

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



TPMHF0040

#### 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 are 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 is also available.

#### **The R2486 series are new photomultiplier tubes which enable the acquisition of 2-dimensional information from 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.

#### **Potential applications span a wide range of imaging fields**

The R2486 series use a mesh-dynode with excellent linearity and position-sensitive crossed wire anodes, enabling detection and imaging of a wide variety of emission phenomena.

#### Applications

- **Radiology:** compact scintillation cameras, positron CTs
- **High-energy physics**
- **Astronomy:** sensing and imaging of cosmic radiation
- **Chemical analysis, materials research, life sciences**

#### **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. 7)
2. R2486-01: Provided with high-voltage divider circuit; enables direct reading of signals from each anode through an IC socket. (Fig. 8)
3. R2486-02: Provided with high-voltage divider circuit and resistive chains for signal processing, simplifying connection to external devices. (Fig. 9)
4. R2486-03: -02 version with HA coating and light shield treatment.
5. R2486-04: Potting type of -03 (Fig.10)
6. R2486-05: With Pre-Amp of -03 (Fig.11)
7. R2486-06: With housing of -05 (Fig.12)

# 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	mm
	Thickness	3.2 ± 0.3	—
	Index of Refraction at 420nm	1.500 ± 0.001	—
Dynode	Structure	Coarse mesh	—
	Number of Stages	12	—
Anode Number of Wires		16 (X) + 16 (Y)	—
Effective Area		φ50	mm

## MAXIMUM RATINGS (Absolute Maximum Values)

Parameter	Value	Unit
Supply Voltage Between Anode and Cathode	1300	Vdc
Average Anode Current <sup>Ⓐ</sup>	0.1	mA
Ambient Temperature	-80 to +50	°C

## CHARACTERISTICS (Typ. at 25°C)

Parameter		Value	Unit
Cathode Sensitivity	Luminous <sup>Ⓑ</sup>	80	μA/lm
	Radiant at 420nm	77	mA/W
	Blue <sup>Ⓒ</sup>	9.0	μA/lm-b
	Quantum Efficiency at 390nm (peak)	23	%
Anode Sensitivity <sup>Ⓓ</sup>	Luminous	8.0	A/lm
	Radiant at 420nm	7.7 × 10 <sup>3</sup>	A/W
Gain <sup>Ⓓ</sup>		1.0 × 10 <sup>5</sup>	—
Anode Dark Current <sup>Ⓔ</sup>		20	nA
Time Response <sup>Ⓓ</sup>	Rise Time <sup>Ⓕ</sup>	5.5	ns
	Electron Transit Time <sup>Ⓖ</sup>	17	ns

## NOTES

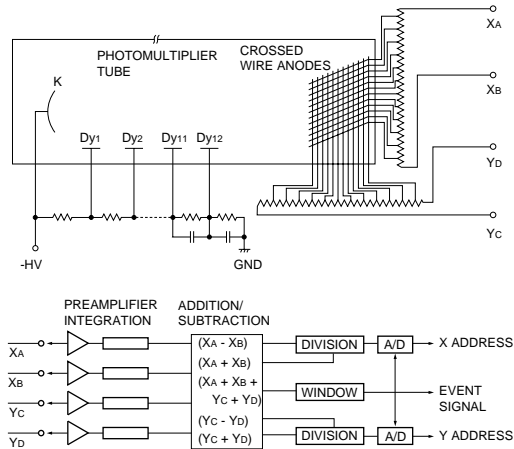
- Ⓐ: Averaged over any interval of 30 seconds maximum.
- Ⓑ: The light source is a tungsten filament lamp operated at a distribution temperature of 2856K. Supply voltage is 150 volts between the cathode and all other electrodes connected together as an anode.
- Ⓒ: The value is cathode output current when 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 Ⓑ.
- Ⓓ: Measured with the same light source as Note Ⓑ and with the anode-to-cathode supply voltage and voltage distribution ratio shown in Table 1.
- Ⓔ: Measured with the same supply voltage and voltage distribution ratio as Note Ⓓ at 30 minutes after removal of light.
- Ⓕ: 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.
- Ⓖ: 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.

Table 1: Voltage Distribution Ratio and Supply Voltage

Electrode	K	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D <sub>9</sub>	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	P
Distribution Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Supply Voltage: 1250 Vdc  
K: Cathode, D: Dynode, P: Anode

Figure 1: Schematic Diagram



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Figure 2: Typical Spectral Response

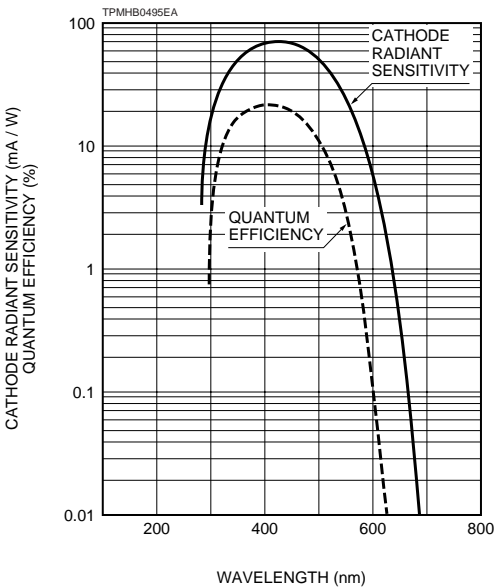
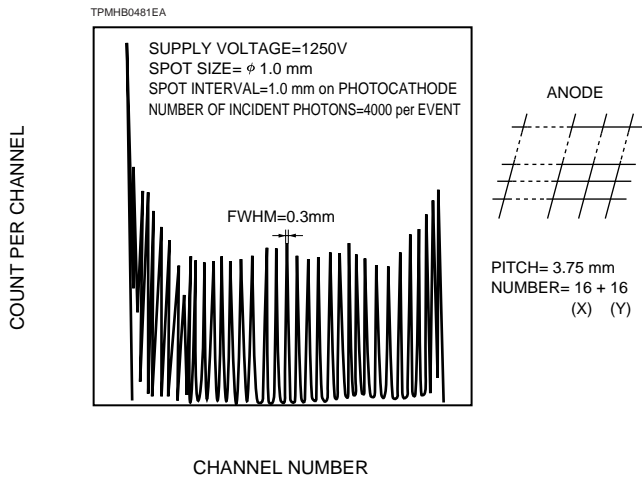


Figure 3: Example of Spatial Resolution



## NOTE:

Measurement should be done by projecting spotlights of  $\phi 1$  mm with an interval of 1 mm, and inputting the position operation output into the Pulse Height Analyzer. Fluctuation of the position signal (FWHM = 0.3 mm) shows the limit of the spatial resolution.

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

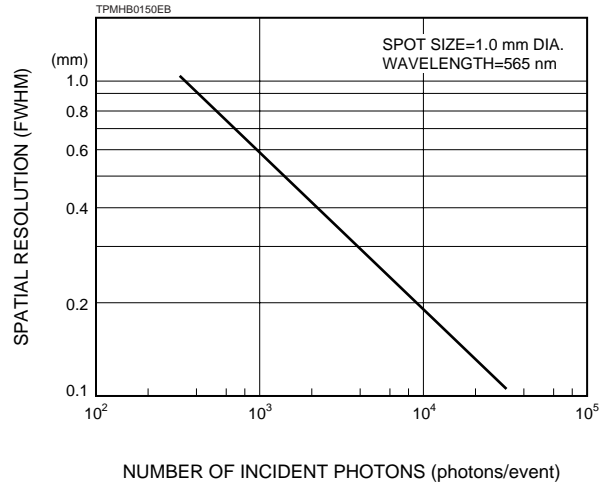


Figure 5: Example of Scintillation Imaging

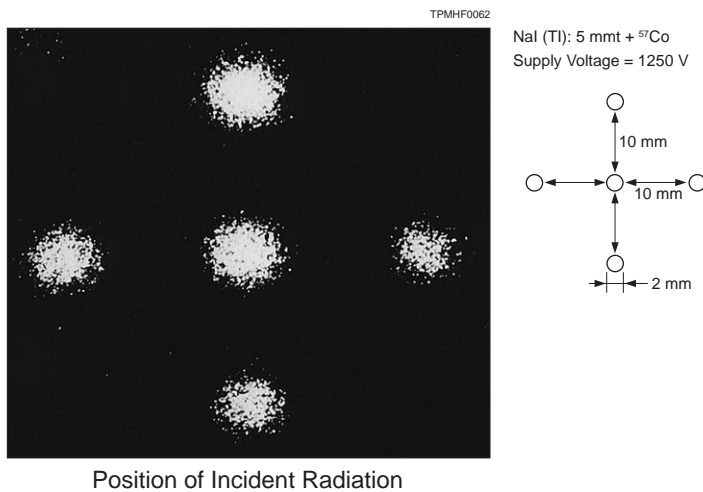
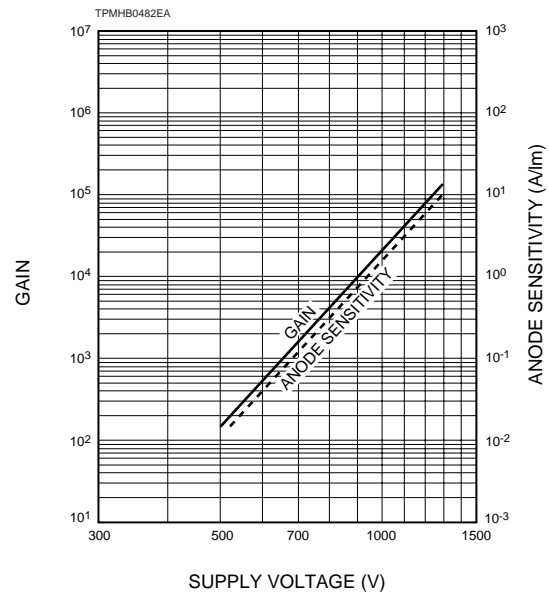


Figure 6: Typical Anode Sensitivity and Gain Characteristics

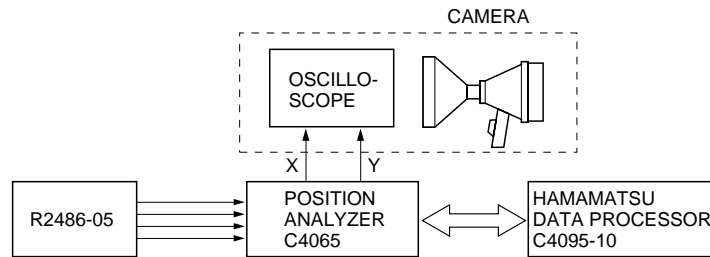


# POSITION-SENSITIVE PHOTOMULTIPLIER TUBES R2486 SERIES

## OPERATING EXAMPLE

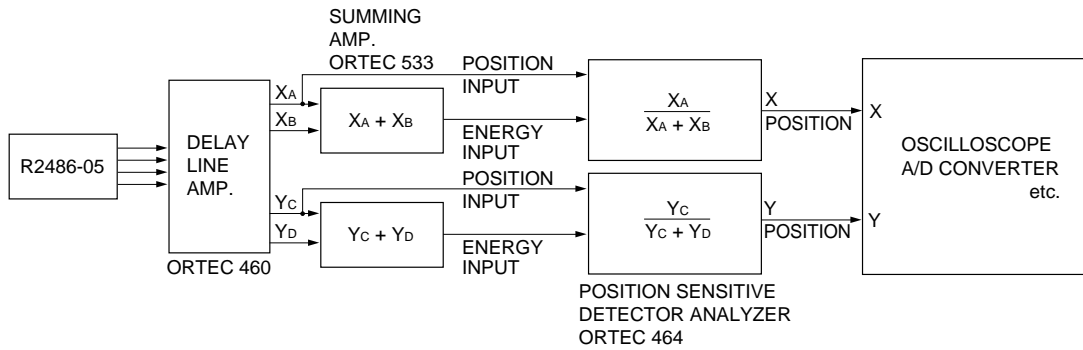
The R2486-05 can be connected commercially available general-purpose measuring instruments. The figures below show a typical connection example.

1. In this setup, the R2486-05 is connected to the Hamamatsu C4065 Position Analyzer, with both analog and digital outputs available.



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2. Owners of the Ortec Position-Sensitive Detector Analyzer (NIM Module) can also connect to this device.



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### DIMENSIONAL OUTLINE (Unit: mm)

Figure 7: R2486

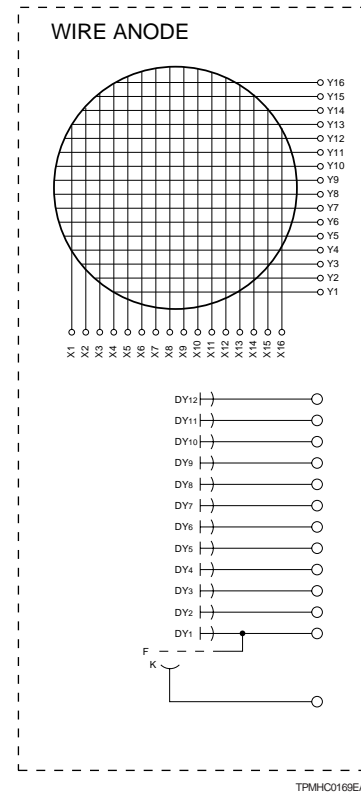
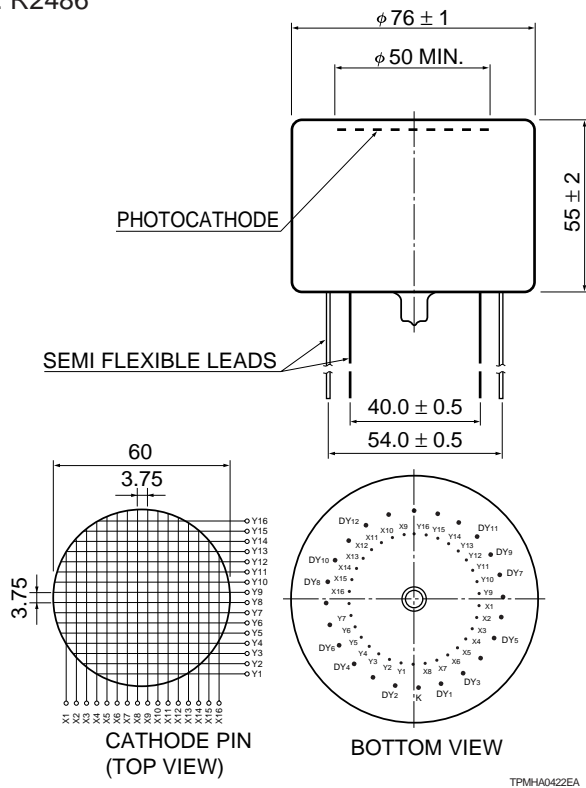
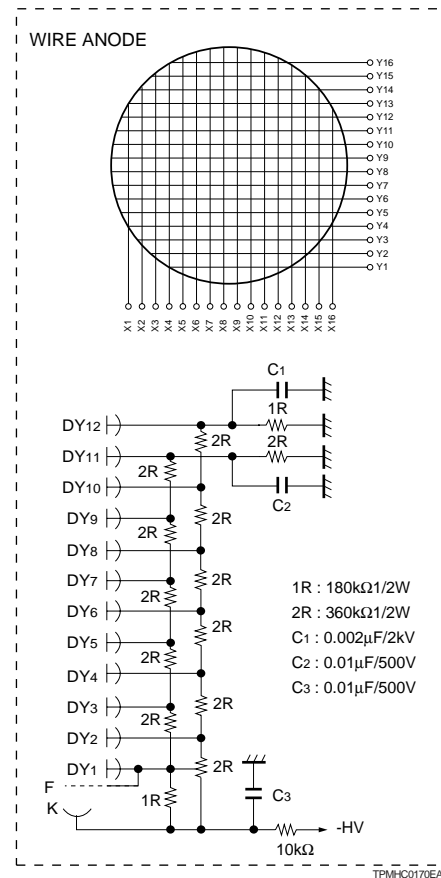
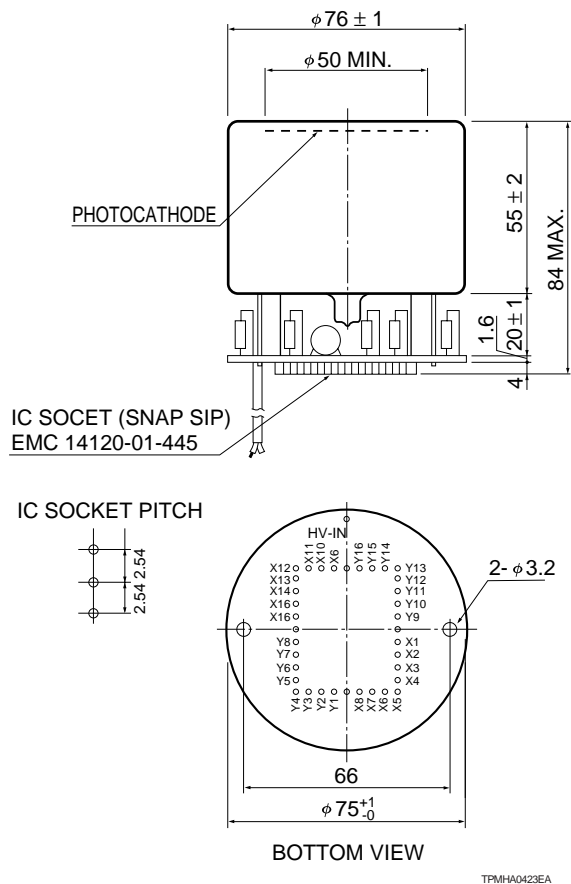
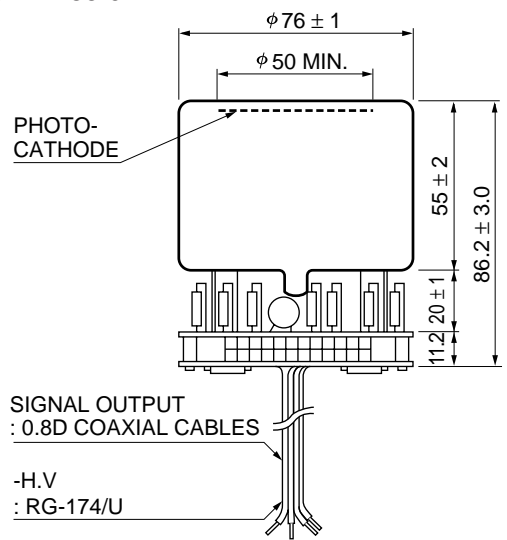


Figure 8: R2486-01

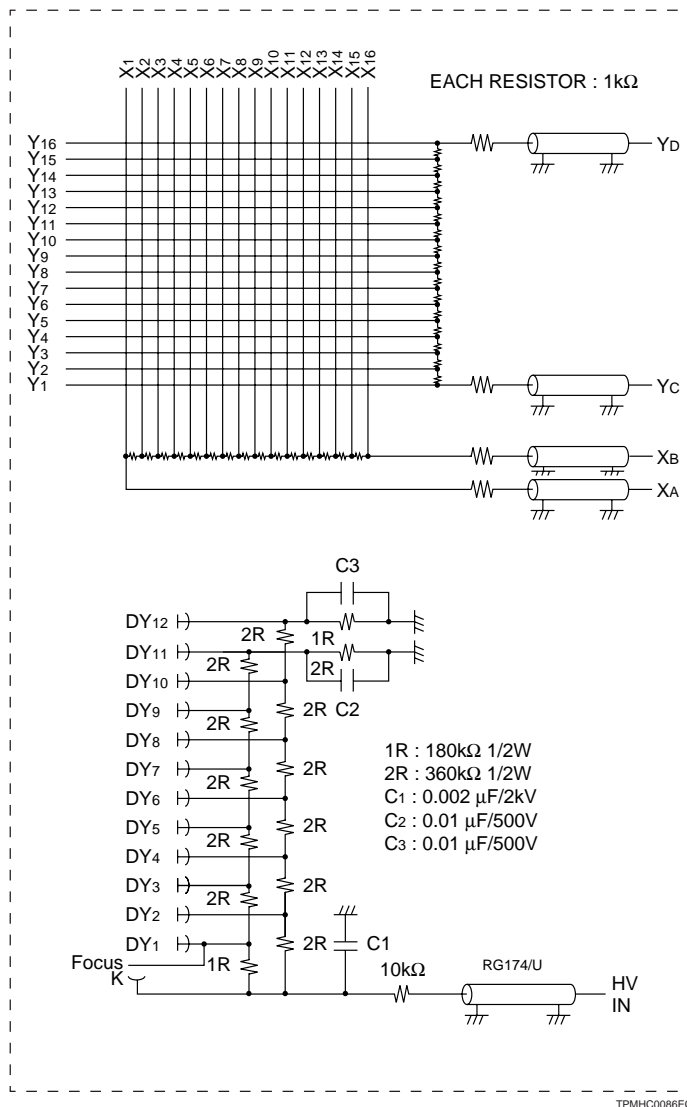


## POSITION-SENSITIVE PHOTOMULTIPLIER TUBES R2486 SERIES

Figure 9: R2486-02



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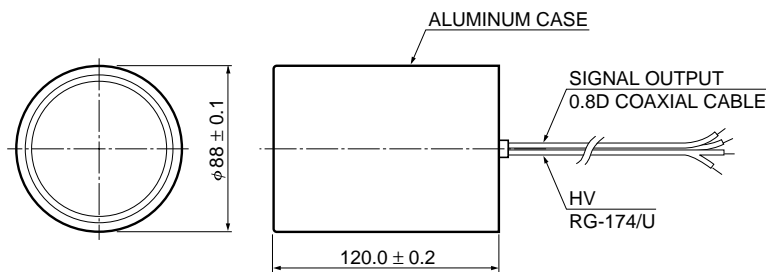
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## R2486-03

Variant type of R2486-02 having HA coating and  $\mu$ -metal shielding. Tube diameter  $\phi 77 \pm 1$ .

Figure 10: R2486-04

Potting type of R2486-03



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Figure 11: R2486-05

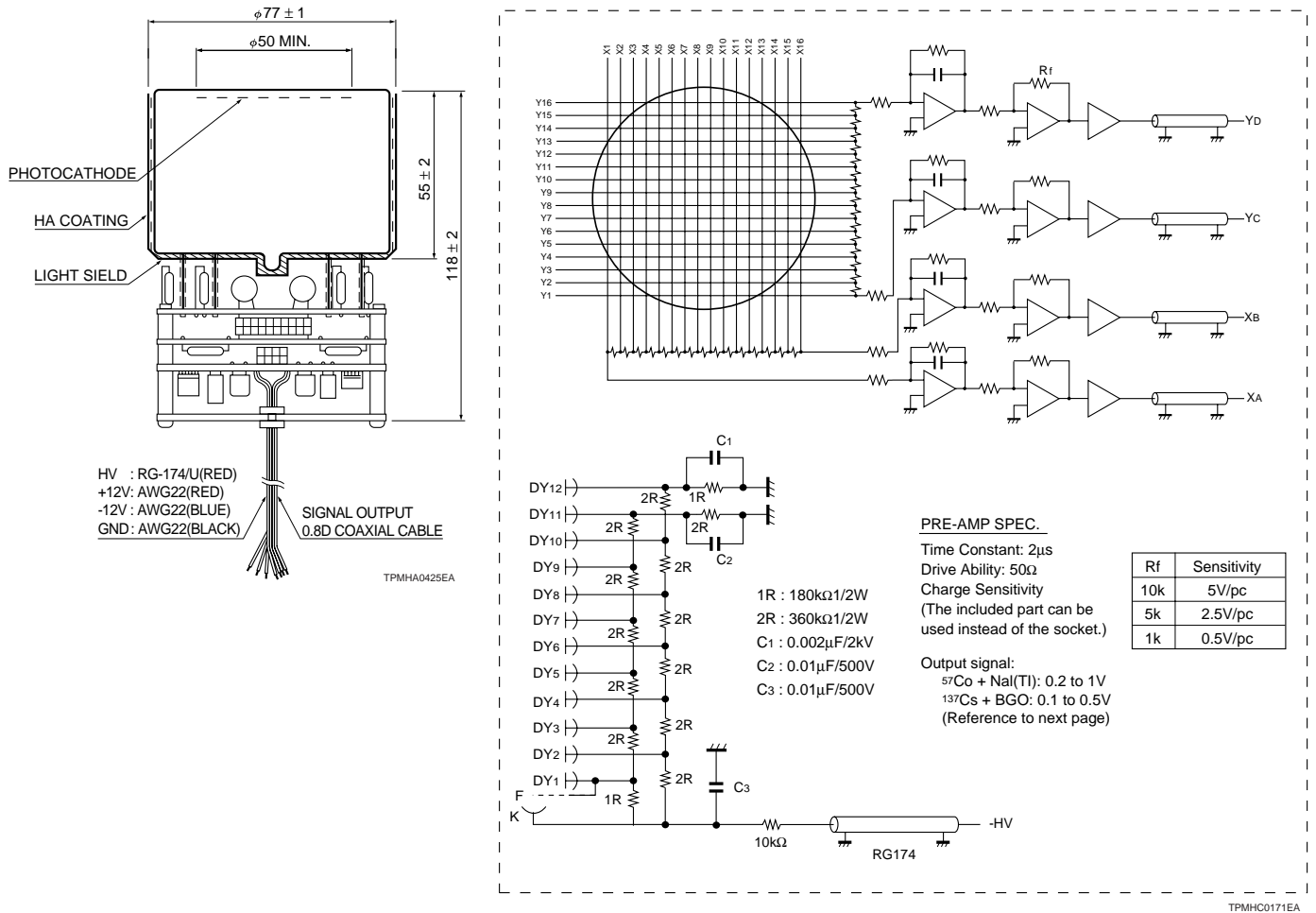
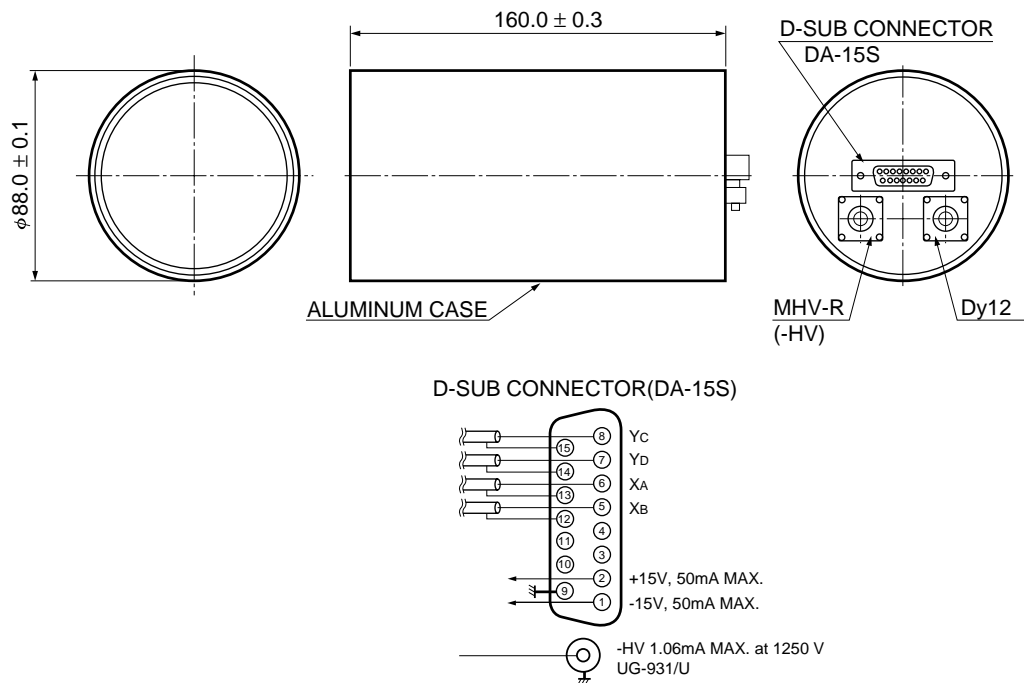


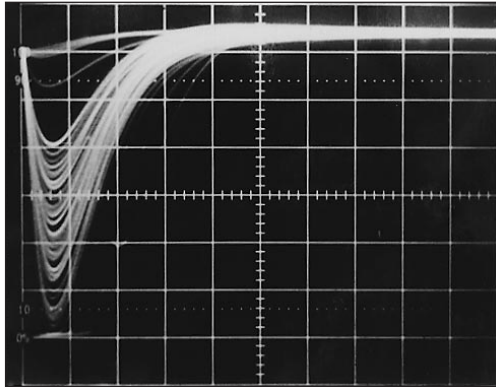
Figure 12: R2486-06



# POSITION-SENSITIVE PHOTOMULTIPLIER TUBES R2486 SERIES

## OUTPUT SIGNAL EXAMPLE OF R2486-05

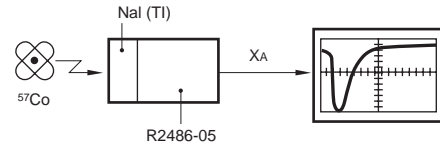
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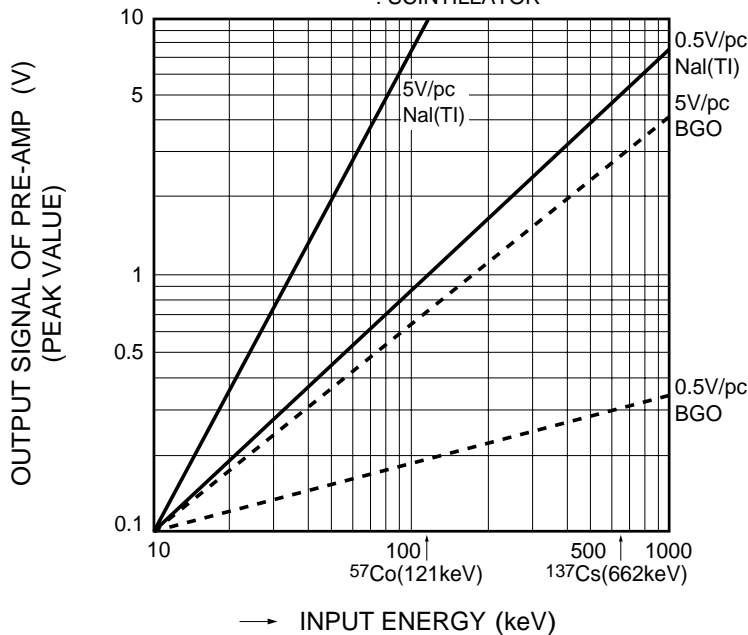
2  $\mu$ s, 0.2V/DIV.

### CONDITION:

PMT Gain .....  $1 \times 10^5$   
 Scintillator ..... NaI (TI) thickness 5 mm  
 Pre-Amp Sensitivity ..... 0.5 V/pc



### OUTPUT SIGNAL VS. INPUT ENERGY PARAMETER: PRE-AMP SENSITIVITY : SCINTILLATOR



TPMHB0483EA

# HAMAMATSU

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