HAMAMATSU CORPORATION

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To:

From: barbara corsilli

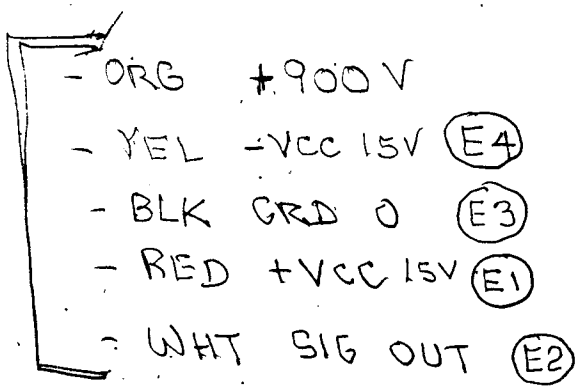
Fax: 630-979-3105

Pages (Including Cover Page):

Date: 05/11/98

Subject: R1306-02

Please note that the -02 is not available, therefore, I am sending you information on the R1306-01.
Thank you.
Barbara Corsilli



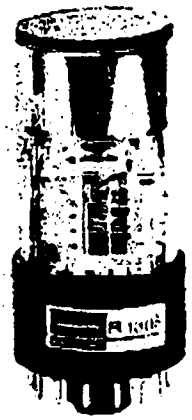
HAMAMATSU

TECHNICAL DATA SHEET No. PM-231-01(Supersedes PM-231)

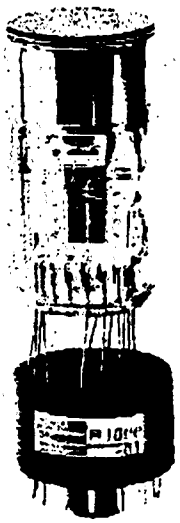
R1306
R1306-01

PHOTOMULTIPLIER TUBES

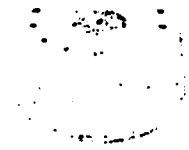
For Scintillation Counting, Especially For Gamma Camera
2" (51 mm) Diameter, 8 Stage, Head-on Type
Bialkali Photocathode Photomultiplier Tubes



R1306



R1306-01
(Semiflexible leads attached to temporary base)



E678-14A
(Option)

FEATURES:

	Typ.	Max.
• Quantum Efficiency at 420 nm	27	– %
• Pulse Height Resolution		
with ^{137}Cs Source (Note 1, 2)	6.7	7.2 %
with ^{57}Co Source (Note 1, 2)	9.3	9.8 %
• Stability		
Anode Current Drift (D.C.Output) (Note 1, 3)	3	– %
Long Term (MGD) (For 16 Hours at 1,000 cps) (Note 1, 4a)	0.5	– %
Short Term (From 10,000 cps to 1,000 cps) (Note 1, 4b)	0.5	– %

GENERAL:

Spectral Response	See Fig. 1
Wavelength of Maximum Response	420 ± 30 nm
Direct Interelectrode Capacitance (approx.)	
Anode to Dynode No. 8	6.0 pF
Anode to All Other Electrodes	6.5 pF
Window	
Material	Borosilicate glass
Index of Refraction at 420 nm	1.500 ± 0.001
Faceplate Flatness	Less than ± 50μm
Shape	Plano-plano
Dynode	
Structure	Box and grid
Material of Secondary Emitting Surface	Alkali-antimonide
Operating Position	Any
Net Weight (approx.)	154 g
Socket	HAMAMATSU No. E678-14A or equivalent

MAXIMUM RATINGS, Absolute Maximum Values:

Supply Voltage	
Between Anode and Cathode	1300 Vdc
Between Anode and Dynode No. 8	250 Vdc
Average Anode Current (Note 5)	0.1 mA
Average Cathode Current (Note 6)	50 nA
Ambient Temperature	−80 ~ +50°C

CHARACTERISTICS:

	Min.	Typ.	Max.	Units
Anode Luminous Sensitivity (Note 1, 7)	10	50	–	A/*lm*
Anode Blue Sensitivity (Note 1, 8)	–	6.0	–	A/*lm*-blue
Cathode Luminous Sensitivity (Note 9)	80	95	–	μA/*lm*
Cathode Blue Sensitivity (Note 10)	10	11.5	–	μA/*lm*-blue
Current Amplification (Note 1)	–	5.2×10^5	–	–
Anode Dark Current (Note 1, 11)	–	5	20	nA
Time Response				
Anode Pulse Rise Time (Note 1, 12)	–	12	–	ns
Electron Transit Time (Note 1, 13)	–	57	–	ns

FIGURE 1
Typical Spectral Response

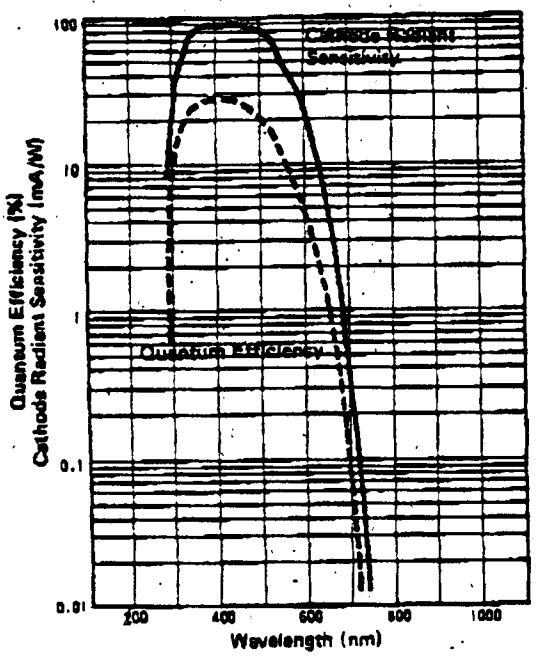


FIGURE 2
Anode Sensitivity and Amplification Characteristic (Note 1, 7)

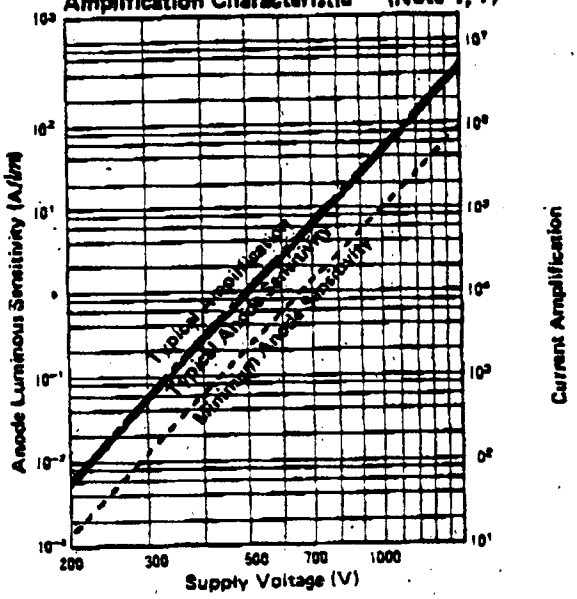


FIGURE 3
Effect of Magnetic Field

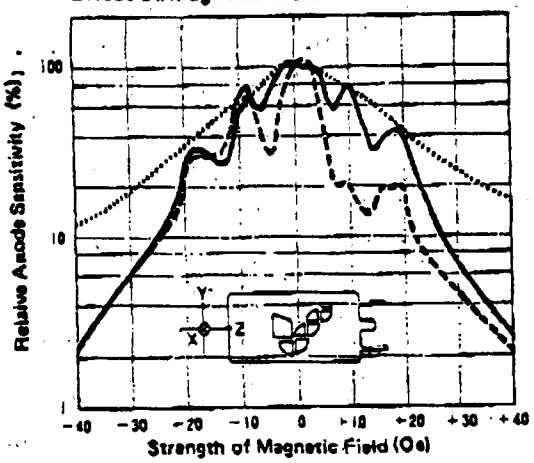


FIGURE 4
Typical Time Response (Note 1, 12, 13)

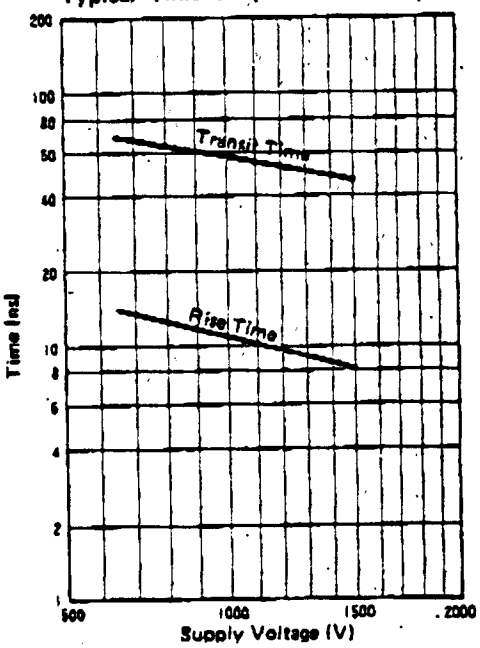


FIGURE 5 (a)
Typical Single Photoelectron Pulse Height Distribution (See Fig. 5 (b) and Note 14)

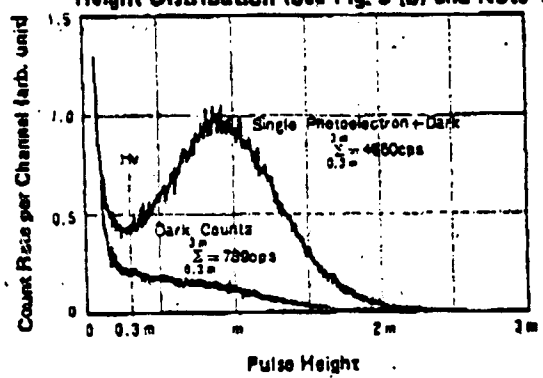
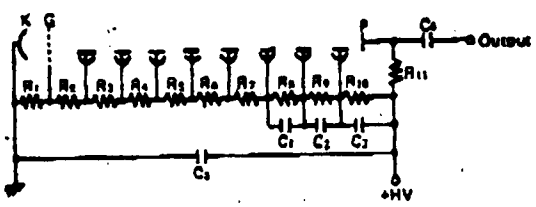


FIGURE 5 (b)
Voltage Divider for PHD Measurement



R1 ~ R10 : 200 kΩ, R11 : 1 MΩ
C1 - C5 : 0.01 μF, C6 : 0.022 μF, C7 : 0.01 μF, C8 : 0.005 μF

FIGURE 6
Typical Temperature Characteristic on Dark Current
Measured after 16-hour storage in the dark.
(Note 1)

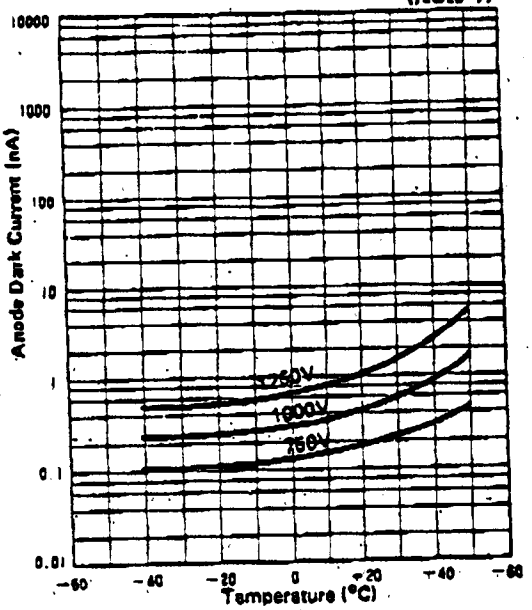


FIGURE 7
Typical Temperature Characteristics on Pulse Height of ^{57}Co
(Note 1, 2)

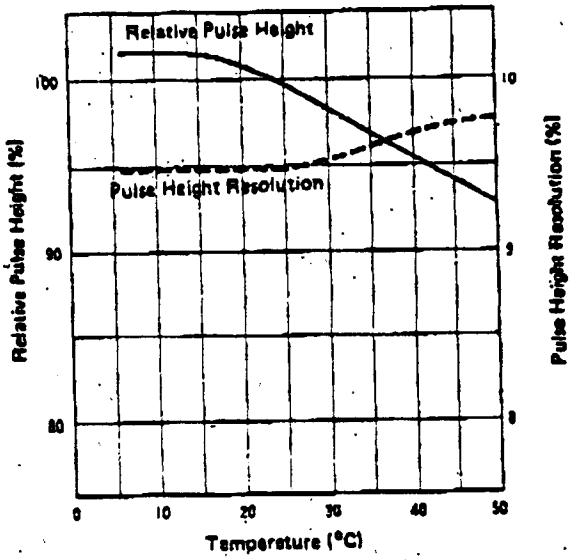
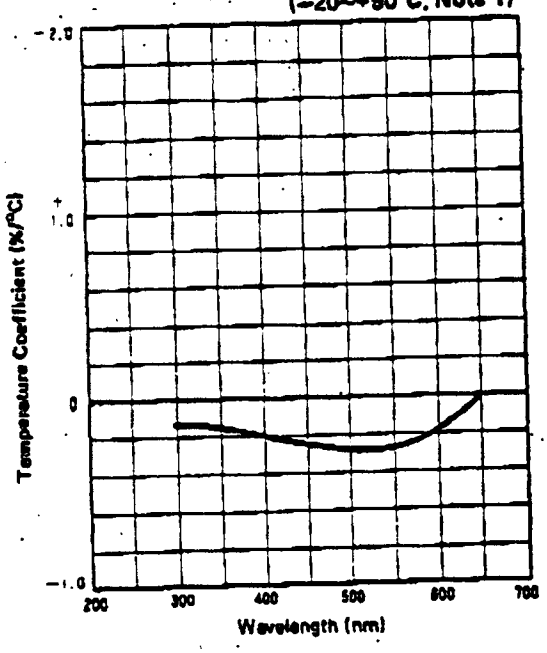


FIGURE 8
Typical Temperature Coefficient of Anode Sensitivity
(−20~+50°C, Note 1)



NOTES

1. Voltage distribution ratio
   Supply voltage (Ebb) = 1000 Vdc
   K: Cathode, G: Focusing Electrode, Dy: Dynode, P: Anode

electrode	K	G	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	P
distribution ratio	1	1	1	1	1	1	1	1	1	1	

2. Scintillator is manufactured by Harshaw Chemical. (Type BD B), and BICRON (Type 2R2), NaI(Tℓ), 2" diameter 2" thickness.
3. Drift for 1 hour after 10 minutes of initial warming up with 10 μA anode current.
4. A ^{137}Cs source and an NaI(Tℓ) crystal are employed to measure the pulse height. Warming up time is about 1 hour.
   a) Long term (Mean Gain Deviation) is defined as follows.

$$Dg = \frac{\sum_{i=1}^{n} |P - P_i|}{n} \cdot \frac{100}{P} \quad (\%)$$

   where P is the mean pulse height averaged over n readings, P_i is the pulse height at the i-th reading, and n is the total number of readings.
   b) Short term
   Scintillator (NaI(Tℓ) crystal) is 2" diameter 2" thickness. The photomultiplier is first operated at about 10,000 cps. The photopeak counting is then decreased to approximately 1,000 cps by increasing the distance between source and crystal on the tube.
5. Averaged over any interval of 30 seconds maximum.
6. Same as Note 5 and the whole photocathode is illuminated.
7. The light source is a tungsten filament lamp operated at a distribution temperature of 2856K. The light input of 10^{-7} lumen is used.
8. The value is anode output current when the blue filter (Corning CS No. 5-58 polished to 1/2 stock thickness) is interposed between the light source (providing 10^{-7} lumen) and the tube under the same condition as Note 7.
9. The condition is the same as shown in Note 7 except that the value of light input is 10^{-4} lumen and 150 volts are applied between cathode and all other electrodes connected together as anode.
10. These values are cathode output current when the blue filter (Corning CS No. 5-58 polished to 1/2 stock thickness) is interposed between the light source (providing 10^{-4} lumen) and the tube under the same condition as Note 9.
11. Measured after 5-second storage in the dark.
12. The rise time is the time for the output pulse to rise from 10 % to 90 % of the peak output when the tube is illuminated by a flash of light of very short duration. In measurement, the whole photocathode is illuminated.
13. The electron transit time is the interval between the arrival of delta function light pulse at the entrance window of the tube and the time when the output pulse at the anode terminal reaches peak amplitude.
14. m is the mean value of total counts, i.e.

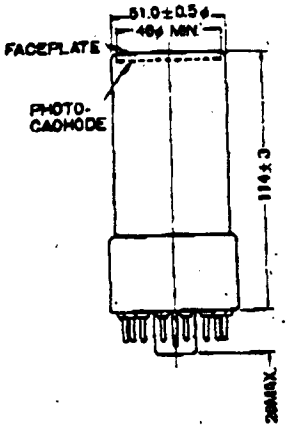
$$\sum_{0.3m}^{m} (\text{counts per channel}) = \sum_{ch}^{320} (\text{counts per channel})$$

Test conditions: Incident light wavelength is 400 nm. Supply voltage is +1000V. Ambient temperature is 20°C. The voltage divider is shown in Fig. 5(b).

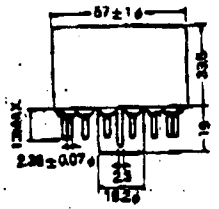
R1306,R1306-01 PHOTOMULTIPLIER TUBES

FIGURE 9
Dimensional Outlines (Unit:mm)

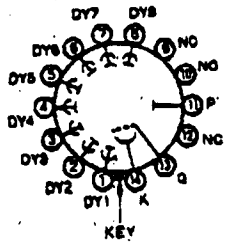
a) R1306



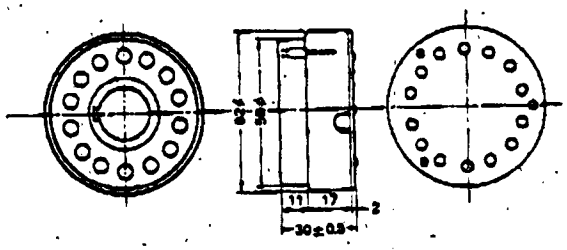
Detail of Base
(JEDEC No. B14-38)



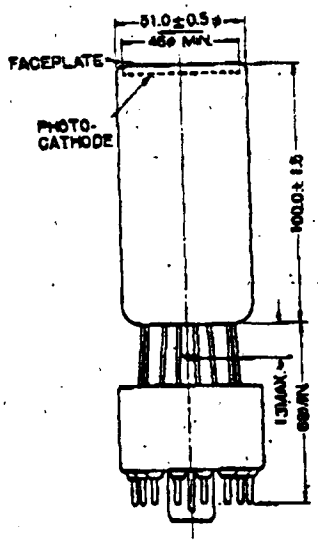
Basing Diagram
(Bottom View)



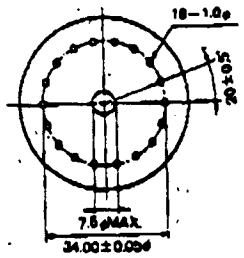
Socket (E678-14A, available as an option)



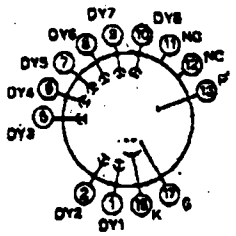
b) R1306-01



Detail of Stem
(Bottom View)



Basing Diagram
(Bottom View at
Semiflexible Leads)



• Basing diagram of temporary base is the same as that of R1306.

Warning — Personal Safety Hazards
Electrical Shock — Operating voltages applied to this device present a shock hazard

PHOTON IS OUR BUSINESS

HAMAMATSU

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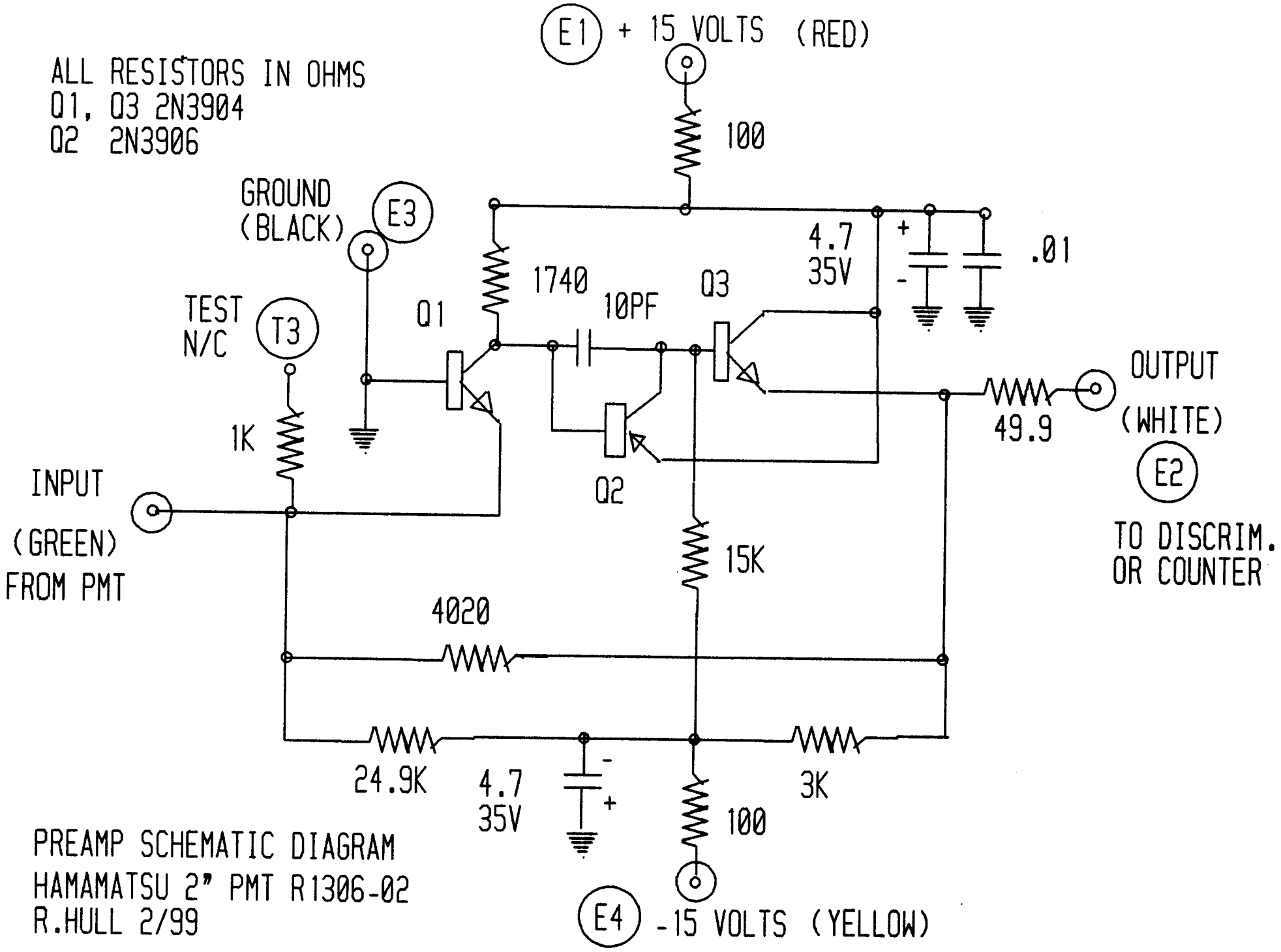
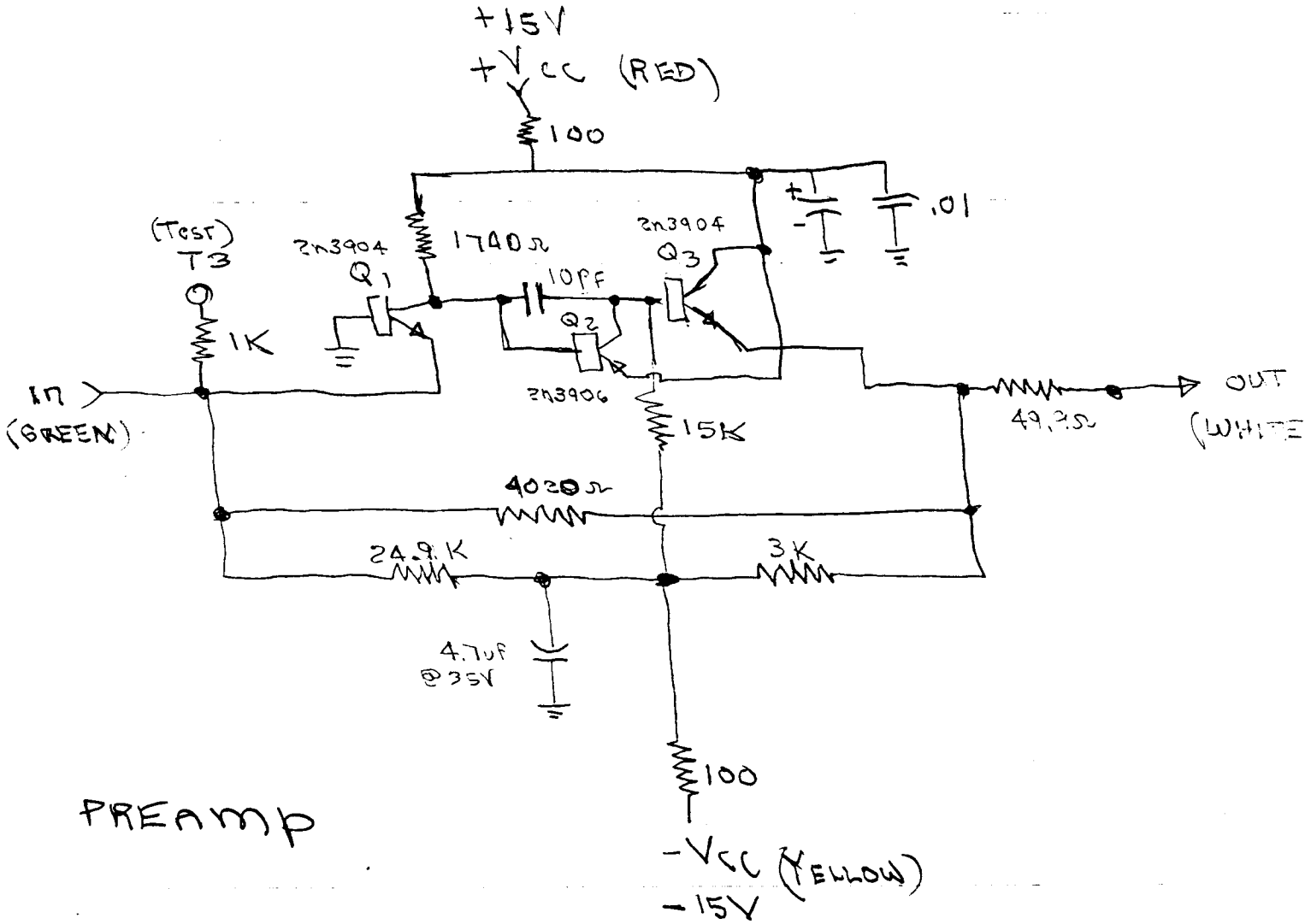
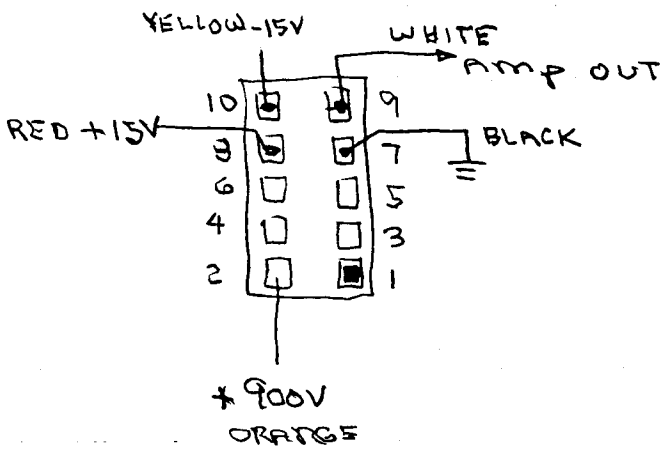
T80-11-15


ALL RESISTORS IN OHMS
Q1, Q3 2N3904
Q2 2N3906
E1
+ 15 VOLTS (RED)
100
GROUND
(BLACK)
E3
4.7
35V
.01
1740
10PF
Q3
Q1
TEST
N/C
T3
OUTPUT
(WHITE)
49.9
E2
1K
INPUT
(GREEN)
FROM PMT
Q2
15K
TO DISCRIM.
OR COUNTER
4020
24.9K
4.7
35V
3K
100
PREAMP SCHEMATIC DIAGRAM
HAMAMATSU 2" PMT R1306-02
R.HULL 2/99
E4
-15 VOLTS (YELLOW)

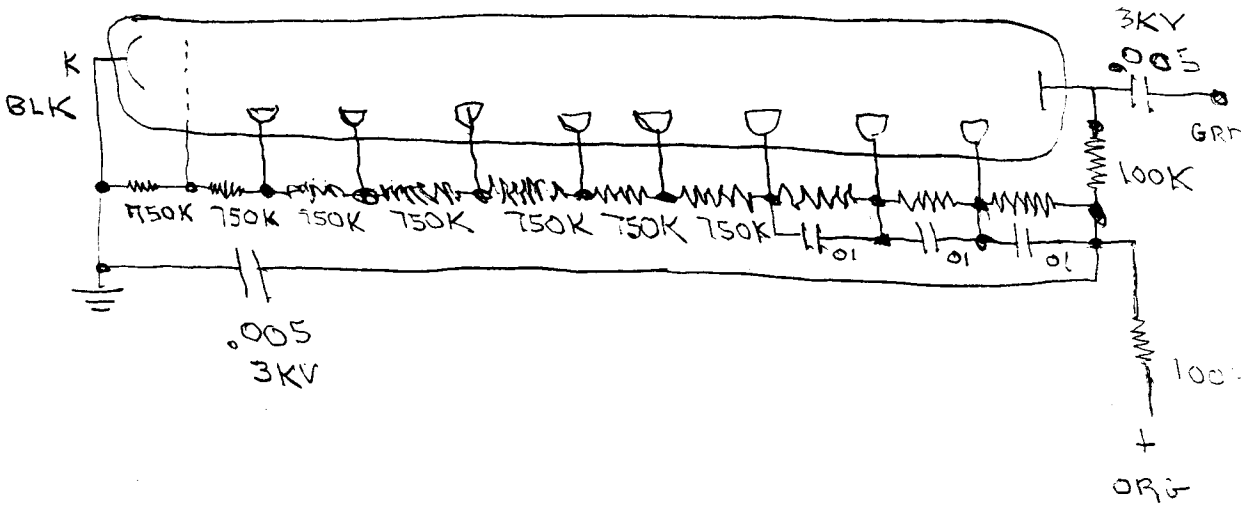


PREAMP

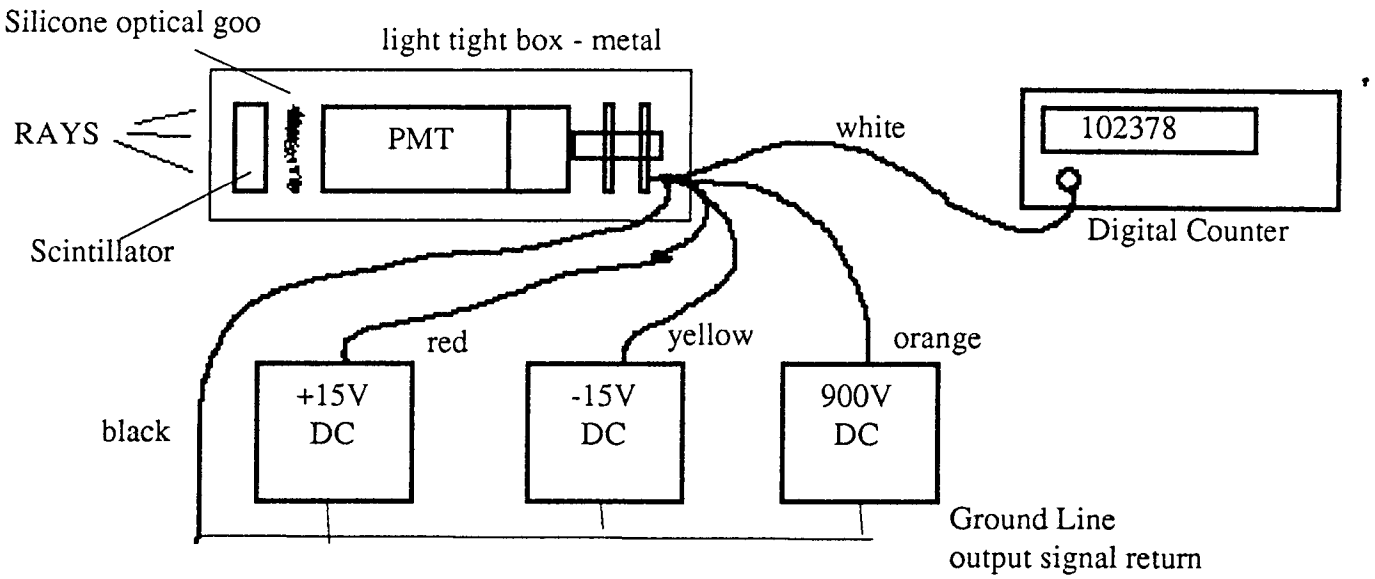


PLUG
CONNECTOR

HAMAMATSU R1306-02



Full system diagram



Above is a diagram to illustrate the PMT in use in a system to detect any form of radiation. The plastic scintillator must be purchased. A good inexpensive source is listed below for the BC-400 plastic. Silicone optical couling compound is smeared on the plastic and PMT face place to join them together for a perfect non- refractive, clear transmission of the light. Make this coupling well and seal the two together with plenty of black electrical tape wrapped around the tube and scintillator at the joint. The digital counter is suggested, but an oscilloscope or computer inteface is also possible. The power supplies are not critical and the 900 volt supply can supply as little as 500 microamps. Never expose a powered up PMT to even the tiniest trace of light!! The metal (preferably steel) box or enclosure must be truely light tight and painted flat black inside. It is important to obtain light, magnetic and electrostatic shielding for the tube. Be very careful about the electrical connections!
The wires are color coded and only a real dummy will hook them up incorrectly. I warrant this assembly to be working correctly and will, for 90 days, cover any problems other than obvious user broken tubes or reversed electrical hookups. Return to me for replacement. **No refunds - Replacement only**

Bicron BC-400 or equivalent nuclear scintillation plastic can be obtained very inexpensively from O.E. Technologies, Box 703, Madera, NM 87539. Contact Don Orie (505) 583-2482

The BC-720 Fast Neutron plastic scintillator can be purchased only from Bicron. Bicron Corp., Newbury, Ohio (216) 564-2251

Ideally, you should be asking for a 2" diameter, round scintillator. They are typically 1/2" to 1" thick.

I am not going to buld this thing for you, but for simple questions and provided you are not a pest, call me for ideas, tips, once you get down to the "doing". Richard Hull (804) 262-9499