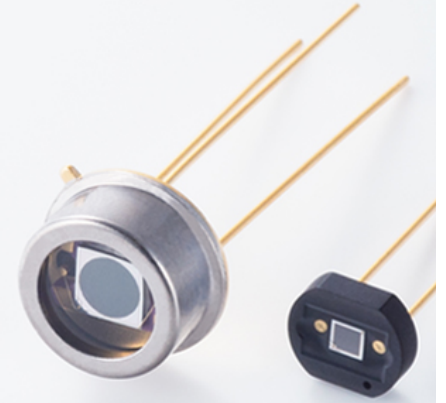


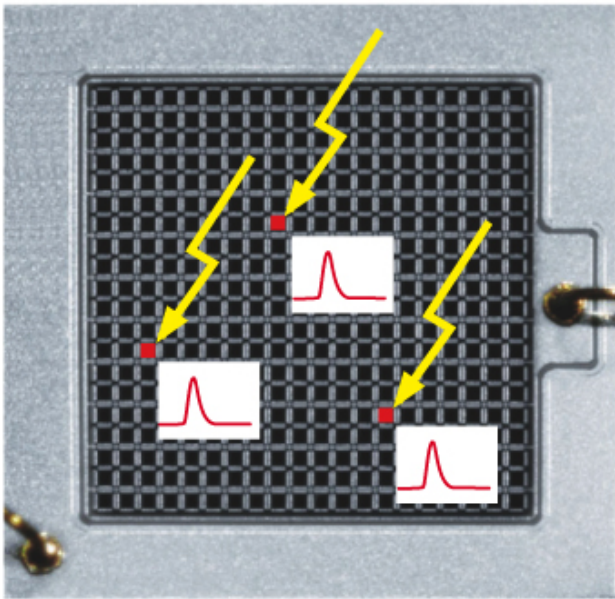
Time of Flight exercise

Multi-Pixel Photon Counters (MPPCs/SiPM)



https://www.hamamatsu-news.de/hamamatsu_optosemiconductor_handbook/

- Three exercises use MPPC.
- MPPC is short for Multi-Pixel Photon Counter, and this detector is also known as silicon photomultiplier (SiPM). It is a solid state photodetector that uses multiple avalanche photodiode (APD) pixels operating in Geiger mode.



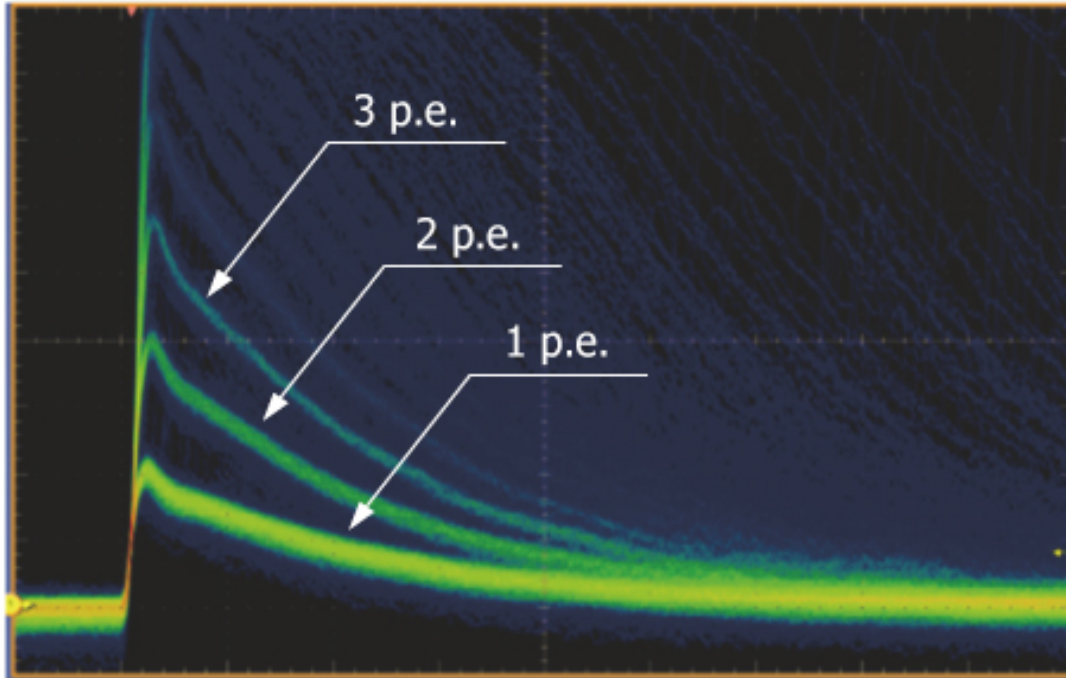
Each pixel is a photo sensor (Geiger mod).

Geiger mode is high gain but cannot distinguish the number of photon. Just ON or OFF.

Since each pixel is small, the probability of multi photon is small. Increasing the number of incoming photon, linearity can be worse.

https://www.hamamatsu.com/resources/pdf/ssd/s13360_series_kapd1052e.pdf

Type no.	Pixel pitch (μm)	Effective photosensitive area (mm)	Number of pixels	Package	Fill factor (%)
S13360-1375CS	75	1.3 × 1.3	285	Ceramic	82
S13360-1375PE				Surface mount type	
S13360-3075CS		3.0 × 3.0	1600	Ceramic	
S13360-3075PE				Surface mount type	
S13360-6075CS		6.0 × 6.0	6400	Ceramic	
S13360-6075PE				Surface mount type	



MPPC signal has a rich of information

- 1) Pulse height or Charge integration tells the number of photon.
- 2) Signal timing

•Practice of MPPC bias control

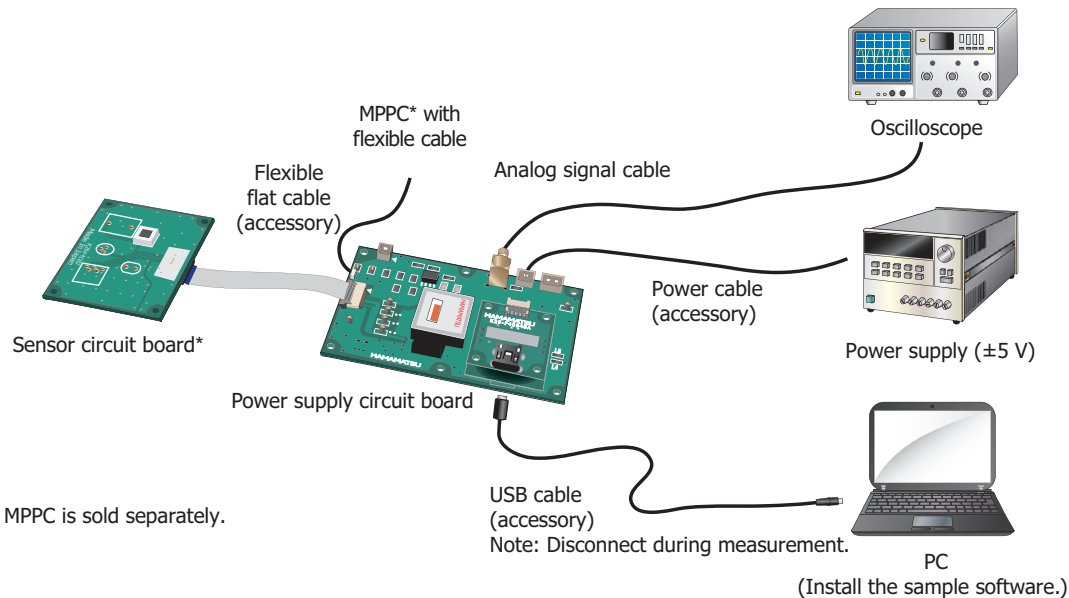
Change bias voltage and measure relative gain.

<https://www.hamamatsu.com/jp/en/product/type/C12332-01/index.html>

Driver circuit for MPPC

C12332-01

Connection example



* MPPC is sold separately.

KACCC0788EA

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C11204 Sample application

Serial port: COM3 [Open] [Close] High voltage output: [ON] [OFF]

EEPROM parameter setting

Reference voltage: V_b (range: 50-90) [22.00] [V] [Write]

Reference temperature: T_b (range: 0-50) [25.0] [°C] [Read]

Temperature coefficient (High temp.): ΔT_1 (range: 0-1000) [0.0] [mV/°C]

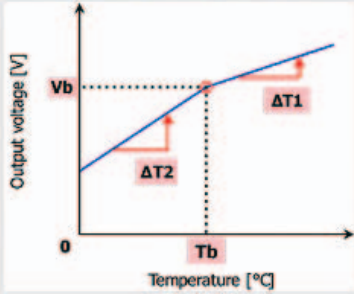
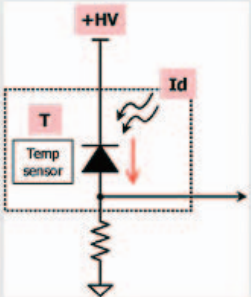
Temperature coefficient (Low temp.): ΔT_2 (range: 0-1000) [0.0] [mV/°C]

Monitor

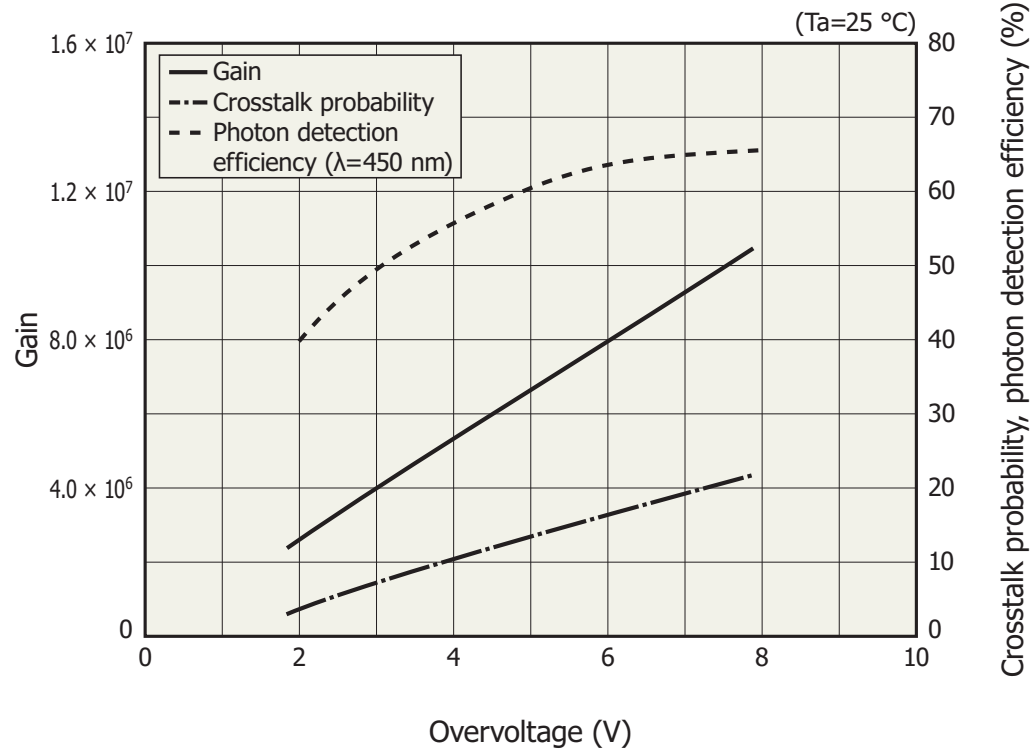
Output voltage: +HV [] [V]

Output current: I_d [] [mA]

Temperature: T [] [°C]

Pixel pitch: 75 μm

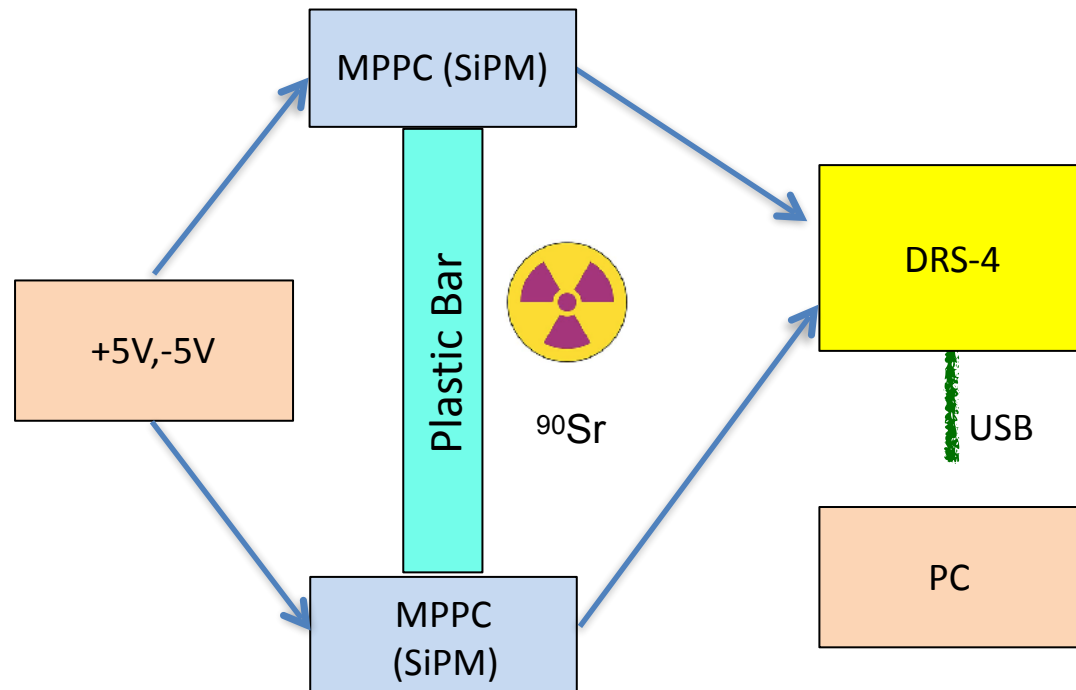


KAPDB0326EA

MPPC characteristics vary with the operating voltage. Although increasing the operating voltage improves the photon detection efficiency and time resolution, it also increases the dark count and crosstalk at the same time, so an optimum operating voltage must be selected to match the application.

1. Time of Flight measurement

- Position measurement by time difference.
 - Propagation time is proportional to the distance
 - Position is measured by the arrival time difference.
 - Propagation speed is also measured.





$$T_L < T_R$$



$$T_L > T_R$$