

HAMAMATSU

PHOTON IS OUR BUSINESS

RUGGEDIZED HIGH TEMPERATURE PHOTOMULTIPLIER TUBES



HAMAMATSU PHOTONICS K.K.

Introduction

This catalog provides the latest information for Hamamatsu ruggedized high temperature photomultiplier tubes ranging in diameter from 13 mm (1/2") to 51 mm (2"). All listed tubes employ high temperature bialkali photocathode that feature stable operation and long life at temperatures up to 90 °C, 175 °C or 200 °C. The electrode supporting structures have been designed so that tubes can be used in severe environments such as may be found in oil well logging, geological exploration, and aerospace applications.

If you do not find the tube that meets your needs in this brochure, we will be pleased to custom produce a tube or assembly for your unique requirements. We offer a wide variety of complete assemblies of tubes, sockets, voltage dividers and tube shields which have been quality tested to assure reliable operation.

Applications

- Oil well logging (Wireline, MWD and LWD)
- Geological exploration
- Gauge meter
- Aerospace research













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Index by type number










R1288A	10	R3991A-28	8	R6877A	12
R1288A-01	10	R3991A-31	8	R6877A-01	12
R1288A-04	10	R3991AH	8	R6877A-04	12
R1288A-06	10	R3991AH-07	8	R6877A-06	12
R1288A-07	10	R3991AH-27	8	R6877A-07	12
R1288A-08	10	R3991AH-31	8	R6877A-08	12
R1288A-27	10	R4177	6	R6877A-27	12
R1288A-28	10	R4177-01	6	R6877A-28	12
R1288A-31	10	R4177-04	6	R6877A-31	12
R1288AH	10	R4177-06	6	R8874-01	16
R1288AH-07	10	R4177-27	6	R9722A	14
R1288AH-27	10	R4177-28	6	R9722A-01	14
R1288AH-31	10	R4607A-01	16	R9722A-04	14
R3991A	8	R4607A-06	16	R9722A-06	14
R3991A-04	8	R4607A-27	16	R9722A-27	14
R3991A-07	8	R4607A-28	16	R9722A-28	14
R3991A-27	8	R5473-02	16		

Quick reference



Diameter	Maximum temperature	Temporary base	Button stem	Assembly	Product photo
Standard types					
ϕ 13 mm (1/2")	90 °C	R4177-04	R4177-06	R4177-28	 R4177-04  R4177-01/-06  R4177-27/-28
	175 °C	R4177	R4177-01	R4177-27	
ϕ 19 mm (3/4")	90 °C	R3991A-04		R3991A-28	 R3991A-07  R3991A-04  R3991AH-07  R3991AH-07  R3991A-27/-28/-31  R3991AH-27/-31
	175 °C	R3991A		R3991A-07 R3991A-27 R3991A-31	
	200 °C	R3991AH		R3991AH-07 R3991AH-27 R3991AH-31	
ϕ 25 mm (1")	90 °C	R1288A-04	R1288A-06	R1288A-08 R1288A-28	 R1288A/-04  R1288A-07/-08  R1288AH  R1288AH-07  R1288A-01/-06  R1288A-27/-28/-31  R1288AH-27/-31
	175 °C	R1288A	R1288A-01	R1288A-07 R1288A-27 R1288A-31	
	200 °C	R1288AH		R1288AH-07 R1288AH-27 R1288AH-31	

Diameter	Maximum temperature	Temporary base	Button stem	Assembly	Product photo
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Standard types

ϕ 28 mm (1-1/8")	90 °C	R6877A-04	R6877A-06	R6877A-08 R6877A-28	 R6877A-04  R6877A-07/-08  R6877A-01/-06  R6877A-27/-28/-31
	175 °C	R6877A	R6877A-01	R6877A-07 R6877A-27 R6877A-31	
ϕ 38 mm (1-1/2")	90 °C	R9722A-04	R9722A-06	R9722A-28	 R9722A-04  R9722A-01/-06  R9722A-27/-28
	175 °C	R9722A	R9722A-01	R9722A-27	
ϕ 51 mm (2")	90 °C		R4607A-06	R4607A-28	 R4607A-01/-06  R4607A-27/-28
	175 °C		R4607A-01	R4607A-27	

Highly ruggedized types

ϕ 19 mm (3/4")	175 °C			R8874-01	 R8874-01
ϕ 25 mm (1")	175 °C			R5473-02	 R5473-02

Type No. are suitable for MWD application.

Maximum temp. (°C)	Type No.	Base configuration	Socket or resistor value	Dynode structure number of stages	MWD appl.	Maximum ratings		Anode to cathode voltage (V)	Shock
						④	⑤		
						Anode to cathode voltage (V)	Average anode current (mA)		

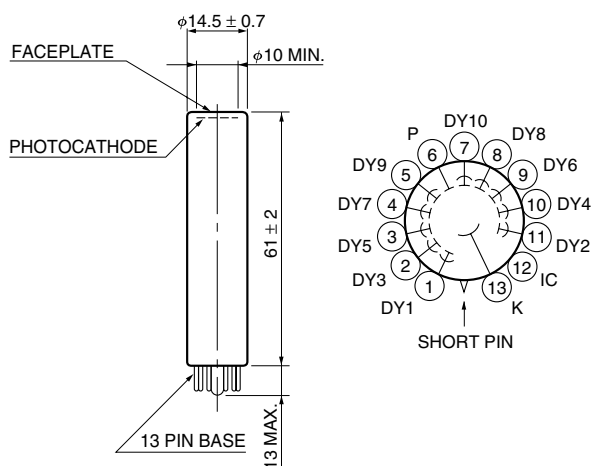
13 mm (1/2") dia. types

90	R4177-04	Temporary base	E678-12R	Linear focused/10	—	1800	0.02	1500	A	5000 m/s ² (500 g) 0.5 ms
	R4177-06	Button stem	E678-13E				0.01		B	
	R4177-28	Assembly (S/S case)	1R=2 MΩ				0.02		A	
175	R4177	Temporary base	E678-12R				0.02		A	
	R4177-01	Button stem	E678-13E				0.01		B	
	R4177-27	Assembly (S/S case)	1R=2 MΩ				0.01		B	

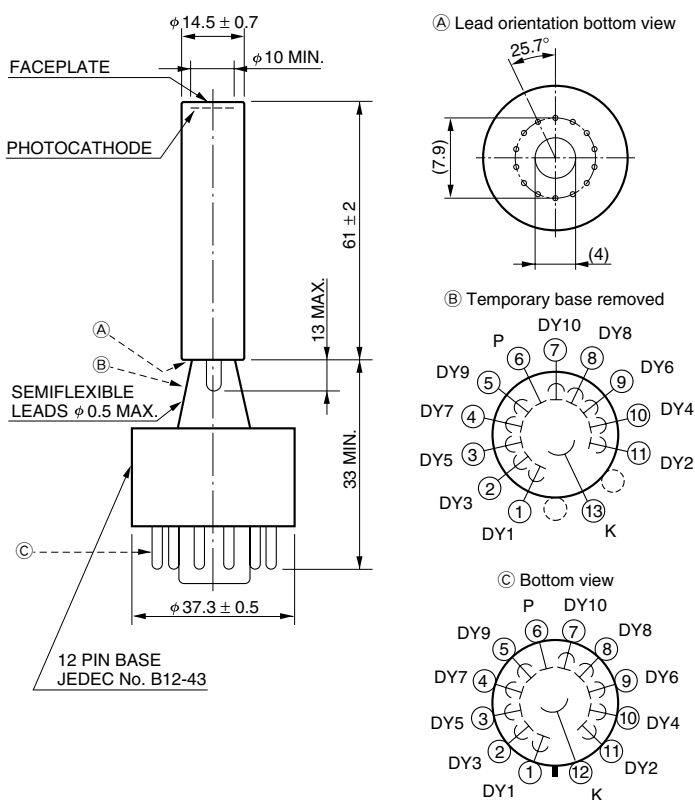
S/S: Stainless steel

Dimensional outlines and basing diagrams (Unit: mm)

R4177-01/-06



R4177/-04



TPMHA0006EA

TPMHA0007EC

Voltage distribution ratios

Number of stages	Distribution ratio codes	Voltage distribution ratio K: Cathode Dy: Dynode P: Anode											
		K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P
10	A	1	1	1	1	1	1	1	1	1	1	1	1
	B	1	1	1	1	1	1	1	1	1	1	1	1

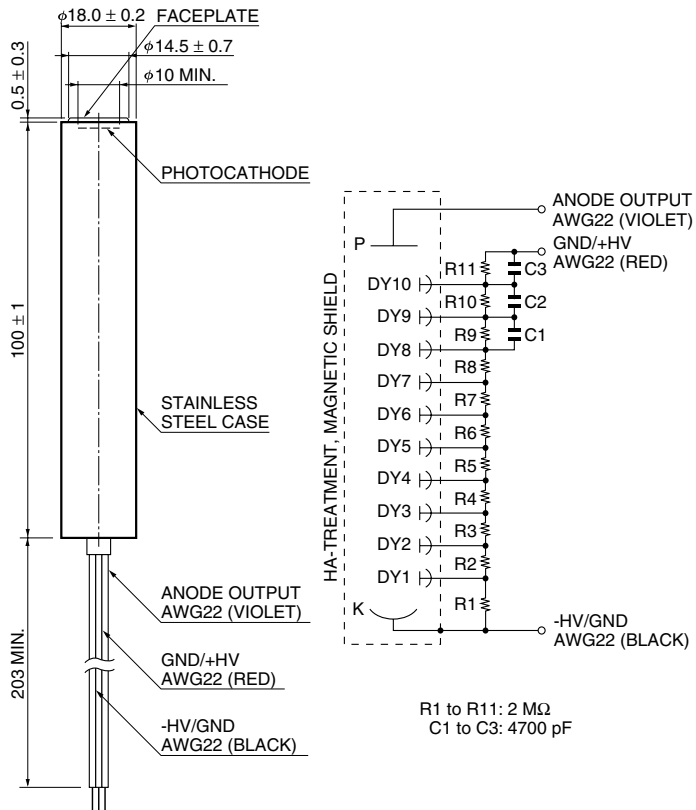
* (4700) (4700) (4700)

* The parentheses indicate the value of capacitors in pF.

Sine vibration	Cathode sensitivity				Anode sensitivity and characteristics						Type No.
	Luminous at 25 °C		Blue sensitivity index (CS 5-58) at 25 °C		Gain at 25 °C	Luminous at 25 °C		Dark current			
								at 25 °C		at 175 °C	
	Min. (μA/lm)	Typ. (μA/lm)	Min.	Typ.		Typ.	Min. (A/lm)	Typ. (A/lm)	Typ. (nA)	Max. (nA)	

200 m/s ² (20 g)	20	30	3.0	4.5	5.0 × 10 ⁵	6	15	0.5	10	5 (90 °C)	R4177-04
											R4177-06
											R4177-28
	20	40	4.0	6.0		10	20	0.5	10	100	R4177
											R4177-01
											R4177-27

R4177-27/-28 (See Note 2 on page 18)



TPMHA0032EE

Maximum temp. (°C)	Type No.	Base configuration	Socket or resistor value	Dynode structure number of stages	MWD appl.	Maximum ratings		Anode to cathode voltage (V)	Average anode current (mA)	Anode to cathode voltage (V)	Shock
						④	⑤				
						Anode to cathode voltage (V)	Average anode current (mA)				

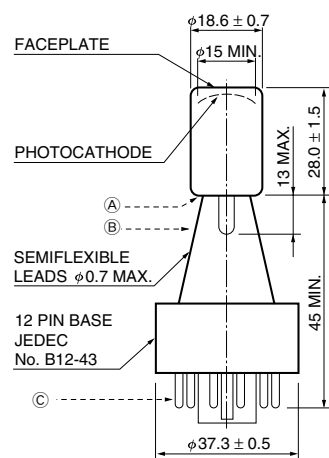
19 mm (3/4") dia. types

90	R3991A-04	Temporary base	E678-12R	Circular and linear focused/10	—	1800	0.02	1500	C	10 000 m/s ² (1000 g) 0.5 ms
	R3991A-28	Assembly (S/S case)	1R=2 MΩ							
175	R3991A	Temporary base	E678-12R							
	R3991A-07	Assembly	1R=2 MΩ							
	R3991A-27	Assembly (S/S case)	1R=2 MΩ							
	R3991A-31	Assembly (S/S case)	1R=2 MΩ							
200	R3991AH	Temporary base	E678-12R							
	R3991AH-07	Assembly	1R=2 MΩ							
	R3991AH-27	Assembly (S/S case)	1R=2 MΩ							
	R3991AH-31	Assembly (S/S case)	1R=2 MΩ							

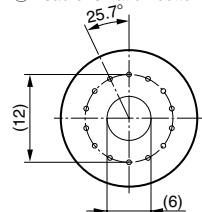
S/S: Stainless steel

Dimensional outlines and basing diagrams (Unit: mm)

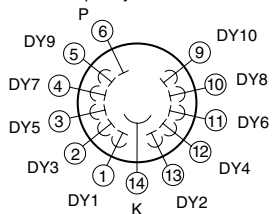
R3991A/-04, R3991AH



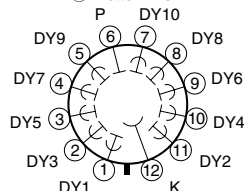
(A) Lead orientation bottom view



(B) Temporary base removed

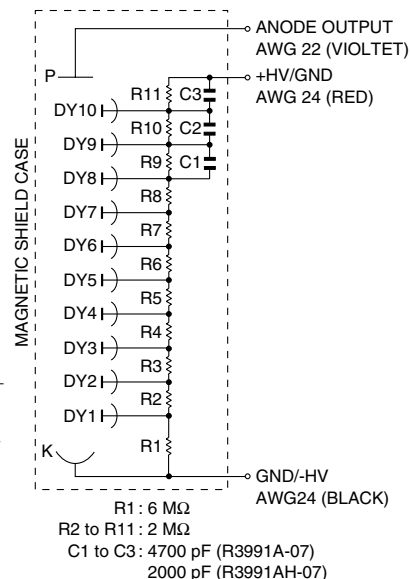
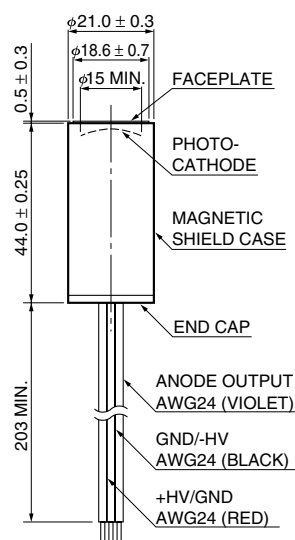


(C) Bottom view



TPMHA0361ED

R3991A-07, R3991AH-07 (See Note 2 on page 18)



TPMHA0563EB

Voltage distribution ratios

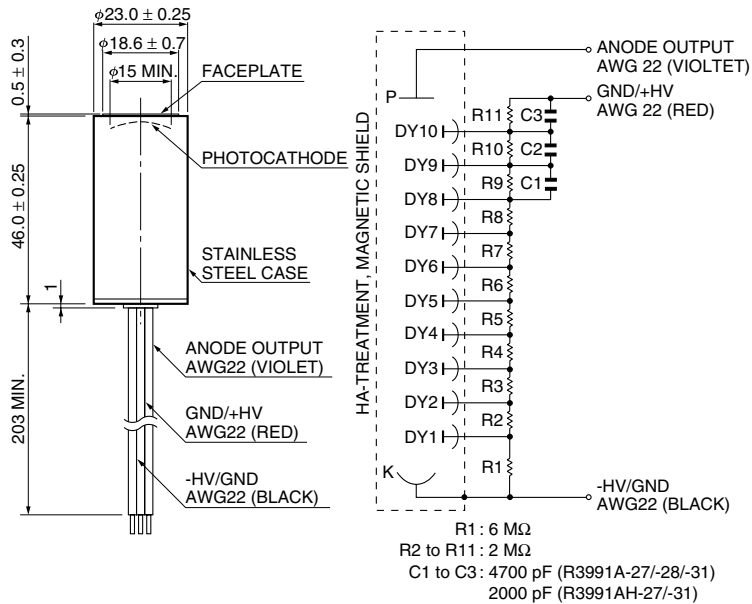
Number of stages	Distribution ratio codes	Voltage distribution ratio K: Cathode Dy: Dynode P: Anode												
10	C	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P	
		3	1	1	1	1	1	1	1	1	1	1	1	
	D	3	1	1	1	1	1	1	1	1	1	1	1	
		* (4700) (4700) (4700)												
	E	3	1	1	1	1	1	1	1	1	1	1	1	
* (2000) (2000) (2000)														

* The parentheses indicate the value of capacitors in pF.

Sine vibration	Cathode sensitivity				Anode sensitivity and characteristics						Type No.
	Luminous at 25 °C		Blue sensitivity index (CS 5-58) at 25 °C		Gain at 25 °C	Luminous at 25 °C		Dark current			
								at 25 °C		at 175 °C	
	Min. (μA/lm)	Typ. (μA/lm)	Min.	Typ.		Typ.	Min. (A/lm)	Typ. (A/lm)	Typ. (nA)	Max. (nA)	

300 m/s ² (30 g)	20	30	3.0	4.5	3.3×10^5	5	10	0.1	10	10 (90 °C)	R3991A-04
											R3991A-28
	20	40	4.0	6.0	5.0×10^5	5	20	0.1	10	200	R3991A
											R3991A-07
											R3991A-27
											R3991A-31
	30	50	5.0	7.0	5.0×10^5	10	25	0.1	10	2000 (200 °C)	R3991AH
											R3991AH-07
											R3991AH-27
											R3991AH-31

R3991A-27/-28/-31, R3991AH-27/-31 (See Note 2 on page 18)



TPMHA0350EC

Maximum temp. (°C)	Type No.	Base configuration	Socket or resistor value	Dynode structure number of stages	MWD appl.	Maximum ratings		Anode to cathode voltage (V)	Shock
						④	⑤		
						Anode to cathode voltage (V)	Average anode current (mA)	Anode to cathode voltage (V)	

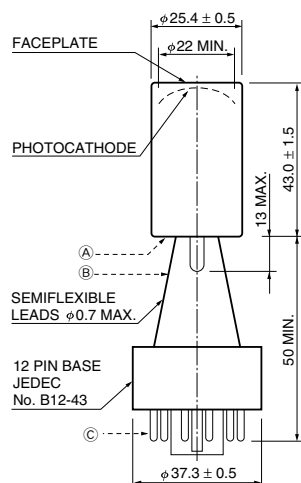
25 mm (1") dia. types

90	R1288A-04	Temporary base	E678-12R	Circular and linear focused/10	—	1800	0.02	1500	C	10 000 m/s ² (1000 g) 0.5 ms
	R1288A-06	Button stem	E678-14-03				0.01		F	
	R1288A-08	Assembly	1R=2 MΩ				0.02		C	
	R1288A-28	Assembly (S/S case)	1R=2 MΩ				0.01		F	
175	R1288A	Temporary base	E678-12R		YES	1800	0.02	1500	C	
	R1288A-01	Button stem	E678-14-03				0.01		F	
	R1288A-07	Assembly	1R=2 MΩ				0.02		C	
	R1288A-27	Assembly (S/S case)	1R=2 MΩ				0.01		F	
200	R1288A-31	Assembly (S/S case)	1R=2 MΩ		YES	1800	0.02	1500	C	
	R1288AH	Temporary base	E678-12R				0.01		F	
	R1288AH-07	Assembly	1R=2 MΩ				0.02		C	
	R1288AH-27	Assembly (S/S case)	1R=2 MΩ				0.01		F	
200	R1288AH-31	Assembly (S/S case)	1R=2 MΩ		YES	1800	0.02	1500	C	
	R1288AH-07	Assembly	1R=2 MΩ				0.01		F	
	R1288AH-27	Assembly (S/S case)	1R=2 MΩ				0.02		C	
	R1288AH-31	Assembly (S/S case)	1R=2 MΩ				0.01		F	

S/S: Stainless steel

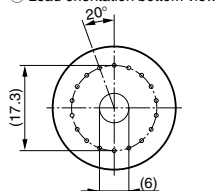
Dimensional outlines and basing diagrams (Unit: mm)

R1288A-04, R1288AH

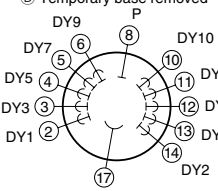


R1288A-04

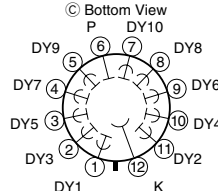
① Lead orientation bottom view



② Temporary base removed

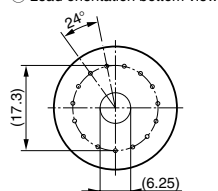


③ Bottom View

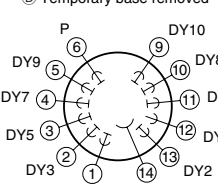


R1288AH

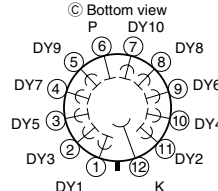
① Lead orientation bottom view



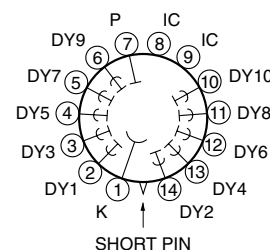
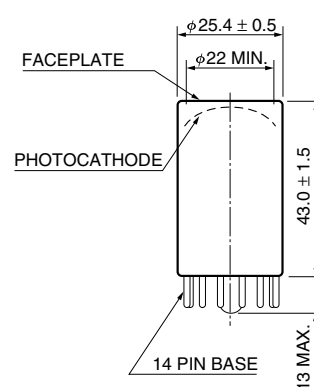
② Temporary base removed



③ Bottom View



R1288A-01/-06



Voltage distribution ratios

Number of stages	Distribution ratio codes	Voltage distribution ratio K: Cathode Dy: Dynode P: Anode											
		K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P
10	C	3	1	1	1	1	1	1	1	1	1	1	1
	F	3	1	1	1	1	1	1	1	1	1	1	1

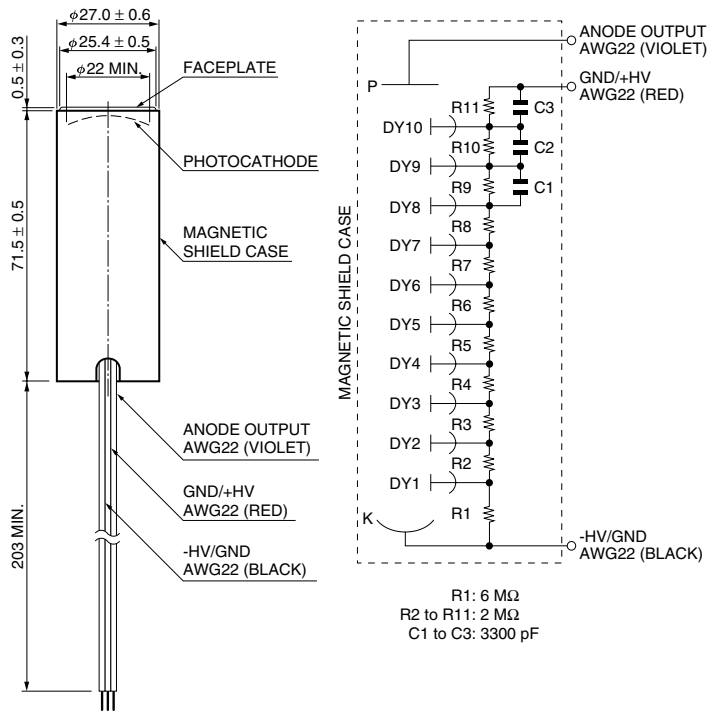
* (3300) (3300) (3300)

* The parentheses indicate the value of capacitors in pF.

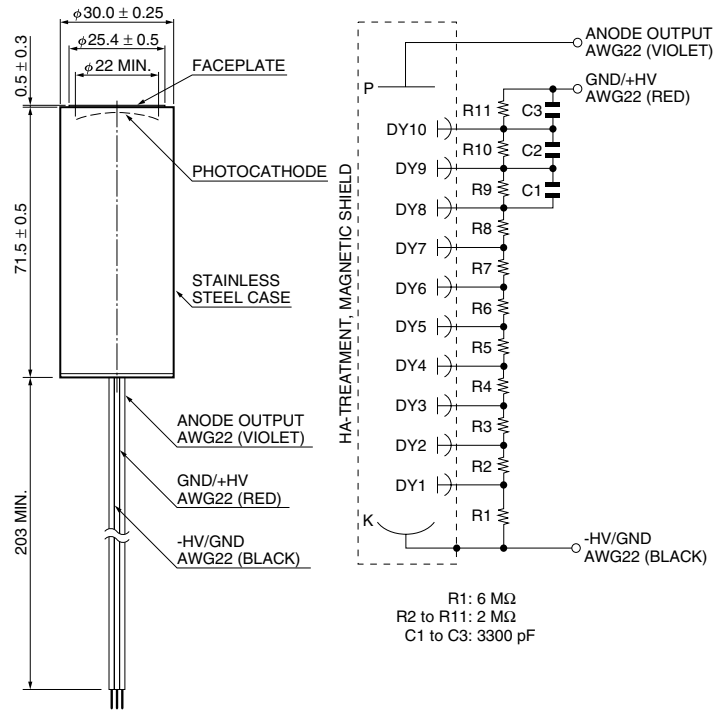
Sine vibration	Cathode sensitivity				Anode sensitivity and characteristics						Type No.
	Luminous at 25 °C		Blue sensitivity index (CS 5-58) at 25 °C		Gain at 25 °C	Luminous at 25 °C		Dark current			
								at 25 °C		at 175 °C	
	Min.	Typ.	Min.	Typ.	Typ.	Min.	Typ.	Typ.	Max.	Typ.	
	(μA/lm)	(μA/lm)				(A/lm)	(A/lm)	(nA)	(nA)	(nA)	

300 m/s ² (30 g)	20	30	3.0	4.5	3.3×10^5	5	10	0.1	10	20 (90 °C)	R1288A-04
											R1288A-06
											R1288A-08
											R1288A-28
	20	40	4.0	6.0	5.0×10^5	8	20	0.1	10	400	R1288A
											R1288A-01
											R1288A-07
											R1288A-27
	30	50	5.0	7.0	5.0×10^5	10	25	0.1	10	4000 (200 °C)	R1288A-31
											R1288AH
											R1288AH-07
											R1288AH-27
											R1288AH-31

* R1288A-07/-08, R1288AH-07 (See Note 2 on page 18)



R1288A-27/-28/-31, R1288AH-27/-31 (See Note 2 on page 18)



TPMHA0029EF

TPMHA0351EC

* CAUTION: These tubes have open ends potted with silicon.
Do not apply force to this potted portion, or do not fill any additional potting material. Either actions could damage the voltage divider built in.

Maximum temp. (°C)	Type No.	Base configuration	Socket or resistor value	Dynode structure number of stages	MWD appl.	Maximum ratings		Anode to cathode voltage (V)	Shock
						④	⑤		
						Anode to cathode voltage (V)	Average anode current (mA)		

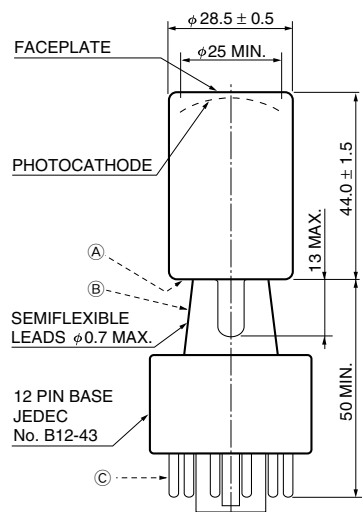
28 mm (1-1/8") dia. types

90	R6877A-04	Temporary base	E678-12R	Circular and linear focused/10	—	1800	0.02	1500	C	5000 m/s ² (500 g) 0.5 ms
	R6877A-06	Button stem	E678-14-03				0.01		F	
	R6877A-08	Assembly	1R=2 MΩ						C	
	R6877A-28	Assembly (S/S case)	1R=2 MΩ				0.02		F	
175	R6877A	Temporary base	E678-12R		YES	1800	0.02	1500	C	
	R6877A-01	Button stem	E678-14-03						F	
	R6877A-07	Assembly	1R=2 MΩ				0.01			
	R6877A-27	Assembly (S/S case)	1R=2 MΩ							
	R6877A-31	Assembly (S/S Case)	1R=2 MΩ							

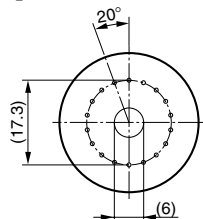
S/S: Stainless steel

Dimensional outlines and basing diagrams (Unit: mm)

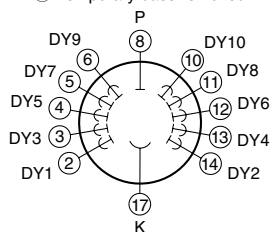
R6877A/-04



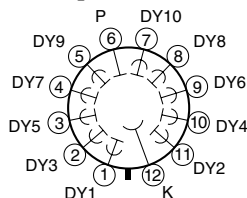
① Lead orientation bottom view



② Temporary base removed

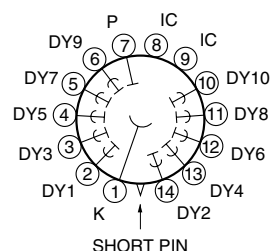
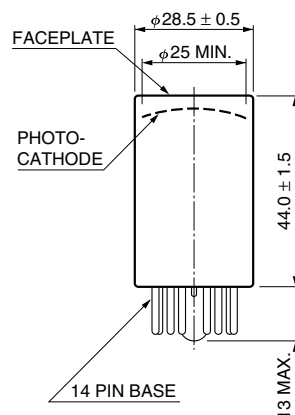


③ Bottom view



TPMHA0451ED

R6877A-01/-06



TPMHA0564EA

Voltage distribution ratios

Number of stages	Distribution ratio codes	Voltage distribution ratio K: Cathode Dy: Dynode P: Anode											
		K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P
10	C	3	1	1	1	1	1	1	1	1	1	1	1
	F	3	1	1	1	1	1	1	1	1	1	1	1

* (3300) (3300) (3300)

* The parentheses indicate the value of capacitors in pF.

38 mm (1-1/2") dia. types

S/S: Stainless steel

R9722A/-04 R9722A-01/-06



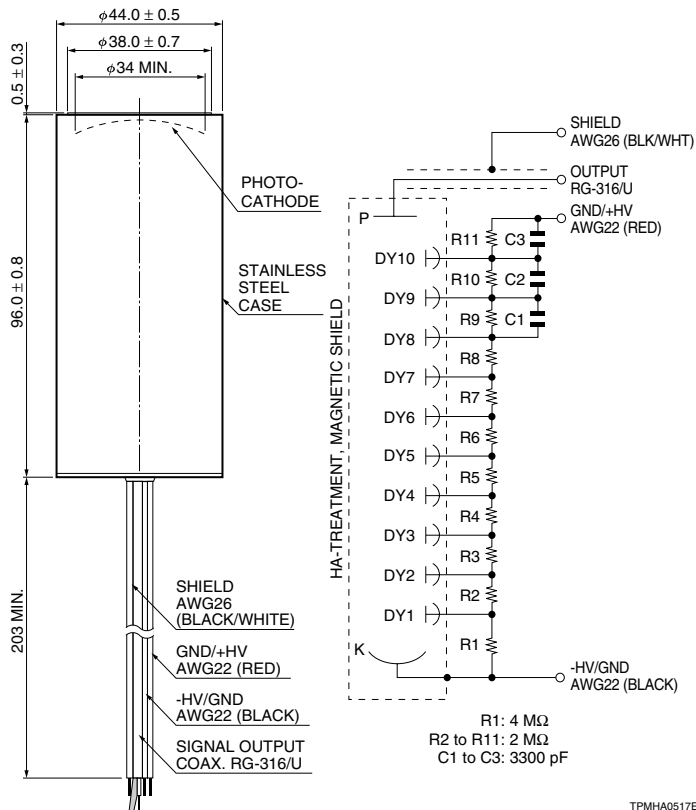
Number of stages	Distribution ratio codes	Voltage distribution ratio K: Cathode Dy: Dynode P: Anode												
		K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P	
10	G													
		2	1	1	1	1	1	1	1	1	1	1		
	H	2	1	1	1	1	1	1	1	1	1	1		
										* (3300)	(3300)	(3300)		

14

Sine vibration	Cathode sensitivity				Anode sensitivity and characteristics						Type No.
	Luminous at 25 °C		Blue sensitivity index (CS 5-58) at 25 °C		Gain at 25 °C	Luminous at 25 °C		Dark current			
								at 25 °C		at 175 °C	
	Min.	Typ.	Min.	Typ.		Typ.	Min.	Typ.	Typ.	Max.	
	(μA/lm)	(μA/lm)				(A/lm)	(A/lm)	(nA)	(nA)	(nA)	

200 m/s ² (20 g)	20	30	3.0	4.5	3.3×10^5	5	10	0.5	10	40 (90 °C)	R9722A-04
											R9722A-06
											R9722A-28
	20	40	4.0	6.0	5.0×10^5	5	20	0.5	10	1000	R9722A
											R9722A-01
											R9722A-27

R9722A-27/-28



Maximum temp. (°C)	Type No.	Base configuration	Socket or resistor value	Dynode structure number of stages	MWD appl.	Maximum ratings		Anode to cathode voltage (V)	Shock
						④	⑤		
						Anode to cathode voltage (V)	Average anode current (mA)		

51 mm (2") dia. types

90	R4607A-06	Button stem	E678-15C	Circular and linear focused/10	—	1800	0.02	1500	G	5000 m/s ² (500 g) 0.5 ms
	R4607A-28	Assembly (S/S case)	1R=2 MΩ				0.01		H	
175	R4607A-01	Button stem	E678-15C				0.02		G	
	R4607A-27	Assembly (S/S case)	1R=2 MΩ				0.01		H	

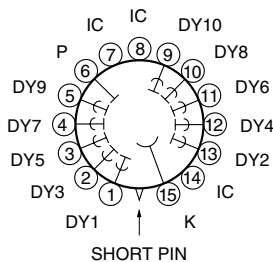
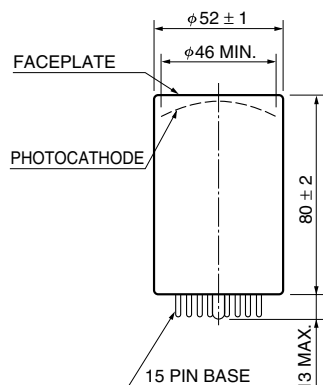
Highly ruggedized types

175	R8874-01	Assembly (S/S case)	1R=2 MΩ	Circular and linear focused/10	YES	1800	0.01	1500	E	10 000 m/s ² (1000 g)
	R5473-02	Assembly		Venetian blind/12		3000		2000	I	0.5 ms

S/S: Stainless steel

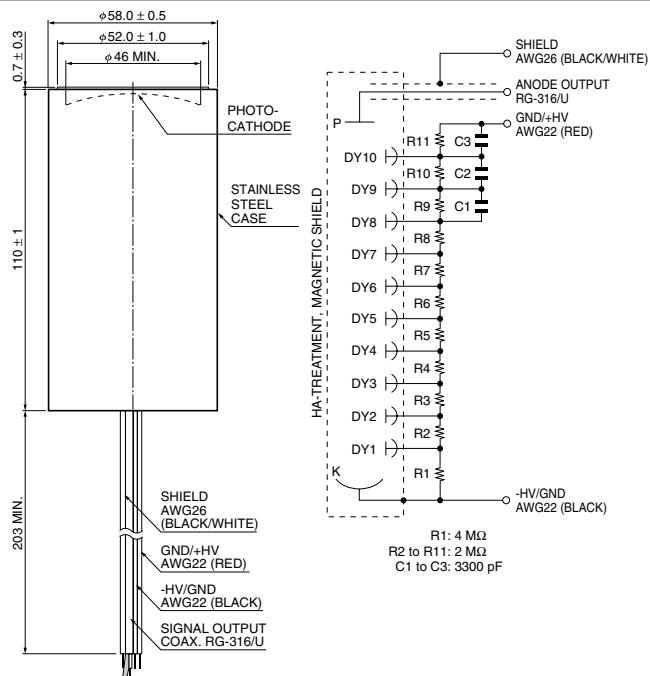
Dimensional outlines and basing diagrams (Unit: mm)

R4607A-01/-06



TPMHA0003ED

R4607A-27/-28



TPMHA0453ED

Voltage distribution ratios

Number of stages	Distribution ratio codes	Voltage distribution ratio K: Cathode Dy: Dynode P: Anode														
10	G	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P			
		2	1	1	1	1	1	1	1	1	1	1	1			
	H	2	1	1	1	1	1	1	1	1	1	1	1			
		* (3300) (3300) (3300)														
	E	3	1	1	1	1	1	1	1	1	1	1	1			
* (2000) (2000) (2000)																
12	I	K	G	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	Dy11	Dy12	P
		2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		* (4700) (4700) (4700)														

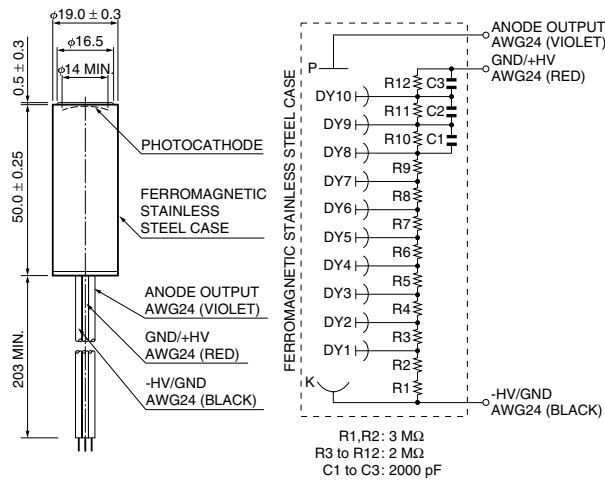
* The parentheses indicate the value of capacitors in pF.

Sine vibration	Cathode sensitivity ^⑨				Anode sensitivity and characteristics						Type No.
	Luminous at 25 °C		Blue sensitivity index (CS 5-58) at 25 °C		Gain at 25 °C	Luminous at 25 °C ^⑩		Dark current ^⑪			
								at 25 °C		at 175 °C	
	Min. (μA/lm)	Typ. (μA/lm)	Min.	Typ.	Typ.	Min. (A/lm)	Typ. (A/lm)	Typ. (nA)	Max. (nA)	Typ. (nA)	

200 m/s ² (20 g)	20	30	3.0	4.5	3.3×10^5	5	10	3	50	50 (90 °C)	R4607A-06
											R4607A-28
	20	40	4.0	6.0	5.0×10^5	5	20	3	50	1500	R4607A-01
											R4607A-27

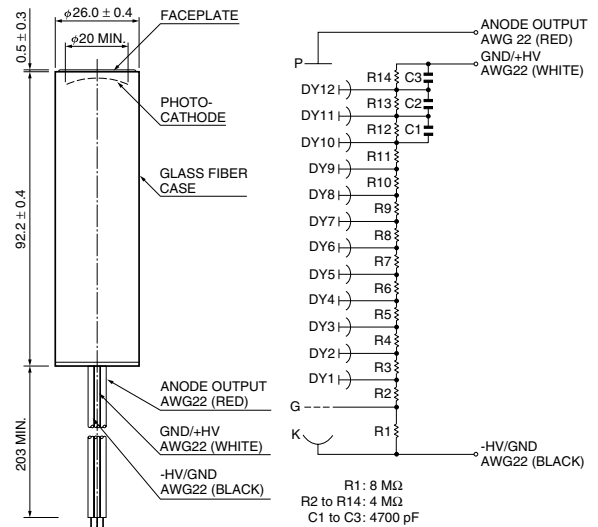
500 m/s ² (50 g)	20	40	4.0	6.0	5.0×10^5	5	20	0.1	10	150	R8874-01
	20	40	4.0	6.0	5.0×10^5	5	20	0.5	10	400	R5473-02

R8874-01



TPMHA0599EB

R5473-02 (See Note 2 on page 18)



TPMHA0349ED

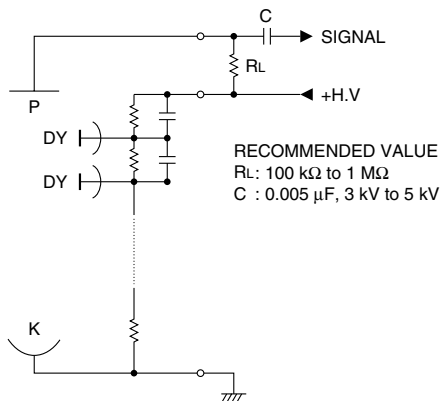
Description of the preceding data

Note 1

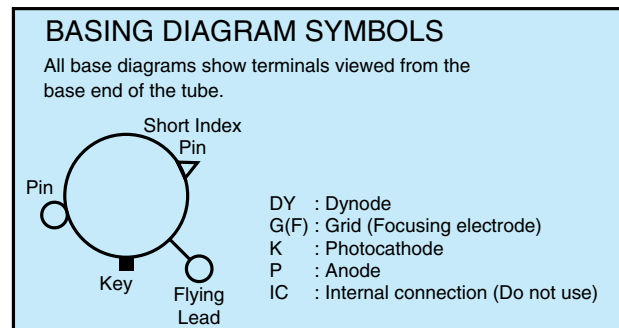
- ① Temperature cycling tests are performed for all 175 °C and 200 °C type tubes.
- ② A socket will be supplied with a tube. (Assembly type is excluded)
- ③ Screening tests are performed all R1288A-31, R1288AH-31, R3991A-31, R3991AH-31, R6877A-31 tubes. See Figure 16 and Figure 17 on page 26.
- ④ The voltage distribution ratios are shown in the bottom table of each page.
- ⑤ Averaged over any interval of 30 seconds maximum.
- ⑥ These voltages are applied when the anode sensitivity and characteristics are measured.
- ⑦ Only initial production tubes are tested for these shock tests. Conditions are as follows: 3 impact shocks per direction (6 directions)
- ⑧ Only initial production tubes are tested for these sine wave vibration tests. Conditions are as follows: 50 Hz to 2000 Hz, 1 oct. per minute, 3 sweeps per axis (3 axes)
- ⑨ The light source is a tungsten filament lamp operated at a distribution temperature of 2856K.
The light input is 0.01 lumen and 150 volts are applied between the cathode and all other electrodes connected together as anode.
In the case of blue sensitivity, a blue filter of corning CS 5-58 polished to 1/2 stock thickness is interposed between the light source and the tube.
- ⑩ The light source is a tungsten filament lamp operated at a distribution temperature of 2856K.
- ⑪ Measured after 30 min. storage in darkness.

Note 2

In use of this assembly at +HV potential, the load resistor (R_L) and the high voltage resistant capacitor (C) must be wired as follows :

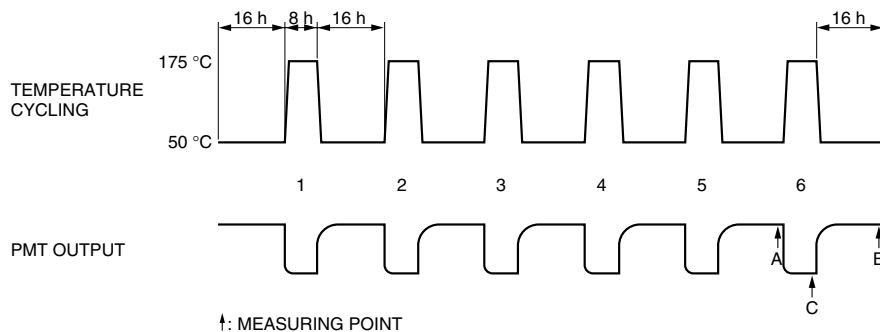


TPMHC0105EA



TPMOC0068EC

Figure 1: An example of the temperature cycling test chart



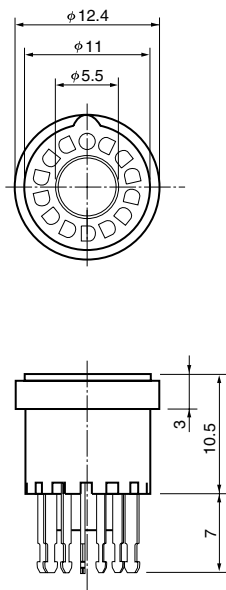
- NOTE: ① Temperature cycling tests are performed for all 175 °C and 200 °C type tubes.
- ② Temperature slope (rise/down condition) 3 °C/min. Max.
- ③ PMT output: $\frac{(B-A)}{A} < 10 \%$
- ④ PMT noise edge < 60 keV (Measured at C of PMT OUTPUT)
- ⑤ The plateau characteristic is measured by LED in C point.

TPMHC0185EC

Sockets

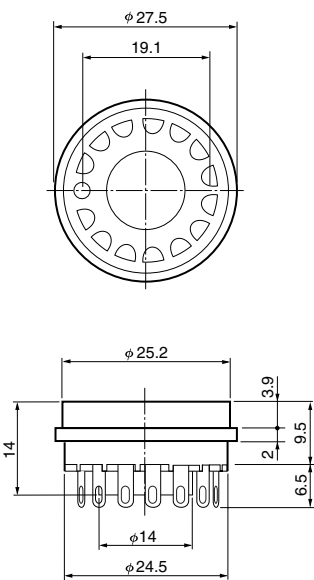
Dimensional outlines (Unit: mm)

E678-13E



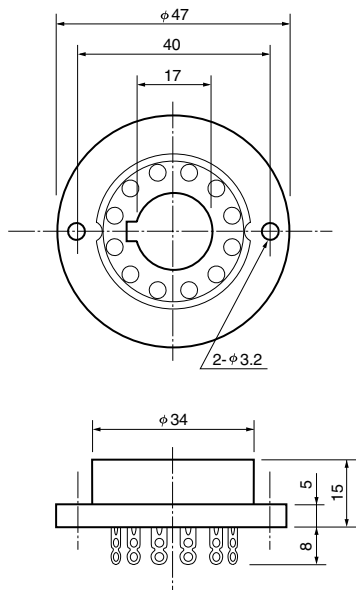
TACCA0013EB

E678-14-03



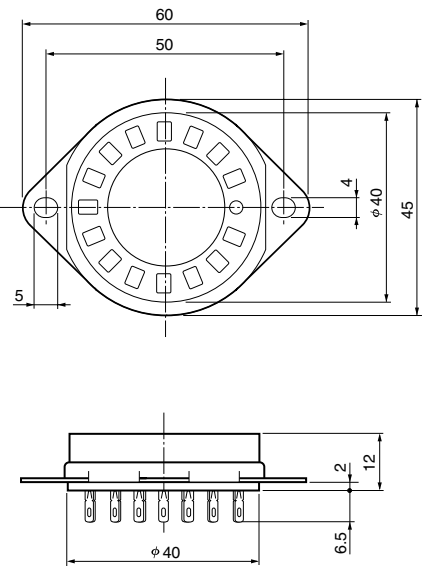
TACCA0184EA

E678-12R



TACCA0009EB

E678-15C



TACCA0185EA

Contact pins are gold plated.

High voltage power supply module C12733-01



Features

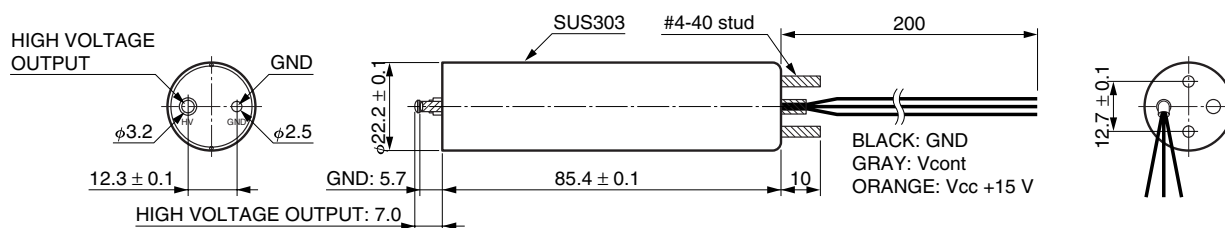
- **Wide operating temperature**
Operating ambient temperature: -40 °C to +175 °C
- **High reliability for shock / vibration**
Vibration: 300 m/s², Shock: 10000 m/s²
- **Best match with most of the hamamatsu ruggedized high temperature PMT assemblies**

Specifications

Parameters		Description / Value	Unit
Input voltage		+15 ± 1	V
Input current (with full load) ^(A)	Typ.	50	mA
Variable output voltage range		-1000 to -1800	V
Output current	Max.	90	μA
Line regulation against ±1 V input change ^{(A)(B)}	Typ.	±0.1	%
Load regulation against 0 % to 100 % load change ^(A)	Typ.	±0.1	%
Ripple / noise (p-p) ^{(A)(B)}	Typ.	50	mV
Output voltage control		By an external control voltage (0 V to +5 V)	—
Control voltage input impedance	Typ.	10	kΩ
Output voltage setting	Typ.	-(Control voltage × 160 + 1000)	V
Output voltage rise time (0 % → 99 %) ^{(A)(B)}	Typ.	350	ms
Temperature coefficient	Typ.	±0.005	%/°C
Operating ambient temperature		-40 to +175	°C
Storage temperature		-55 to +70	°C
Resistance to vibration		300 m/s ² , 10 Hz to 2000 Hz	—
Resistance to shock		10000 m/s ² , 1/2 sine, 0.5 ms	—
Weight	Typ.	80	g
Protective function		Short circuit protection	—

NOTE: (A)At maximum output voltage (B)At maximum output current

Dimensional outline (Unit: mm)



TACCA0320EA

1. General characteristics of photomultiplier tubes

1-1. General characteristics

Figure 1: Typical spectral response of 175 °C version photomultiplier tubes

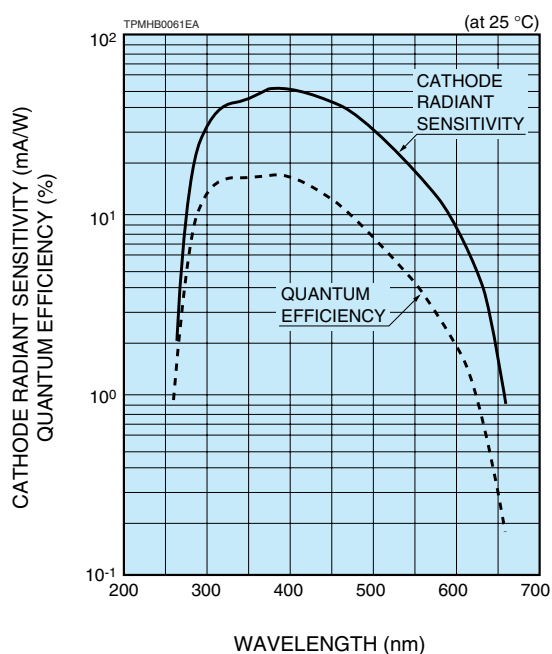


Figure 2: R1288A typical dark current characteristics as a function of temperature

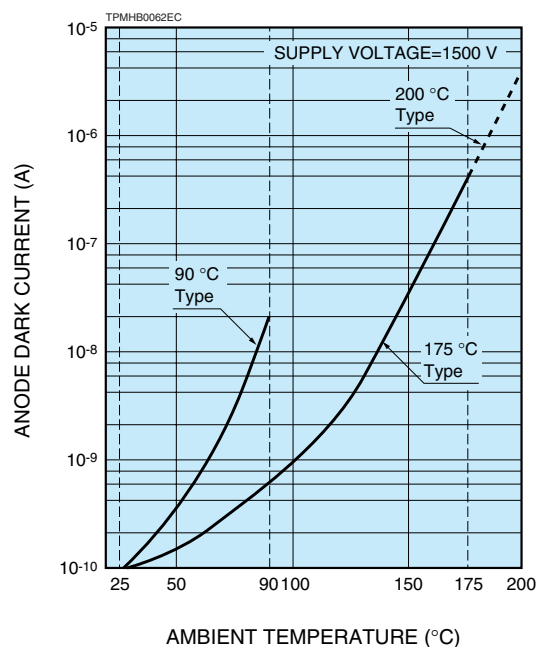


Figure 3: Typical gain

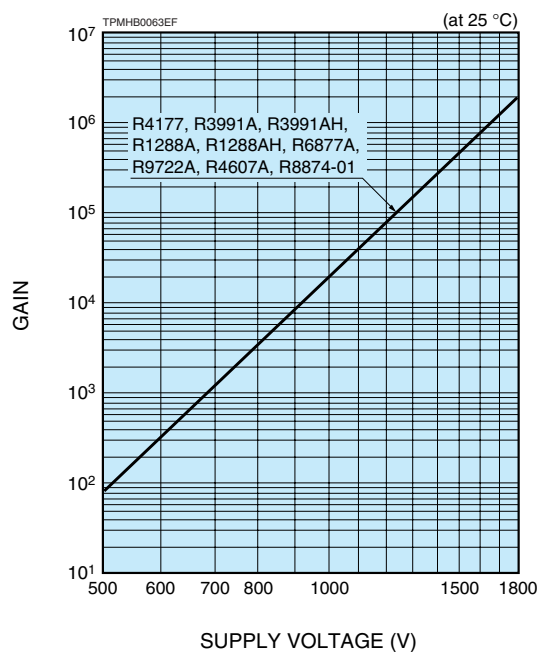


Figure 4: Typical gain

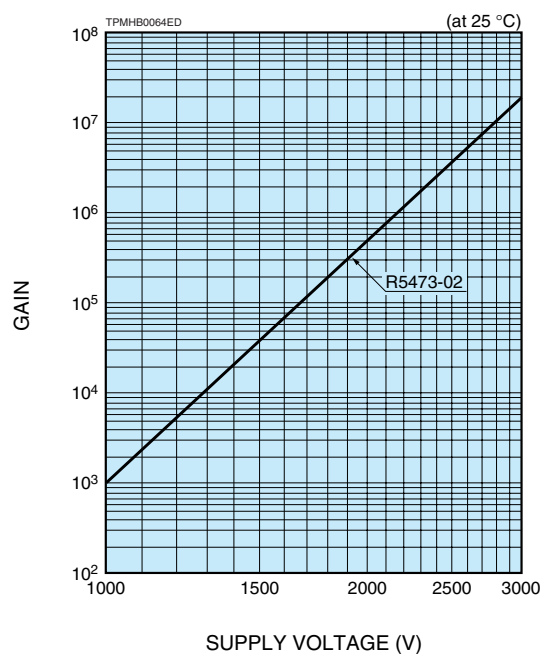


Figure 5: Typical fatigue characteristics with continuous operation (R1288A)

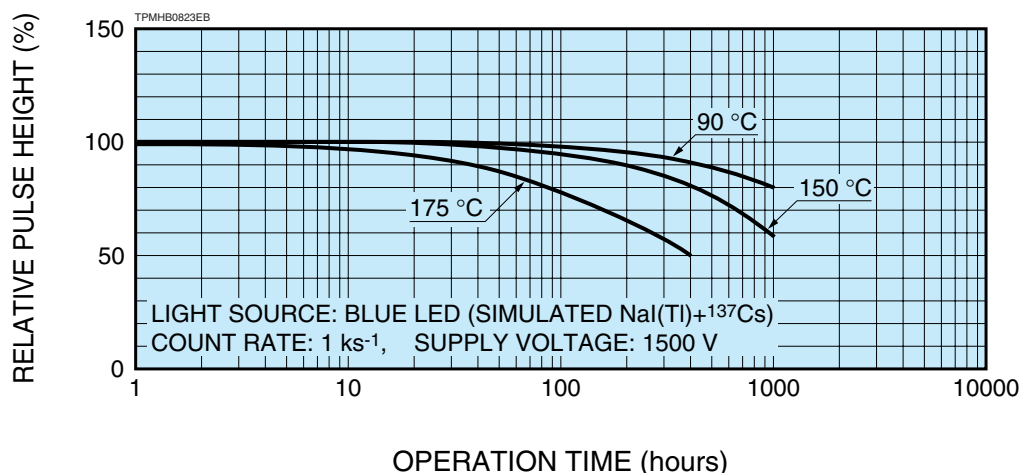


Figure 6: Typical fatigue characteristics with continuous operation (R1288AH)

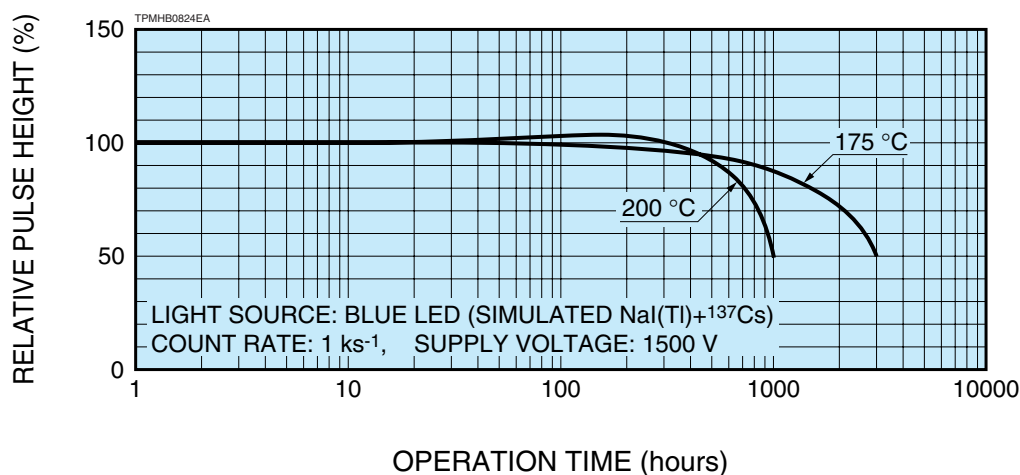


Figure 7: Typical pulse height as a function of temperature (R1288A, R1288AH, R3991A, R3991AH)

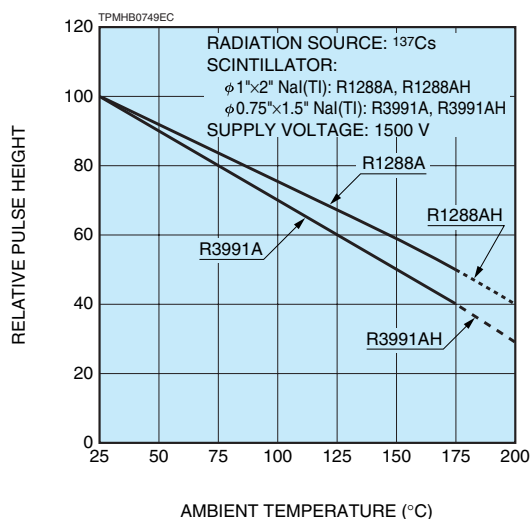


Figure 8: Typical pulse height resolution as a function of temperature (R1288A, R1288AH, R3991A, R3991AH)

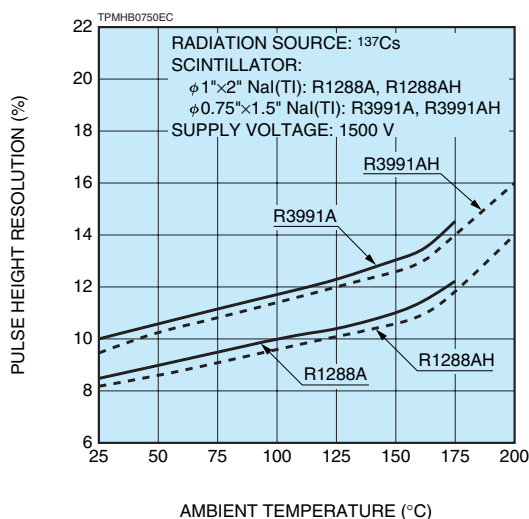


Figure 7 shows the variations of P.H. (pulse height) and Figure 8 shows P.H.R. (pulse height resolution) as a function of the ambient temperature. These degradations are due to performance changes in the photomultiplier tube and efficiency losses in the crystal at high temperature. Both parameters recover close to their initial values when tubes are returned to room temperature. P.H.R. (pulse height resolution) characteristic of a PMT may be changed by the emission efficiency of scintillator used. This data is taken with the scintillator $\phi 1" \times 2"$ NaI(Tl) for R1288A, R1288AH, $\phi 0.75" \times 1.5"$ NaI(Tl) for R3991A, R3991AH.

Figure 9: Typical plateau characteristics (R1288A, R1288AH)

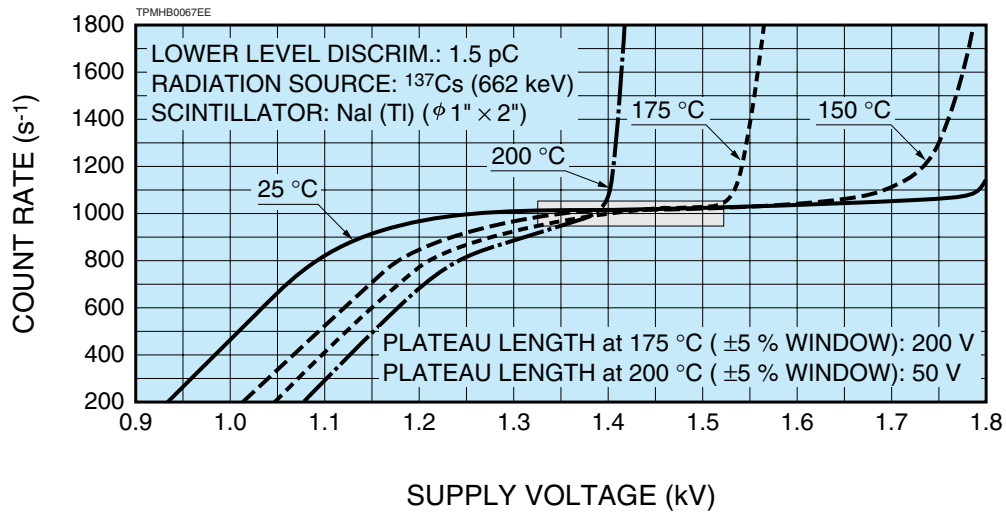


Figure 10: Typical plateau characteristics (R3991A, R3991AH)

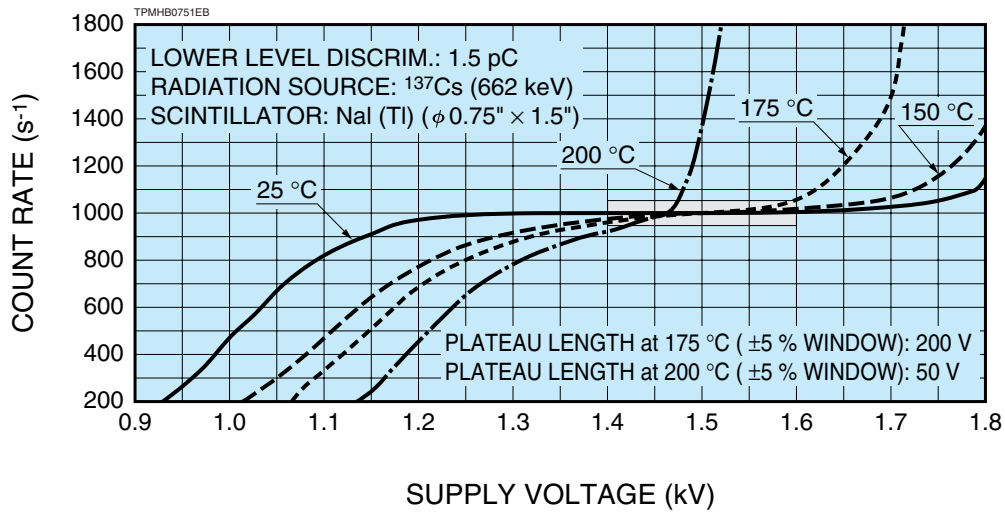


Figure 11: Typical plateau characteristics (R8874-01)

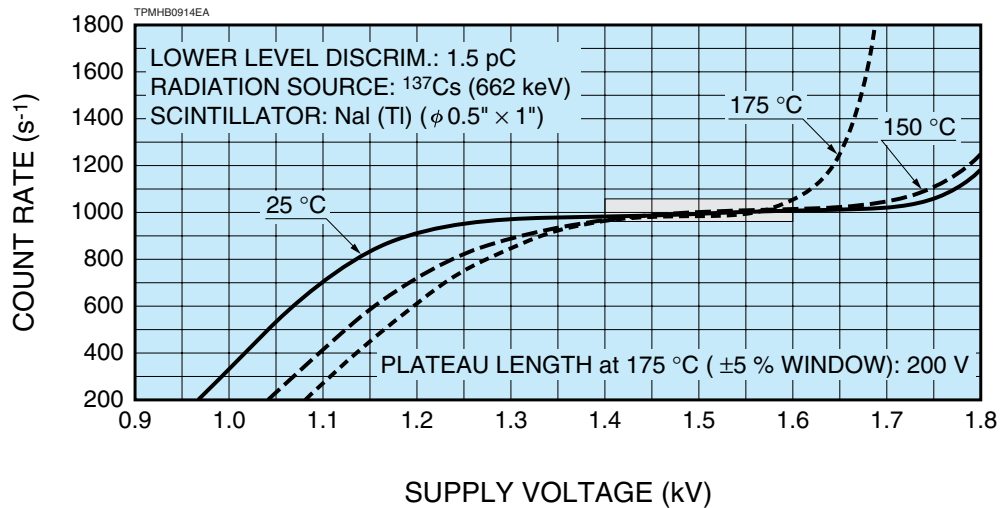
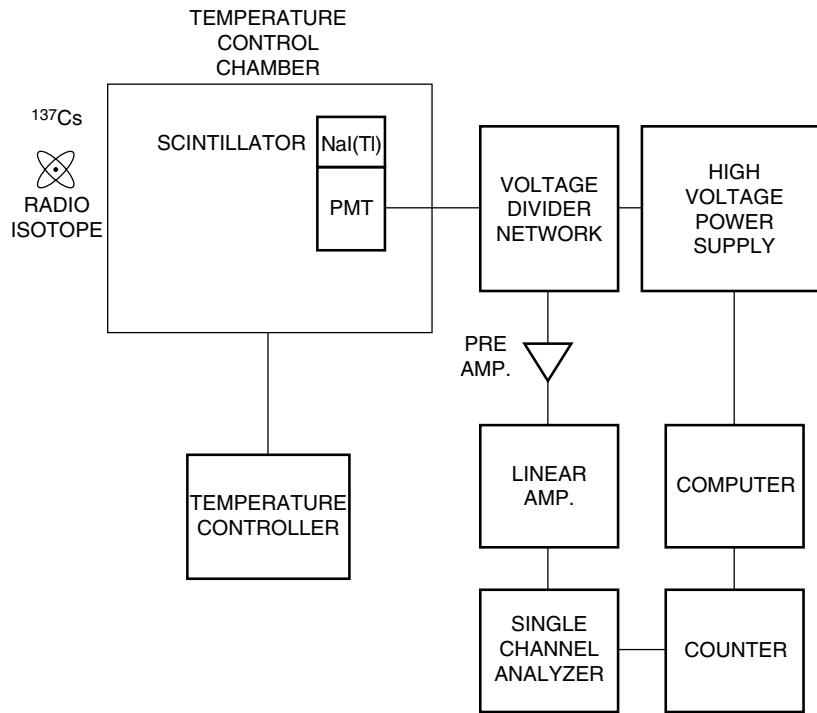


Figure 12: Plateau test block diagram



TPMHCO186EB

1-2. LLD during plateau measurement

This section describes the LLD (lower level discriminator) that should be set to make plateau measurements.

First, let us calculate the charge amount per pulse that is output from the PMT.

The number of photons emitted from a NaI(Tl) scintillator for high temperature and rugged environments is usually about 15 photons per 1 keV of gamma-ray energy.

If using ¹³⁷Cs (gamma-ray energy 662 keV), the number of emitted photons will be about 10,000. It is simply calculated by 662×15 .

If the PMT is used with a ¹³⁷Cs radiation source, the charge amount per pulse of the PMT is obtained as follows:

$$N \times \eta \times \alpha \times \mu \times e = 10,000 \times 0.15 \times 0.8 \times 5 \times 10^5 \times 1.6 \times 10^{-19} \\ = 100 \text{ pC}$$

N : Number of photons emitted from scintillator per event

η : Photocathode quantum efficiency (assumed to be 15 % at room temperature)

α : PMT collection efficiency (assumed to be 80 %)

μ : PMT gain

e : Electron charge

As calculated above, the charge amount per pulse obtained using the ¹³⁷Cs (662 keV) is about 100 pC.

The estimated charge amount obtained under the conditions at 175 °C will therefore be about 50 pC which is approximately half the charge at room temperature (See Fig. 7 on page 22).

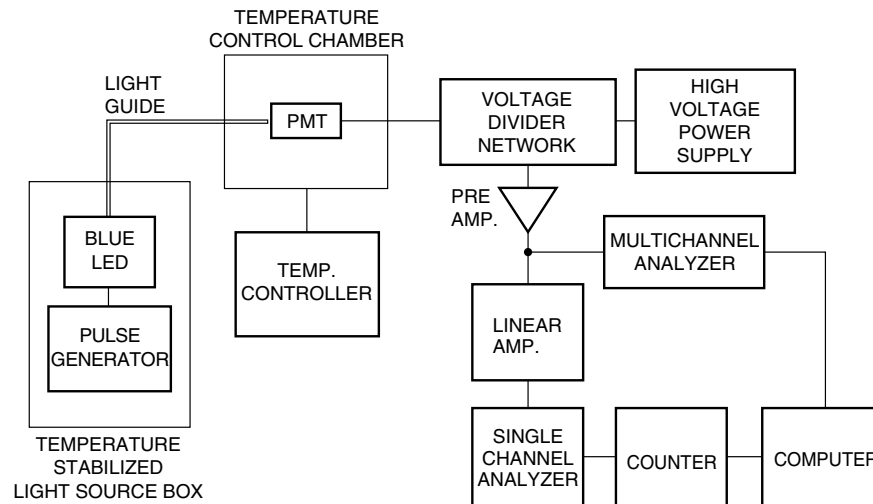
Based on these, the LLD should be adjusted to an optimal level, however, in view of the decrease in output during high temperature operation, it is preferable that the LLD be set so that a plateau region can be obtained at a voltage lower than the rated voltage.

For general characteristics when LLD = 1.5 pC, refer to Figures 9 to 11.

Since the PMT gain and the emission intensity of scintillators differ from product to product, we advise adjusting the LLD setting as needed to match the actual usage conditions so that the plateau region can be obtained below the rated voltage.

When setting the LLD, we suggest using a capacitor with a known capacitance and a pulse generator in order to calibrate by using the pulse output from the capacitor.

Figure 13: Temperature test block diagram (Temperature cycling test and plateau measurement)



TPMHC0184EC

1-3. Plateau measurement using a blue LED

Plateau measurement is usually performed by Hamamatsu with a combination of a ^{137}Cs radiation source and an NaI(Tl) scintillator, which serves as the light source. However, pulsed light from a blue LED can also be used to evaluate plateau characteristics of the photomultiplier tube. Advantages of using a blue LED is that decreasing of the emission efficiency of NaI(Tl) scintillators over time can be eliminated. In addition, the LED is set outside the temperature-controlled chamber so it is not exposed to high temperatures during measurement. This means that inherent characteristics of photomultiplier tubes can be measured. Furthermore, plateau measurement using scintillators often requires a large number of scintillators and also extra processes for measurement setups. This results in more work and increased cost in order to supply customers with plateau measurement data. Using blue LEDs allows simultaneous measurement of many photomultiplier tubes and supplying data with a minimum cost increase.

Figures 14 and 15 show comparisons of plateau length data measured using scintillators and blue LEDs. As can be seen, this data shows a good correlation. The block diagram of the test using a blue LED is also shown in Figure 13.

Figure 14: Correlation of plateau length data measured with scintillator and blue LED

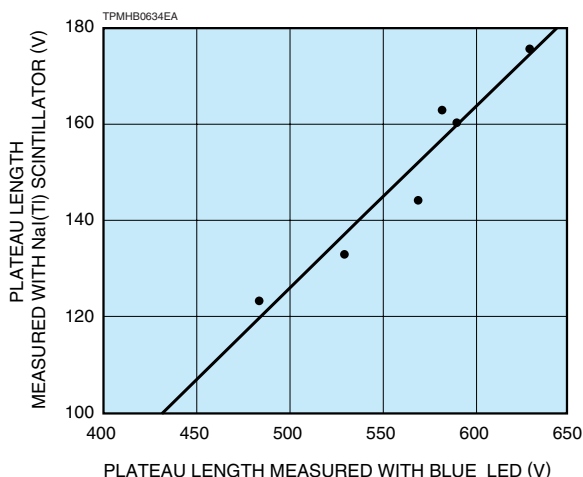
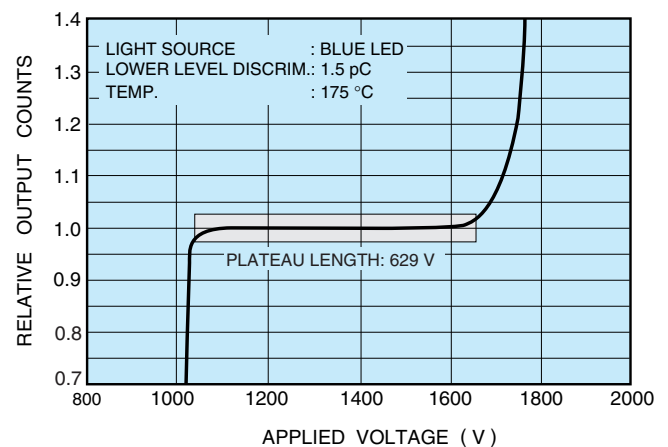
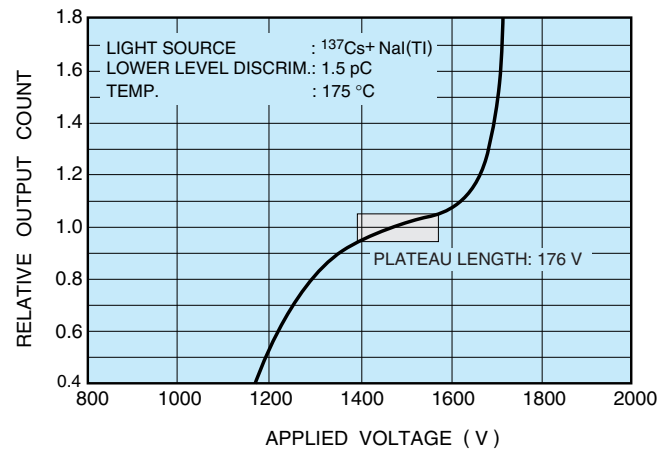
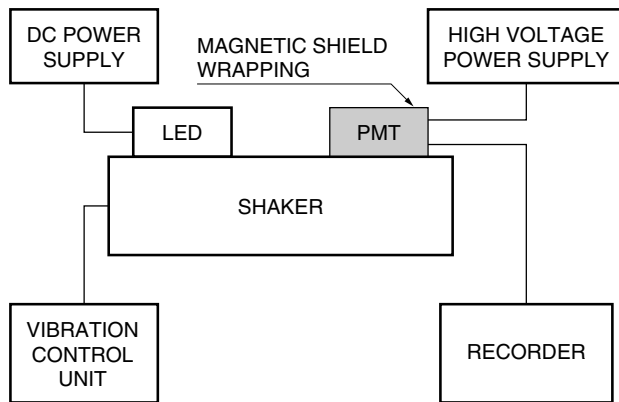


Figure 15: Plateau characteristics of R3991A measured with scintillator and blue LED



TPMHB0633EA

Figure 16: Screening test block diagram for R1288A-31, R1288AH-31, R3991A-31, R3991AH-31, R6877A-31 and an example test data



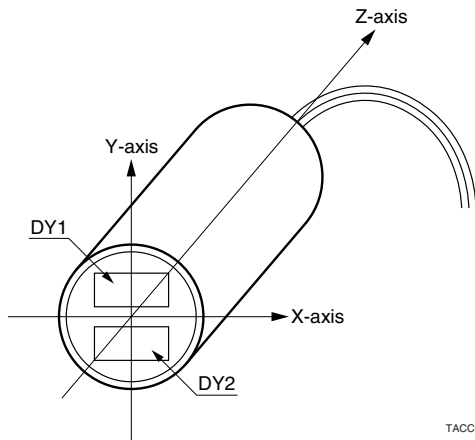
TPMHC0106EB

<Screening Condition>

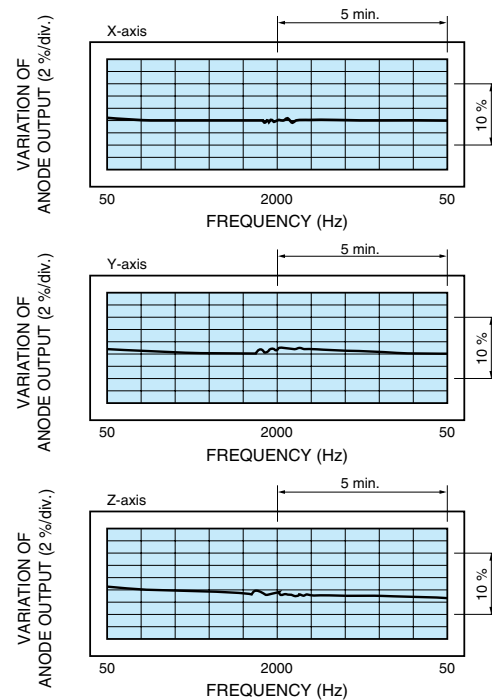
Vibration : Sine wave 200 m/s² (20 g's), 50 Hz to 2000 Hz
Sweep time : 1 oct. per minute, 1 sweep per axis (3 axes)
Supply voltage : -1500 V
Anode output current : Approx. 2 μ A (DC)

<Judgement>

Anode output variation during the screening test: less than ± 5 %



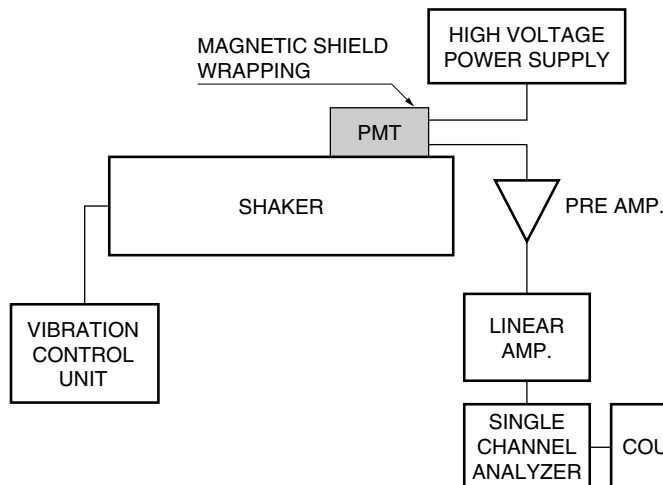
TACCC0043EB



TPMHB0220EA

Random vibration test and monitoring in counting output are also available upon request.

Figure 17: Screening test block diagram in pulse counting measurement



<Screening Condition>

Vibration : Sine wave 200 m/s² (20 g's), 50 Hz to 2000 Hz
Sweep time : 1 oct. per minute, 1 sweep per axis (3 axes)
Supply voltage : equivalent voltage of 5×10^5 gain
Lower level discrim. : 1.5 pC

<Judgement>

Anode output average noise count within 1 s⁻¹ during vibration test

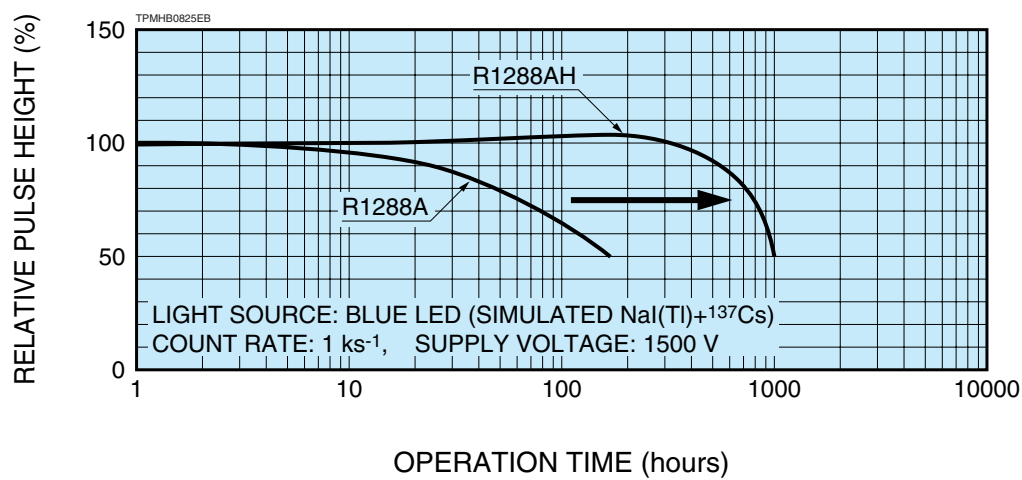
TPMHC00252EA

2. Technical information of photomultiplier tubes

2-1. Long life characteristic of R1288AH

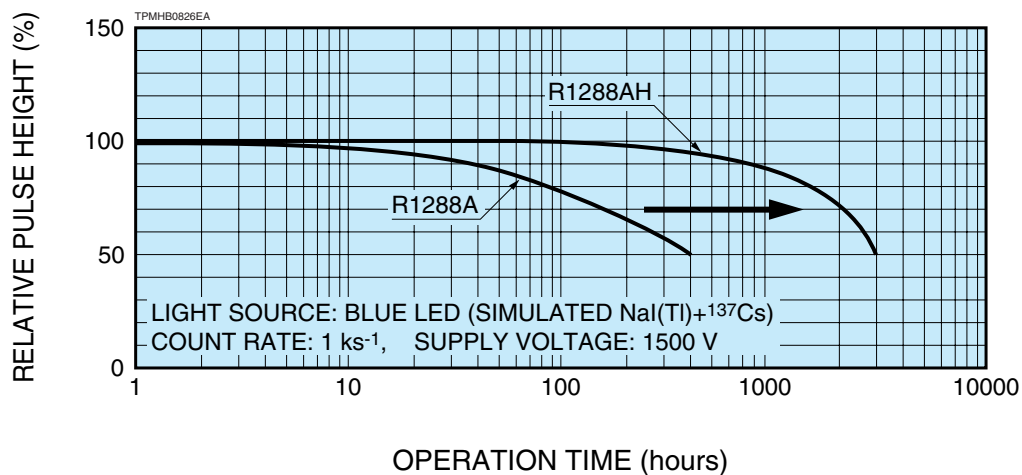
Compared to the R1288A, the R1288AH offers less degradation in output and higher stability even during continuous operation at 200 °C.

Figure 1: R1288AH relative pulse height vs. operating time (Temperature: 200 °C)



Stability is drastically improved even during continuous operation at 175 °C.

Figure 2: R1288AH relative pulse height vs. operating time (Temperature: 175 °C)



2-2. Comparison of pulse height resolution on different dia. PMTs with same sized scintillators

Figure 3: With $\phi 0.75" \times 1.5"$ NaI(Tl) scintillator

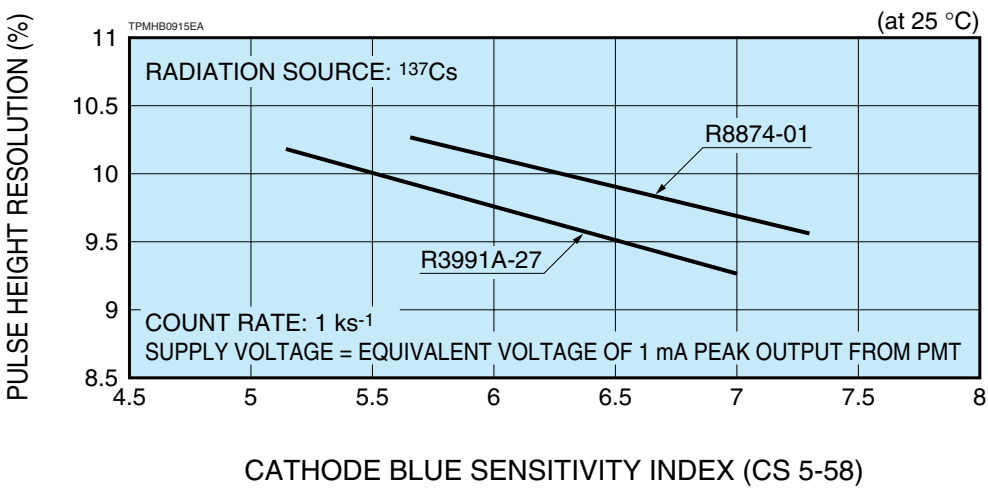
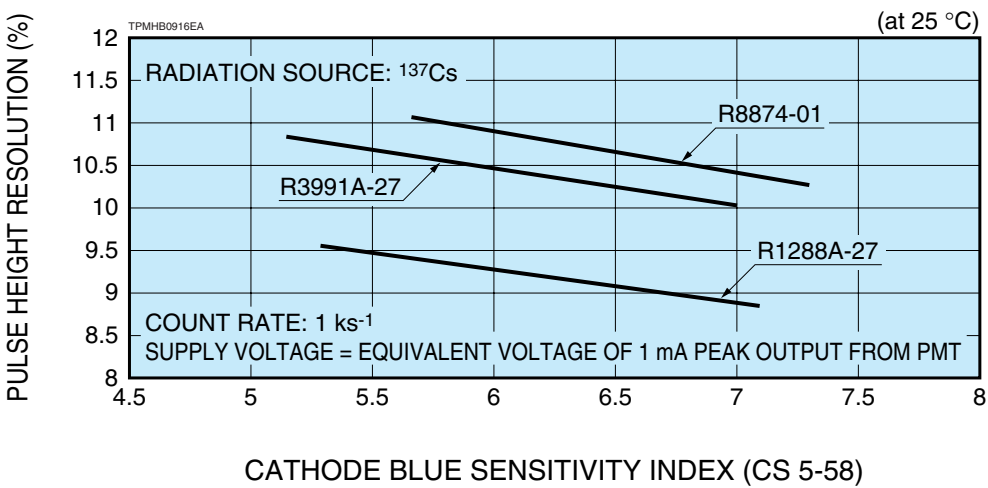


Figure 4: With $\phi 1" \times 2"$ NaI(Tl) scintillator



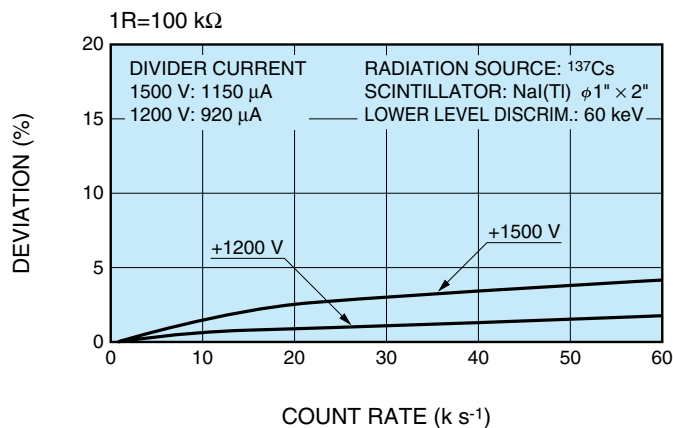
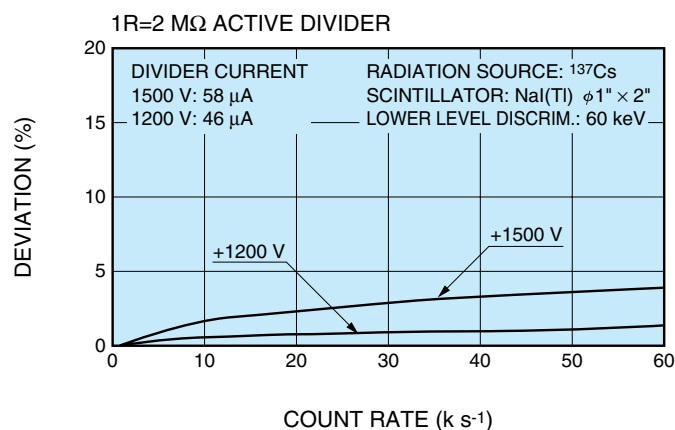
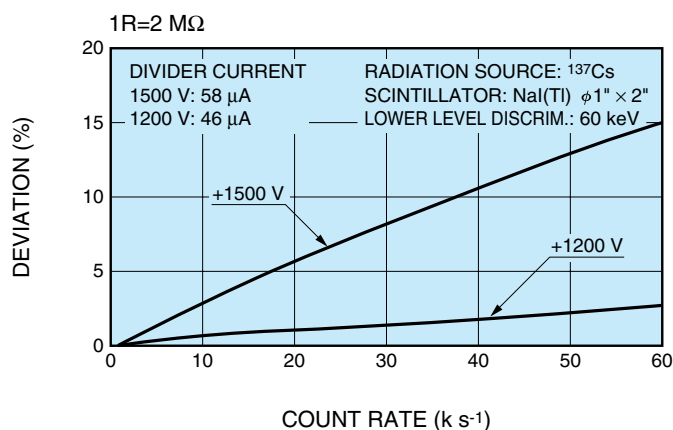
3. Technical information of photomultiplier tube assemblies

3-1. Count rate characteristics

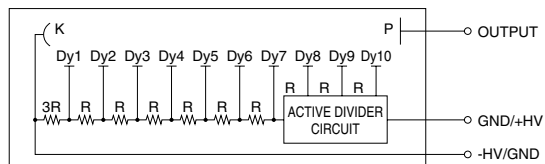
Power consumption is limited in oil well logging equipment. The voltage divider circuit for operating the photomultiplier tube must have low power consumption. A common method to lower power consumption is to use a high resistance to limit the voltage divider current. However, such a design causes deviation in photomultiplier tube gain when operated at a high count rate. An active divider circuit is effective in solving this problem. Fig-

ure 1 shows count rate characteristics of a R1288A photomultiplier tube measured with active divider circuits of different base resistors ($1R=2\text{ M}\Omega$, $1R=100\text{ k}\Omega$ and $1R=2\text{ M}\Omega$ ACTIVE DIVIDER). Active divider circuits are clearly effective in eliminating gain fluctuations while still limiting the voltage divider current. If the active divider circuit is required for your application, please contact our sales office nearest you.

Figure 1: Count rate characteristics



ACTIVE DIVIDER CIRCUIT



TPMHB0752EA

WARNING



HIGH
VOLTAGE

Take sufficient care to avoid an electric shock hazard

A high voltage used in photomultiplier tube operation may present a shock hazard. Photomultiplier tubes should be installed and handled only by qualified personnel that have been instructed in

handling of high voltages. Designs of equipment utilizing these devices should incorporate appropriate interlocks to protect the operator and service personnel.

PRECAUTIONS FOR USE

● Handle tubes with extreme care

Photomultiplier tubes have evacuated glass envelopes. Allowing the glass to be scratched or to be subjected to shock can cause cracks.

● Keep faceplate and base clean

Do not touch the faceplate and base with bare hands. Dirt and fingerprints on the faceplate cause loss of transmittance and dirt on the base may cause ohmic leakage. Should they become soiled, wipe it clean using alcohol.

● Applied force to faceplate

The maximum rating of assembly type is 20 kgf. Do not apply force to faceplate exceeding 20 kgf.

● Do not expose to strong light

Direct sunlight and other strong illumination may cause damage to the photocathode. They must not be allowed to strike the photocathode, even when the tube is not operated.

● Handling of tubes with a glass base

A glass base (also called button stem) is less rugged than a

plastic base, so care should be taken in handling this type of tube. For example, when fabricating the voltage-divider circuit, solder the divider resistors to socket lugs while the tube is inserted in the socket.

● Low temperature storage or operation

Do not leave the tube assembly having a voltage divider in the environment under -30 °C even in storage. A bare tube can withstand down to -80 °C.

● DO NOT use supersonic cleaner.

● Attached base and socket are only for lab inspection, and not guarantee for long time operation at high temperature.

Data and specifications listed in this catalog are subject to change due to product improvement and other factors. Before specifying any of the types in your production equipment, please consult our sales office.

WARRANTY

Hamamatsu photomultiplier tubes and related products are warranted to the original purchaser for a period of 12 months after delivery. The warranty is limited to repair or replacement of a defective product due to defects in workmanship or materials used in its manufacture. However, even if within the warranty period the warranty

shall not apply to failures or damages caused by misoperation, mishandling, modification or accidents such as natural or man-made disasters.

The customer should inspect and test all products as soon as they are delivered.

WHEN DISPOSAL THE PRODUCT

The material in the PMT contains beryllium alloy. Please follow the applicable regulations regarding disposal of hazard-

ous materials and industrial wastes in your country, state, region or province.

Memo

Handwriting practice lines consisting of 24 horizontal dotted lines.

HAMAMATSU

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Main Products

Electron Tubes

Photomultiplier Tubes
Photomultiplier Tube Modules
Microchannel Plates
Image Intensifiers
Xenon Lamps / Mercury Xenon Lamps
Deuterium Lamps
Light Source Applied Products
Laser Applied Products
Microfocus X-ray Sources
X-ray Imaging Devices

Opto-semiconductors

Si photodiodes
APD
Photo IC
Image sensors
PSD
Infrared detectors
LED
Optical communication devices
Automotive devices
X-ray flat panel sensors
Mini-spectrometers
Opto-semiconductor modules

Imaging and Processing Systems

Cameras / Image Processing Measuring Systems
X-ray Products
Life Science Systems
Medical Systems
Semiconductor Failure Analysis Systems
FPD / LED Characteristic Evaluation Systems
Spectroscopic and Optical Measurement Systems

Laser Products

Semiconductor lasers
Applied products of semiconductor lasers
Solid state lasers

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