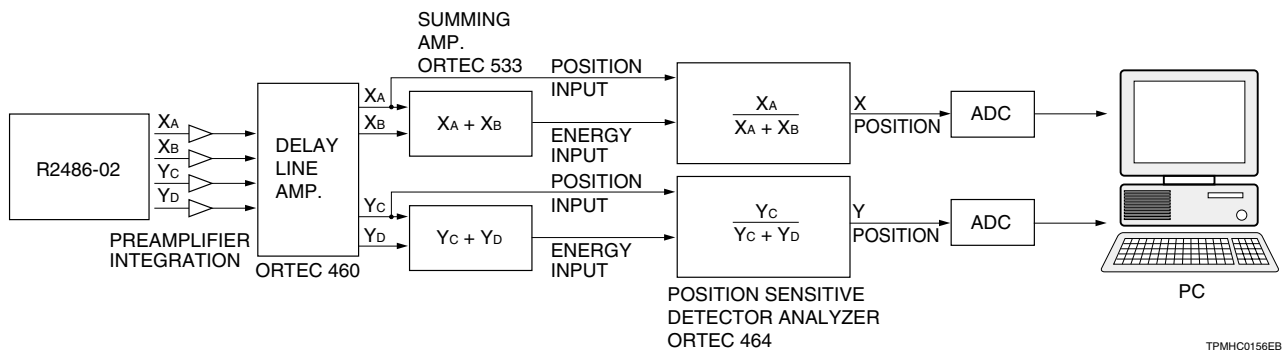
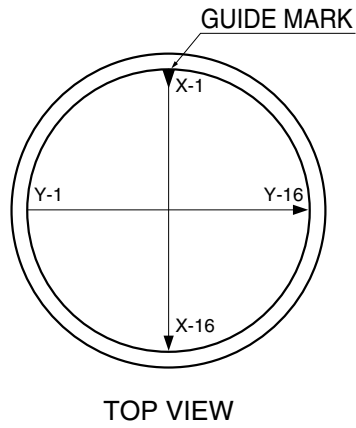


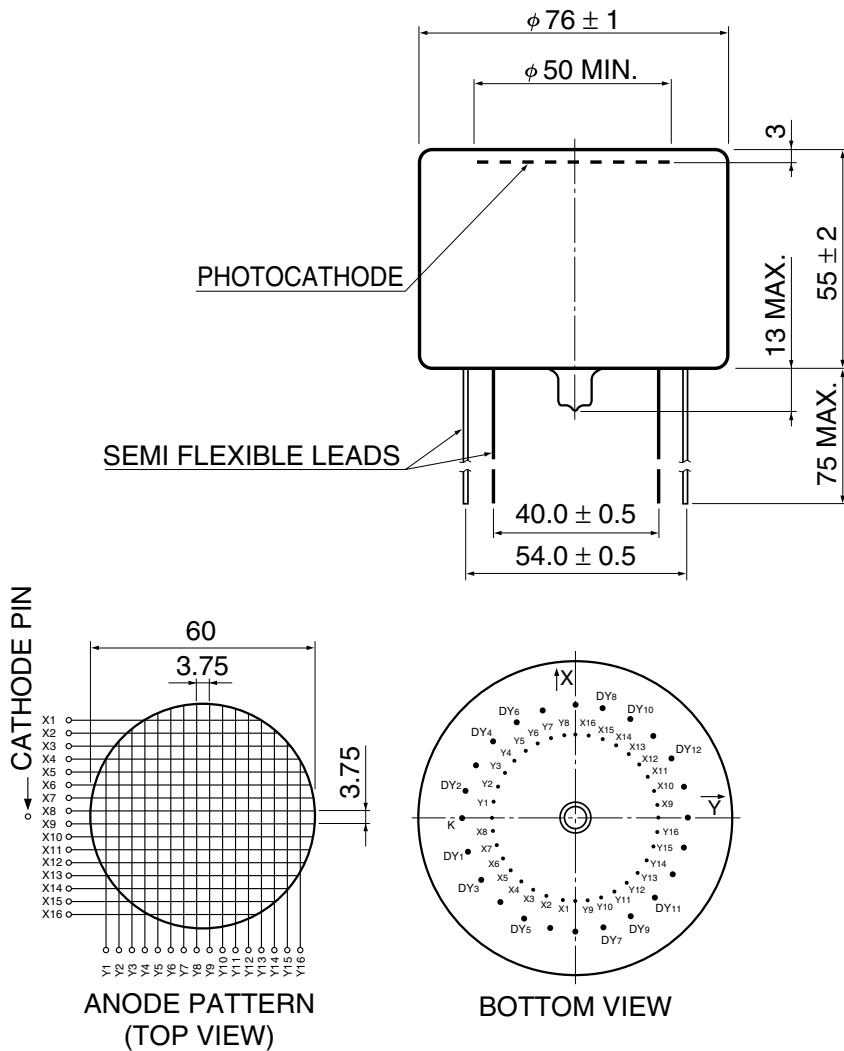
Figure 8: X- and Y-Axis of R2486 Series



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## DIMENSIONAL OUTLINE (Unit: mm)

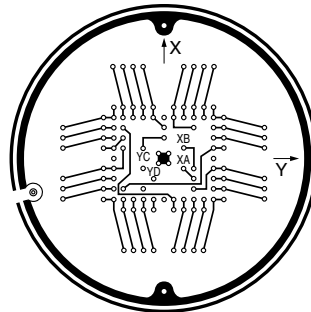
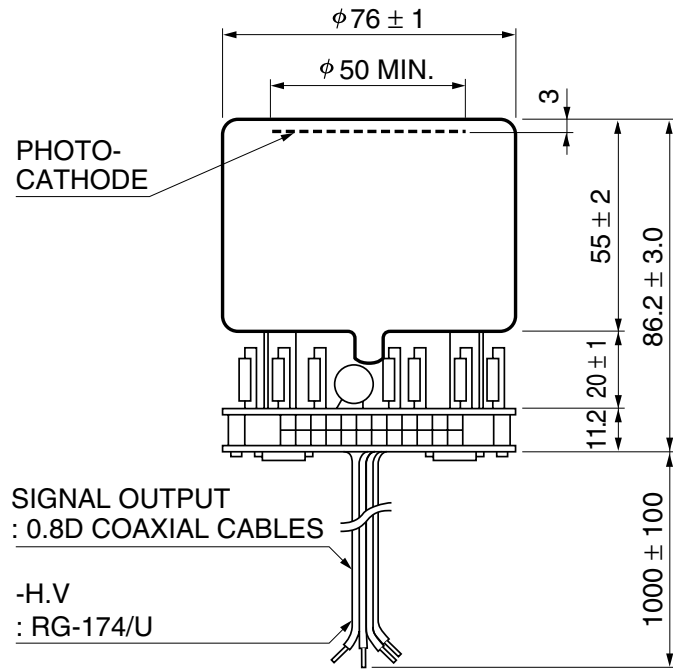
Figure 9: R2486



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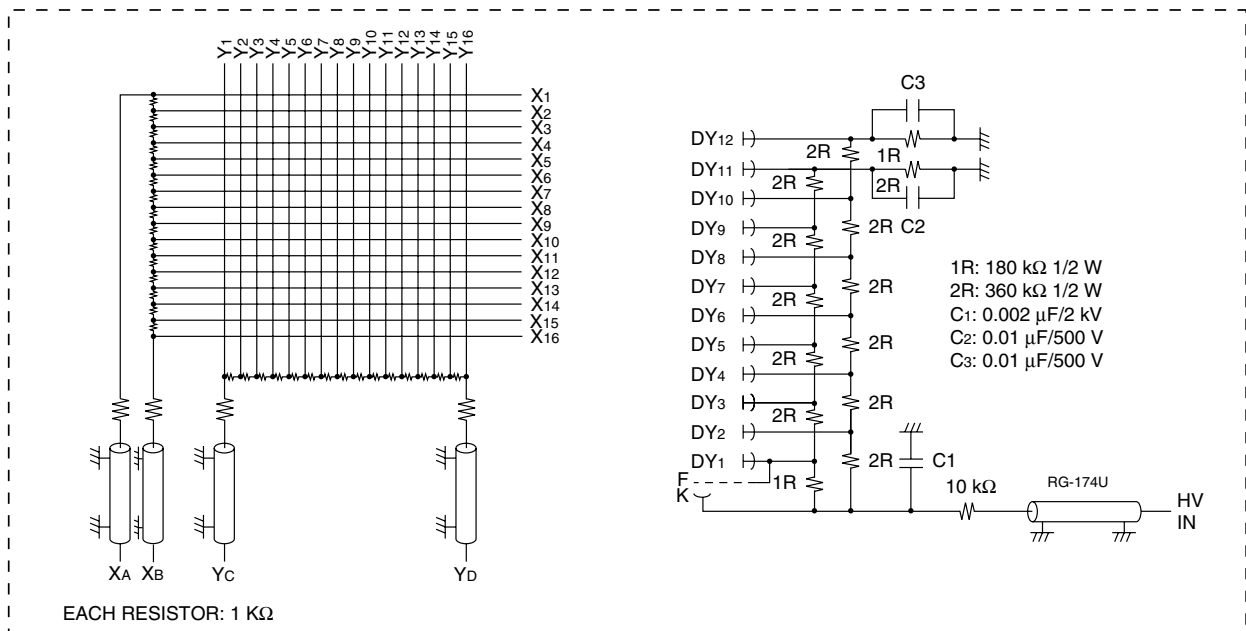


Figure 11: R2486-02



BOTTOM VIEW

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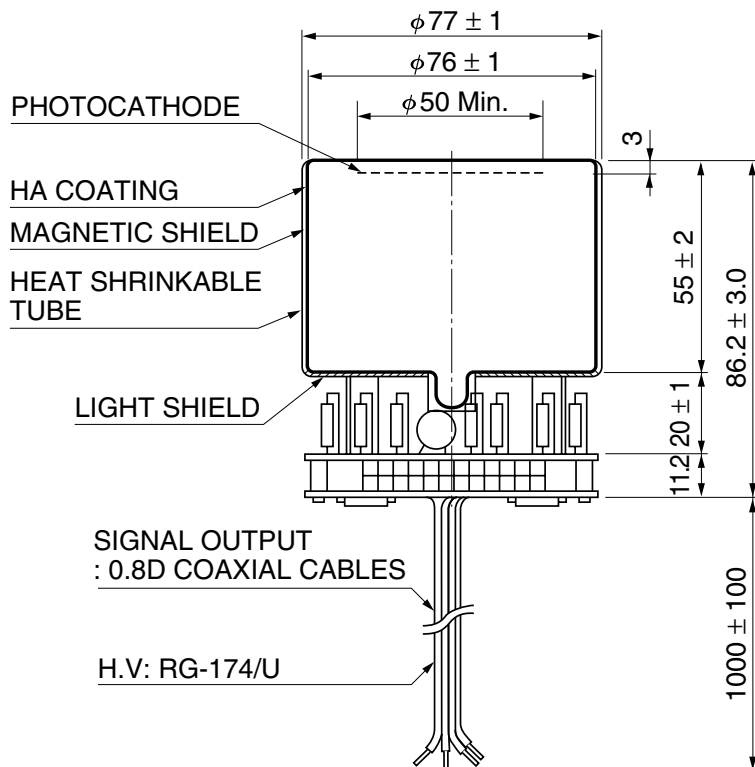


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Figure 12: R2486-03

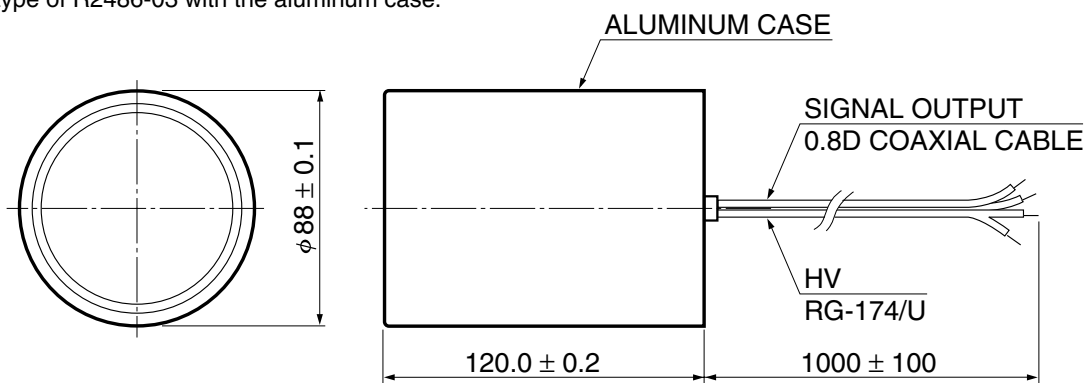
Variant type of R2486-02 having HA coating and  $\mu$ -metal shielding.



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Figure 13: R2486-04

Variant type of R2486-03 with the aluminum case.



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TPMH1206E02  
DEC. 2001 IP