

HAMAMATSU

Customer: HPF/IN2P3 ORSAY

Final Test Sheet

Quantity: 1 pce.

MCP-PMT

(Microchannel Plate Photomultiplier Tube)

R10754X-01-M16

Date: Dec. 6, 2010

Tested by:

Kazumasa Katoh
Kazumasa Katoh

Checked by:

Tsuneo Ihara
Tsuneo Ihara

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1) Test Parameters and Results

- a. Photocathode Spectral Response and Quantum Efficiency Fig. 1
- b. Photocathode Luminous Sensitivity Note 1) 150 $\mu\text{A/lm}$
- c. Average Current Gain and Dark Current Characteristics Note 2) Fig. 2
Average Current Gain at -3250 V 1.0×10^6
Average Dark Current at -3250V 0.83 nA
- d. Output Waveform Note 3) Fig. 3
Rise Time 143 ps
- e. Instrument Response Function (IRF) Note 4) Fig. 4
IRF at FWHM 75.5 ps
Estimated TTS at FWHM Note 5)
- f. Dark Counts $1.0 \times 10^4 \text{ s}^{-1} (\text{cps})$

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2) Maximum Ratings

a. Maximum Supply Voltage

between Photocathode and MCPin.....	180 V
MCPin and MCPout.....	2680 V
MCPout and Anode.....	540 V

b. Maximum Anode Current

Continuous Current per Anode.....	100 nA
Pulsed Peak Current per Anode Note 8).....	350 mA
Ambient Temperature in Operation.....	-20 to +40 °C
in Storage.....	-55 to +65 °C

3) Drawings

- a) Dimensional outlines of the Tube..... Fig. 5

4) Block Diagrams of the Measuring Apparatus

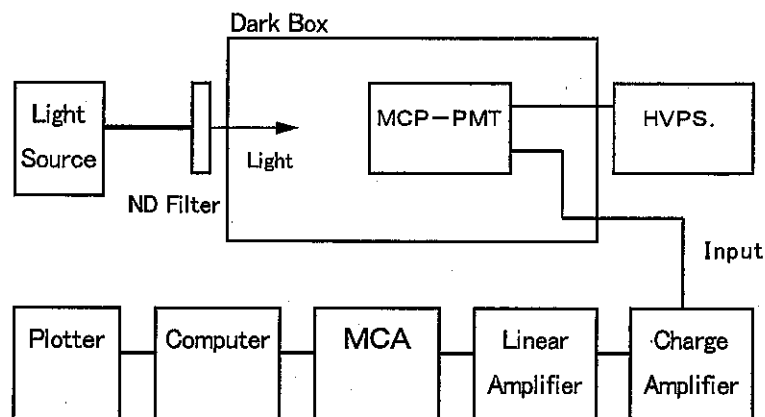
- a. Output waveform measuring apparatus..... Fig. A
- b. IRF measuring apparatus..... Fig. B
- c. Dark Counts measuring apparatus..... Fig. C

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Fig. C Block Diagram of Dark Counts Measuring Apparatus



Equipments	Model Numbers	Specs & Adjustments
Light Source	Royal / #LNS-MD7-545(Halogen Lamp)	Operating Voltage: 5 V dc max.
HVPS	Hamamatsu / #C3360	Output: -5000 V dc max.
Charge Amplifier	Canberra / #2005	Output: 22.5 mV/pC
Linear Amplifier	NAIG / #E-511	
MCA	NAIG / #E-552A / E-562A / E-563A	
Computer	NEC / #PC9801	
Plotter	Graphtec / #9411F	

(Notes)

- 1) The light source used to measure the luminous sensitivity is a halogen lamp operated at a distribution temperature of 2856 K. The input light is approximately 10^{-4} lumen and 100 V dc is applied between photocathode and other electrodes connected all together. The measurements were done under room temperature.

- 2) These were tested by using the voltage divider circuit. The voltage divider ratio is as follows;

$$\begin{aligned} &\text{Photocathode} - 1\text{st MCPin} - 1\text{st MCPout} - 2\text{nd MCPin} - 2\text{nd MCPout} - \text{GND}(=\text{Anode}) \\ &= 0.5 - 2.5 - 2.5 - 2.5 - 1.5 \end{aligned}$$

The entire photocathode was illuminated by the halogen lamp operated at continuous current while tested.

- 3) It is defined as a mean time difference from 10 to 90 % of peak amplitude on the output waveform.
- 4) IRF is a convolution of δ -response function of the measuring apparatus and a function of laser, including pulse width and time jitters. It is defined as FWHM.
- 5) The TTS stands for Transit Time Spread which is a function in transit time between individual pulse and specified as an FWHM (full width at half maximum) with the incident light having a single photoelectron state. The TTS value calculated herein contains a time jitters of all electronics and laser used in IRF measurement.

TTS can be estimated temporarily by the following equation:

$$(\text{IRF})^2 = (\text{TTS})^2 + T_w^2 + T_j^2$$

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Spectral Response Characteristics

Tube Type R10754X-01-M16
Serial No. JT0105
Date Nov.11, 2010

Tested by J.Ohmura
Note + 200 V

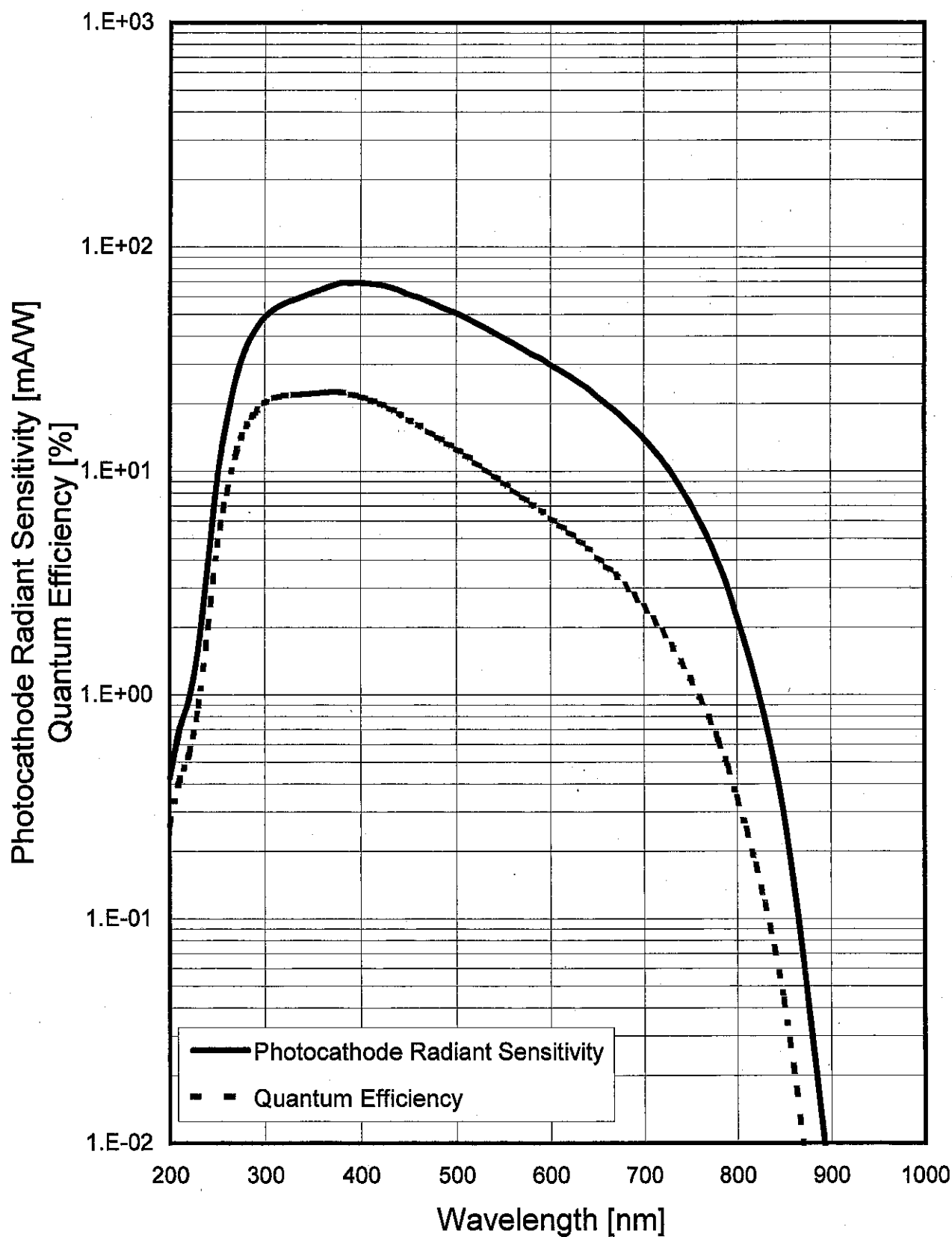
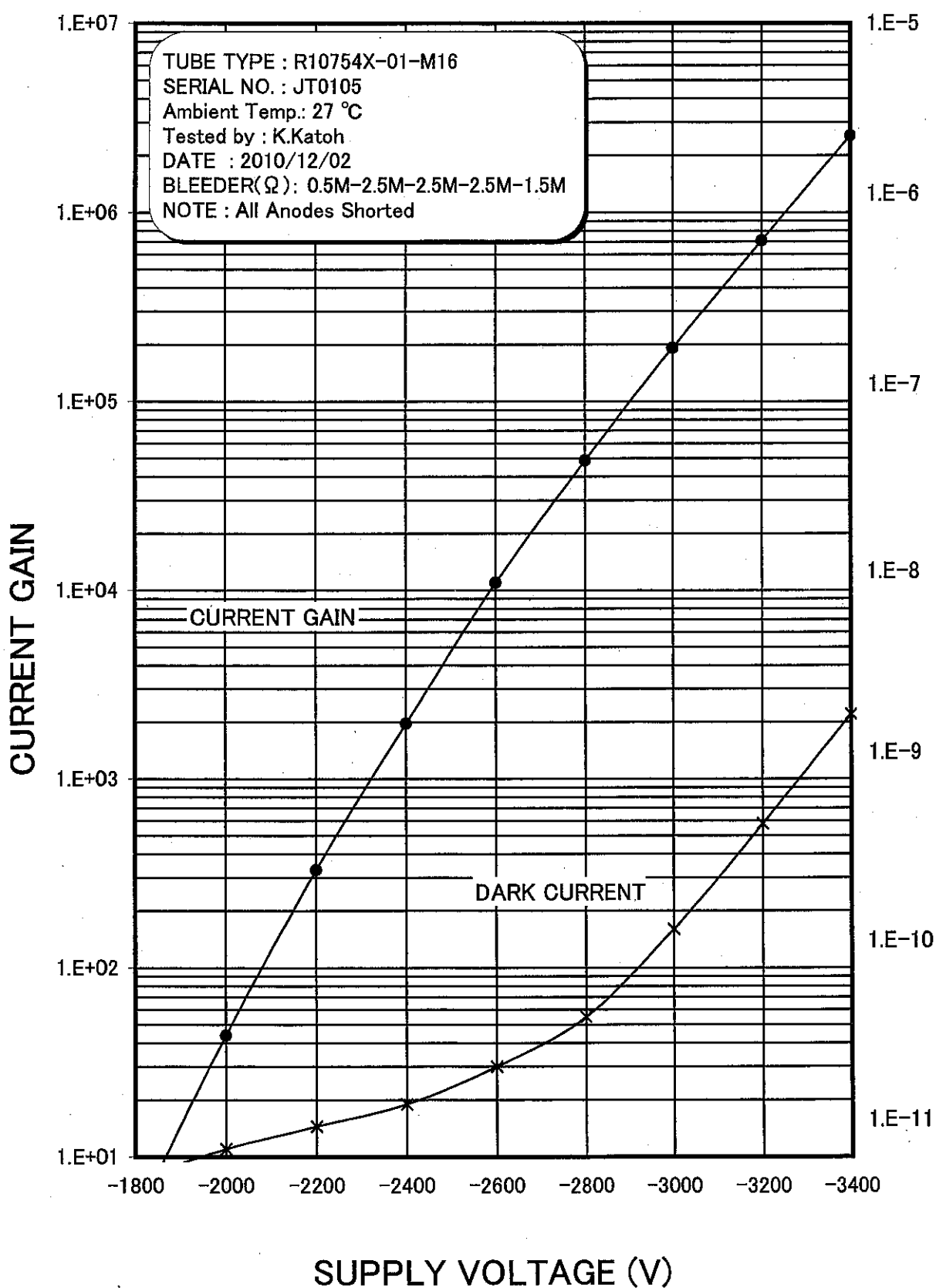
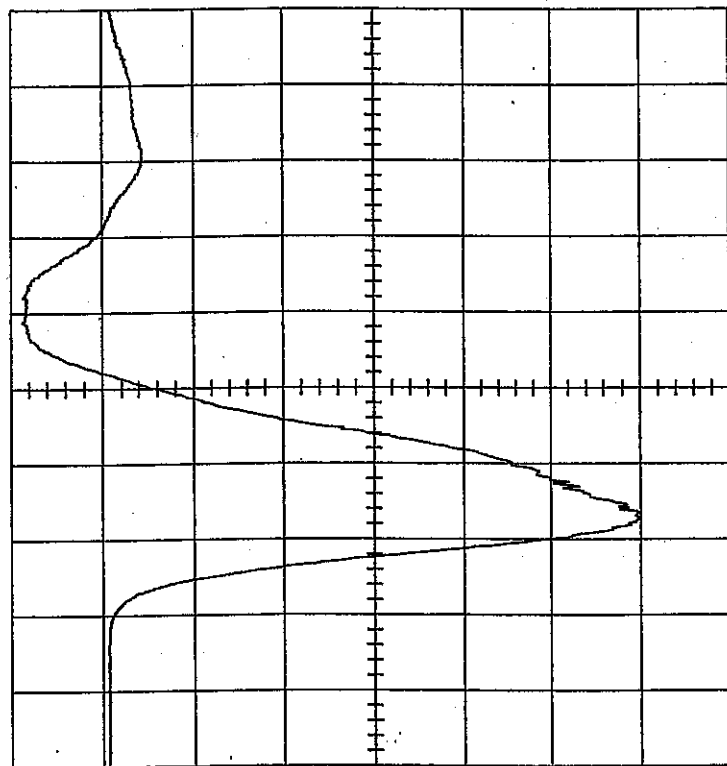


Fig. 2

CURRENT GAIN. & DARK CURRENT VS. SUPPLY VOLTAGE



R10754X-01-M16 WAVEFORM



50 [mV/div]

: 2 [nSec/div]

SERIAL NUMBER : JT0105
 SUPPLY VOLTAGE = -3000 [V]
 RISE TIME = 143 [ps]
 FALL TIME = 276 [ps]
 WIDTH = 329 [ps]
 LOAD RESISTANCE = 50 [ohm]

COMMENT

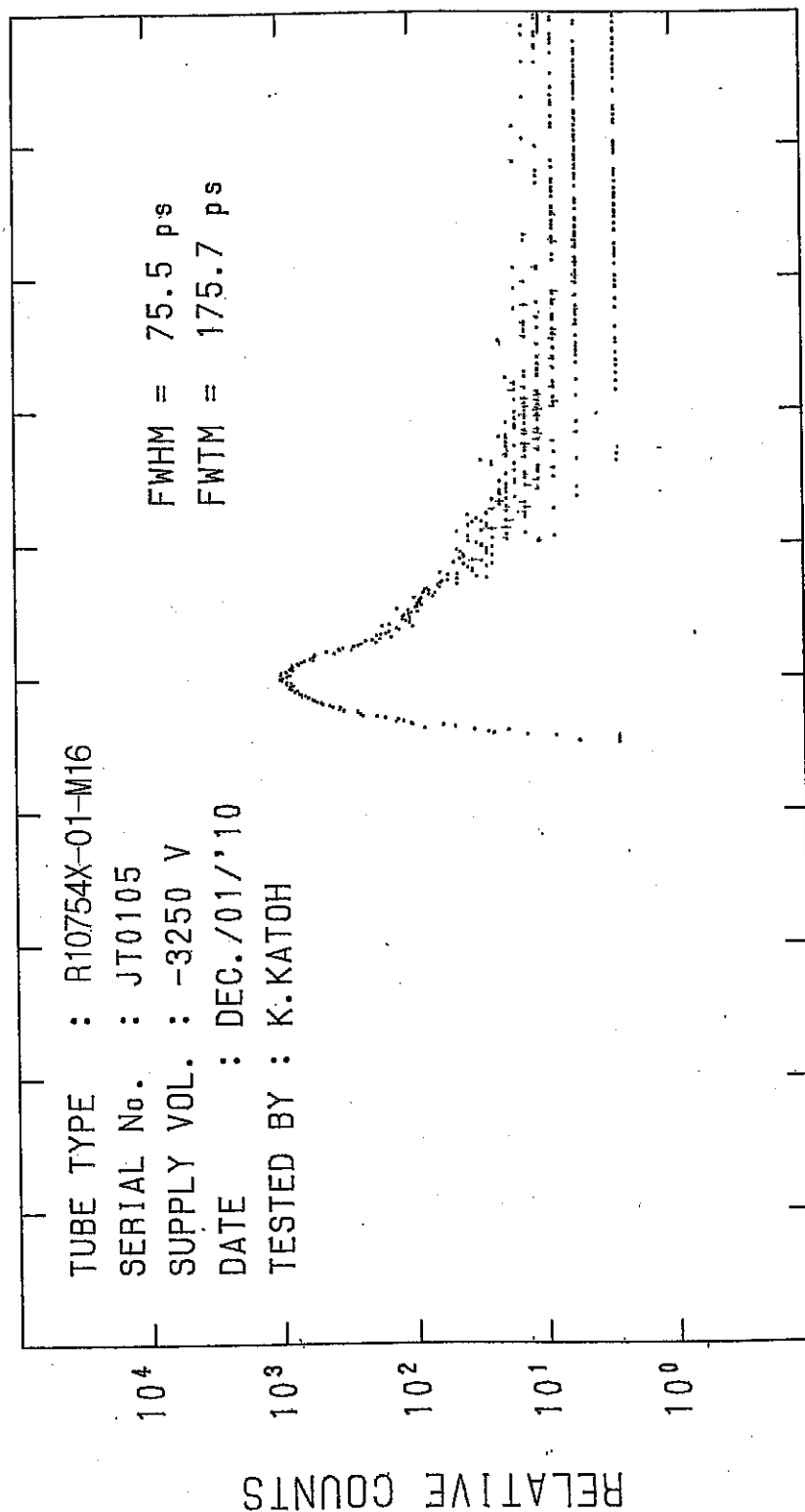
CH#07

TESTED BY K.KATOH

DATE DEC./01/'10

STATUS : MULTI PHOTON STATE
 provided by HAMAMATSU PHOTONICS K. K.

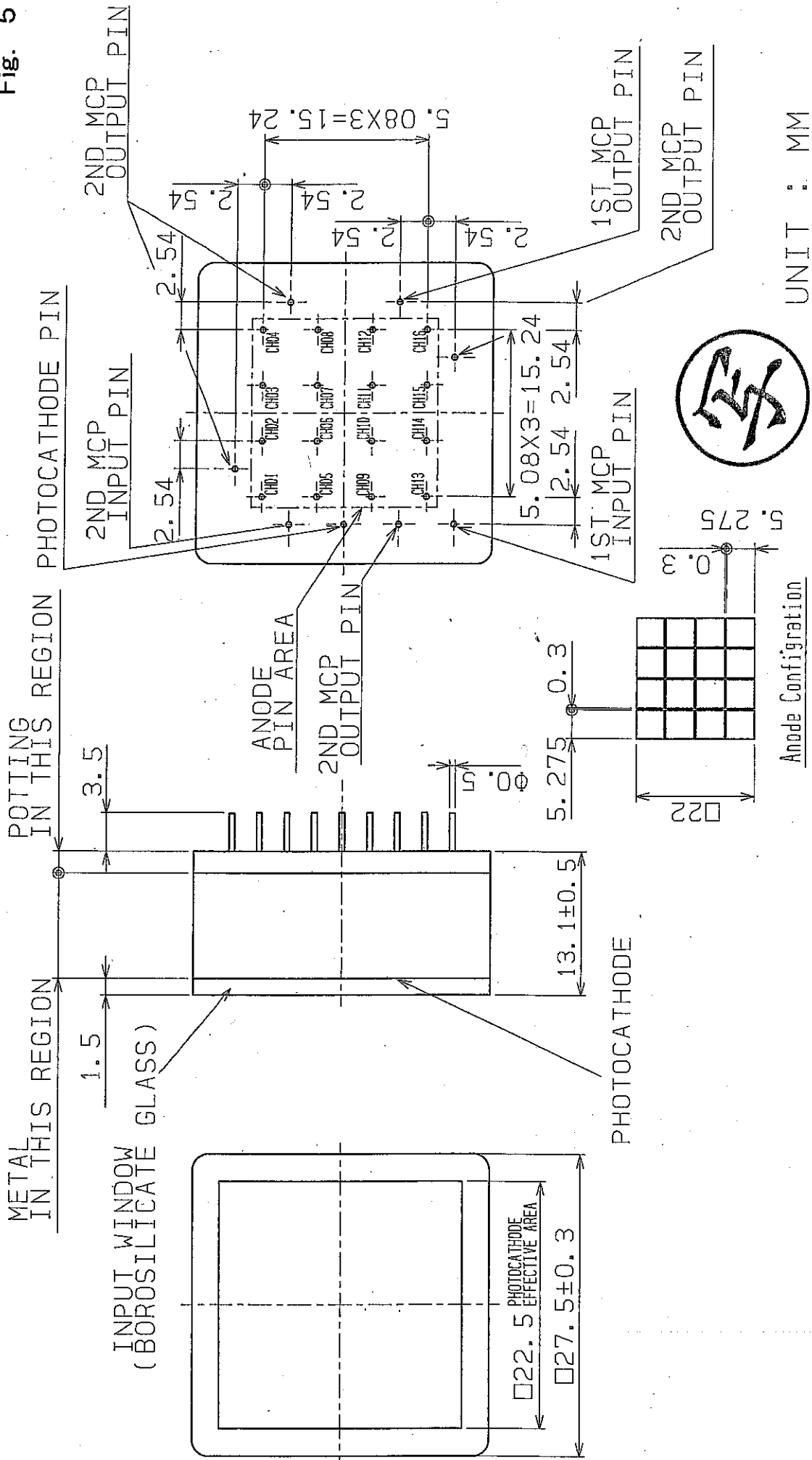
IRF CHARACTERISTIC




*SINGLE PHOTOELECTRON STATE

*Threshold=-281 mV Time-Walk=-17.3 mV Count Rate= 1737/ 4648 s⁻¹(cps)

5
F. 5

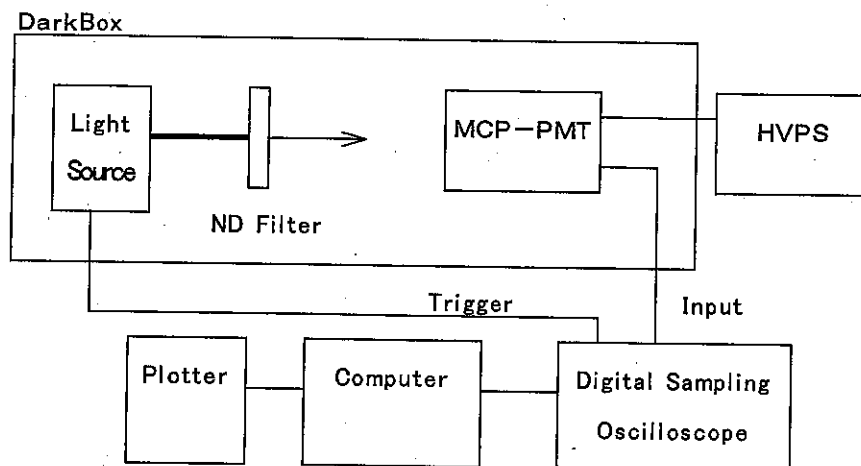
UNIT
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MARK	REASON	SIGN	DATE	MATRL. 材質	SCALE 尺座			DATE	2010. 8. 23		TITLE 品名
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△				Q' TY. 個数	FINISH 仕上		APPD. 承認	CHKD. 検査	DESN. 設計	DFT. 製図	
△							Migano	Saru	H. Nishizawa		
△				TRTM. 処理	PAINT 塗装						
△											

DRAW. NO. 図面番号
 MP0175
HAMAMATSU PHOTONICS K.K.

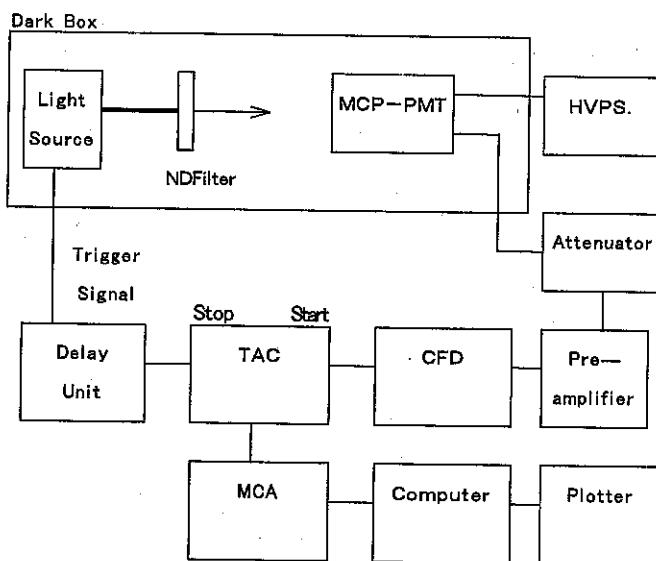
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Fig. A Block Diagram of Output Waveform Measuring Apparatus



Equipments	Model Numbers	Specs & Adjustments
Light Source	Hamamatsu / #PLP-01(410 nm)	Rep. Rate: 100 kHz
HVPS.	Hamamatsu / #C3360	Output: -5000 V dc @max.
Oscilloscope	Tektronix / #11802 + SD-24 or SD-26	
Computer	NEC / #PC9801	
Plotter	Graphtec / "9411F	

Fig. B Block Diagram of IRF Measuring Apparatus



Equipments	Model Numbers	Specs & Adjustments
Light Source	Hamamatsu / #PLP-01(410 nm)	Rep. Rate: 100 kHz
HVPS.	Hamamatsu / #C3360	Output: -5000 V dc @max.
Attenuator	Tektronix / #015-1003-02	5x
Preamplifier	Hamamatsu / #C5594	Gain = 35 dB
Delay Unit	EG&G Ortec / #425	Usually 0 sec
CFD	Tennelec(Canbera) / #TC454ec	Time Walk = -15 to -20 mV
TAC	EG&G Ortec(Canbera) / #457	Range = 0.05 μ s
MCA	NAIG / #E-552A / E-562A / E-563A	
Computer	NEC / #PC9801	
Plotter	Graphtec / #9411F	

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where T_w is a pulse width of the laser and T_j is the jitter caused by the all electrical equipments and can be ignored because T_j is much smaller than TTS and T_w . T_w is $35 \text{ ps} \pm 5 \text{ ps}$.

- 6) This is specified under the operating conditions that the repetition rate light input is 100 Hz or below and its pulse width is 70 ps.

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CAUTION !

Read below before use

Ver. 000613

PRECAUTIONS FOR PROPER OPERATION

● Handling on set-up

- 1) The photomultiplier tube (PMT) in this final data sheet is a glass product under high vacuum. **EXCESSIVE PRESSURE, VIBRATIONS OR SHOCKS TO THE TUBE FROM THE SURROUNDINGS COULD CAUSE A PERMANENT DAMAGE.** Please pay special attention on insuring proper handling.
- 2) **DO NOT PLACE ANY OBJECTS OF GROUND POTENTIAL CLOSER THAN 5 mm TO THE PHOTOCATHODE WINDOW** when negative high voltage is applied to the photocathode. It could generate extra noise and damage the photocathode permanently.
- 3) **DO NOT EXPOSE THE PHOTOCATHODE TO SUNLIGHT DIRECTLY** and any light stronger than the room light even during of no operation.
- 4) **NEVER TOUCH THE INPUT WINDOW WITH YOUR BARE HANDS.** In case the window contaminated by dust or grease, wipe it off using alcohol and a soft cloth or dust free tissue.
- 5) **DO NOT OPERATE OR STORE IN A PLACE OF UNSPECIFIED TEMPERATURE AND HUMIDITY.**

● Supplying high voltage

- 1) **DO NOT SUPPLY ANY VOLTAGE HIGHER THAN SPECIFIED.** Also make sure the output current does **NOT EXCEED THE MAXIMUM CURRENT** specified.
- 2) This device is very sensitive even with weak light input. When applying high voltage to the tube, **GRADUALLY (IDEALLY 100 V dc STEP BUT 500 V dc STEP IS OK) AND CAREFULLY INCREASE THE VOLTAGE** while monitoring the output using an ammeter or oscilloscope (if the PMT has multianodes, make all the anode summed when monitoring). Also make sure before use that the polarity of the applied voltage is correct.

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- 3) **DO NOT REMOVE OR CONNECT ANY INPUT OR OUTPUT CABLES WHILE HIGH VOLTAGE IS APPLIED.** If a high voltage is applied when its output is opened, **DO NOT CONNECT ANY READOUT CIRCUIT TO THE TUBE IMMEDIATELY** after turning the high voltage off. Ground the anode of the tube before connecting in order to avoid possible damage to the readout circuit due to an excessive electron charge flowing from its anode.
- 4) **IT IS RECOMMENDED TO TURN HIGH VOLTAGE OFF WHILE NOT BEING USED FOR MEASUREMENTS.** This is to avoid shortening its period of life time as well as a risk of damage due to an exposure of excessive incident light.

● Incident light amount

- 1) **KEEP THE INCIDENT LIGHT AMOUNT AS LOW AS POSSIBLE** to extend its period of life time.
- 2) In a case of photon counting application, it is recommended to **KEEP THE SIGNAL COUNT RATE LESS THAN $2 \times 10^4 \text{ s}^{-1}$ (cps).**
- 3) **ILLUMINATE PHOTOCATHODE EFFECTIVE AREA AS LARGE AS POSSIBLE** to keep better linearity characteristics and avoid an excessive stress in partial area, which may result in a reduction of sensitivity partially.

● Usage in vacuum

- 1) **DO NOT USE A PMT AS AN INTERFACE BETWEEN VACUUM AND ENVIRONMENTAL PRESSURE.** Standard MCP-PMT is not designed for vacuum-tight construction. If PMT is used as an interface between vacuum and environmental pressure, it may generate an air leakage and damage PMT permanently.
- 2) **KEEP THE TUBE CLEAN.** Unless otherwise, it would cause outgassing in a vacuum.
- 3) **DO NOT SUPPLY HIGH VOLTAGE UNLESS THE VACUUM LEVEL REACHES 1×10^{-3} Pa OR HIGHER.** When applying high voltage to the tube first time or after long store in an atmosphere, it is recommended to keep the vacuum level 1×10^{-3} Pa or higher at least 24 hours.
- 4) **DO NOT PROCEED BAKING VACUUM INSTRUMENTS WHILE THE TUBE IS PLACED INSIDE.**

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● Others

- 1) It is recommended to LEAVE THE TUBE IN DARKNESS (YOUR INSTRUMENT WITHOUT ANY INPUT LIGHT) FOR 30 MINUTES OR SO before start any measurements because it occasionally takes a little while until its dark noise settles down.

WARRANTY

The detectors indicated in this data sheet are warranted to the original purchaser for a period of 12 MONTHS following the date of shipment. The warranty is limited to repair or replacement of any defective material due to defects in workmanship or materials used in manufacture.

- 1) Any claim for damage of shipment must be made directly to the delivering carrier within five days.
- 2) Customer must inspect and test all detectors within 30 days after shipment. Failure to accomplish said incoming inspection shall limit all claims to 75 % of invoice value.
- 3) No credit will be issued for broken detector unless in the opinion of Hamamatsu the damage is due to a manufacturing defect.
- 4) No credit will be issued for any detector which in the judgement of Hamamatsu has been damaged, abused, modified or whose serial number or type number have been obliterated or defaced.
- 5) No detector will be accepted for return unless permission has been obtained from Hamamatsu in writing, the shipment has been returned repaired and insured, the detector is packed in their original box and accompanied by the original data sheet furnished to the customer with the tube, and a full written explanation of the reason for rejection of detector.

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HAMAMATSU*Microchannel Plate Photomultiplier Tube*
R10754X-01-M16**FEATURES**

27.5 mm Square Shape
16 Matrix Multianode
Small Dead Space
Fast Time Response
For High Magnetic Field

APPLICATIONS

TOP COUNTER
Other Detector
In High Energy Physics
Multichannel Time Resolved
Fluorescence Detector
Laser Radar

SPECIFICATIONS**GENERAL**

Parameters		Ratings	Units
Spectral Response		300 to 850	nm
Wavelength of Maximum Response		430	nm
Input Window	Material	Borosilicate Glass	-
	Thickness	1.5	mm
Photocathode	Material	Multialkali	-
	Minimum Effective Area	22 x 22	mm
Microchannel Plate (MCP)	Construction	2 Stages	-
	Channel Diameter	10	μm
Anode	Pattern	4 x 4 ch	-
	Size (each ch)	5.275 x 5.275	mm
Mechanical Size (H x W x L)		27.5 x 27.5 x 13.1 (except the length of pins)	mm

RATINGS

Parameters		Ratings	Maximum Ratings	Units
Supply Voltage	Photocathode - MCPin	160	180	V
	MCPin - MCPout	2360	2680	V
	MCPout - Anode	480	540	V
Operating Ambient Temperature		-	-20 to +40	°C
Storage Temperature		-	-55 to +65	°C

CHARACTERISTICS

Parameters		Min.	Typ.	Max.	Units
Photocathode	Luminous Sensitivity	100	180	-	uA/lm
	Quantum Efficiency at Peak	-	17	-	%
MCP Gain (at 2680 V* between MCPin - MCPout)		4×10^5	1×10^6	-	-
Dark Current at MCP max. voltage or 1×10^6 gain (25 °C, summed all anodes)		-	2×10^{-7}	1×10^{-6}	A
Dark Counts at MCP max. voltage or 1×10^6 gain (25 °C, summed all anodes)		-	1.2×10^4	-	s ⁻¹
Time Response	Rise Time	-	180	-	ps
	T.T.S. (FWHM)	-	70	-	ps

*) The anode to cathode voltage is about 3400 V, when the ratio of dividing resistors is 0.5 : 2.5 : 2.5 : 2.5 : 1.5.

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