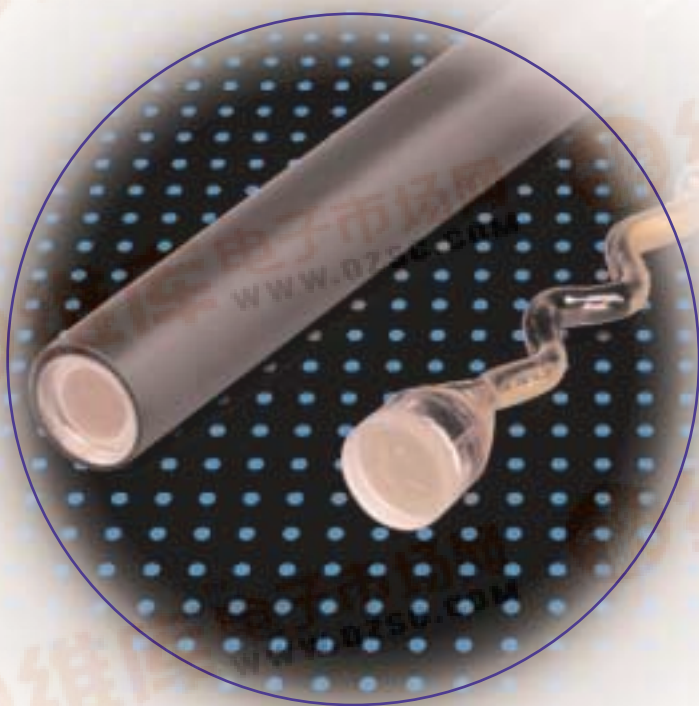


Channel Photomultipliers

Channel Photomultipliers

Overview and Specifications



CHANNEL PHOTOMULTIPLIER

CPM

Features

- Ultra high anode sensitivity up to 10^7 A/W
- Extremely low dark current, typically 3pA @ 10^6 gain
- Very low equivalent noise input (down to 10^{-17} W)
- Very high stability in dark current (no "bursts")
- High gain exceeding 10^8
- Very high dynamic range
- Compact dimensions
- Wide spectral response through multiple window materials
- High resolution
- Fast response time
- High immunity to magnetic fields
- Rugged design

Description

PerkinElmer Optoelectronics, formerly EG&G Optoelectronics, is pleased to introduce the Channel Photomultiplier (CPM), a new ultra high sensitivity optical detector which replaces conventional photomultipliers (PMTs) and avalanche photo diodes (APDs). This device uses a unique detector principle, resulting in a compact design with ultra high gain, high dynamic range, extremely low dark current, and fast response.

This high-performance detector offers fundamental advantages for analytical instrumentation applications such as emission spectroscopy, fluorescence, atomic absorption spectroscopy, and bio and chemo luminescence. The CPM also delivers important advantages in life science products, industrial and medical equipment, and high-energy physics.

When compared to conventional PMTs, the CPM improves anode sensitivity by one order of magnitude, while lowering dark current by one to two orders of magnitude. The noise level shows extreme stability over time, with no "bursts." The extremely low dark current results in a higher dynamic range than conventional PMTs and extends detectable limits for many applications.

The CPM can be used in analog-DC mode, single photon counting mode, and in nuclear spectroscopy (when coupled to scintillation materials like BGO, LSO, NaI, etc.). PerkinElmer Optoelectronics offers a choice of window materials and photocathodes to cover the spectrum from 115 nm (UV range) to 900 nm (NIR).

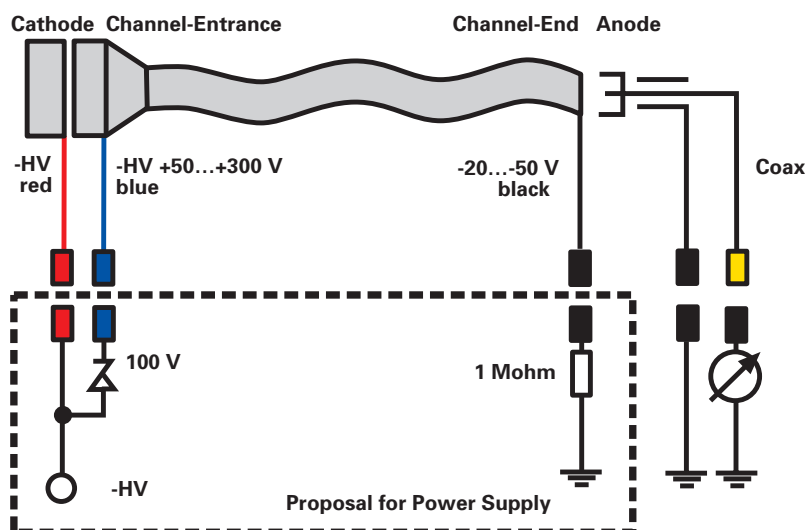
The new detector is a small, head-on type with a total diameter of 10.5 mm including encapsulation. PerkinElmer Optoelectronics also offers custom configurations for specific applications.

PRINCIPLE OF OPERATION

Principle of Operation

The CPM, like conventional photomultiplier tubes, converts a very low light level into photoelectrons by a semitransparent photocathode deposited on the inner surface of the entrance window. On their way from the cathode to the anode the photoelectrons pass through a narrow, semiconductive channel. Each time the electrons hit the inner wall of the curved channel, multiple secondary electrons are emitted. This effect occurs multiple times along the path, leading to an avalanche effect with a gain exceeding 10^8 . The curved shape of the glass tube improves the multiplication effect.

Physical Specification



MAIN FEATURES

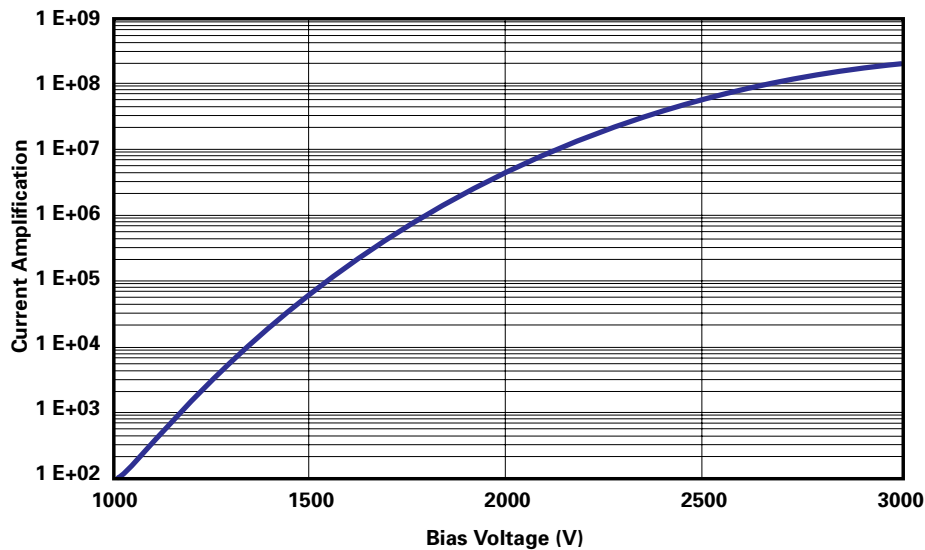
Compact Size

The CPM is one of the smallest head-on type detectors, with a 10.5 mm diameter including encapsulation. The photocathode has a useful diameter of more than 5 mm. The tube is smaller, easier to use, and more rugged than discrete dynode types. Only a single high voltage supply of up to 3000 volts is necessary; no external voltage divider network is required. A variety of different sizes will be available soon ($\frac{1}{2}$ " and $\frac{3}{4}$ ").



Unpotted $\frac{1}{3}$ inch Channel Photomultiplier

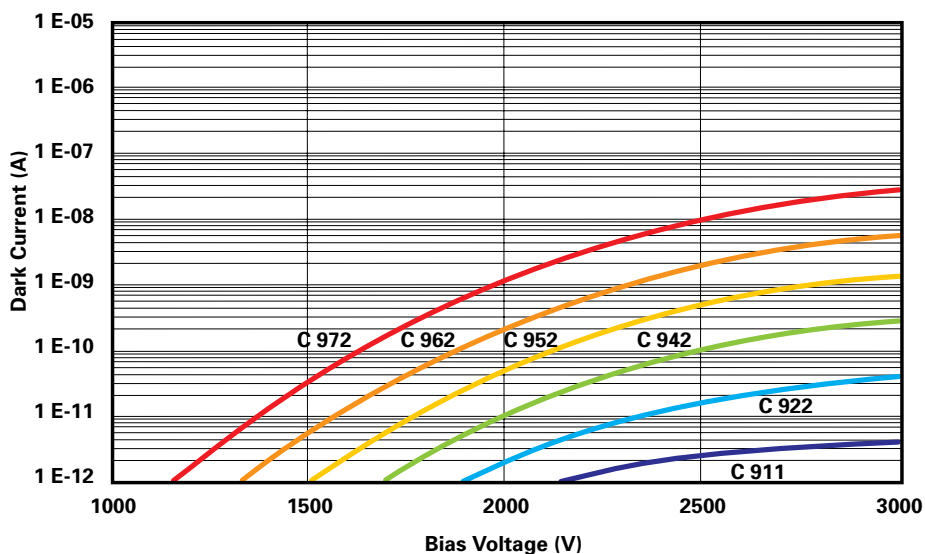
Fig. 1: Typical current amplification



Ultra high anode sensitivity

At the maximum bias voltage of 3000 V, gains can exceed 10^8 . At 2400 V, anode sensitivity is typically 3×10^5 A/W at a wavelength of 410 nm with a bi-alkali photocathode. This performance surpasses conventional PMTs by one to two orders of magnitude and beats APDs by approximately five orders of magnitude (Fig. 1).

Fig. 2: Typical anode dark current



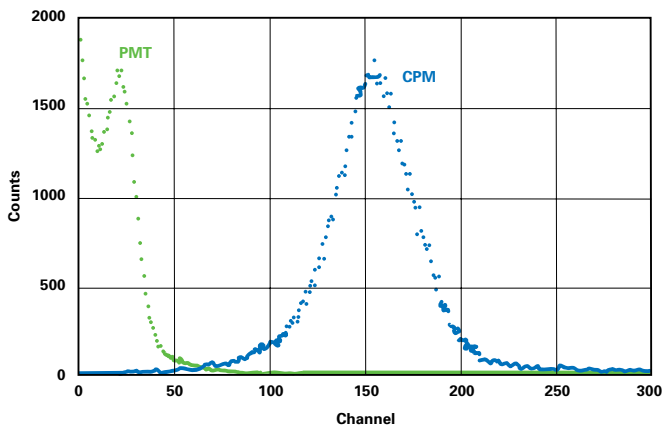
Extremely low dark current

The electron multiplication in the channel is virtually silent, so dark current depends only on the photocathode material, leakage currents are negligible. Bi-alkali photocathodes exhibit typical dark count rates of 10 cps at a gain of 3×10^8 , while UV cathodes have dark count rates below 1 cps. In analog DC mode, the typical dark noise for a bi-alkali photocathode is 20 pA at a gain of 10^7 . In general, the noise level of the PerkinElmer Optoelectronics CPM is one to two orders of magnitude lower than dynode PMTs, resulting in a significantly higher dynamic range (Fig.2).

High stability in dark current level

As a result of the semiconductive inner surface of the CPM, no charge-up effects occur at the glass surface. This results in a very high stability of the dark current level over time, with no sudden changes (bursts). The semiconductive surface also causes high-light recovery times to be extremely small.

Fig. 3: Typical photo electron spectrum



Excellent photon counting resolution

At gains exceeding 10^7 the single photo electron pulse is perfectly separated from the electrical noise, due to a saturation effect of the channel. The CPM exhibits single photon resolution with excellent peak to valley ratios. Fig. 3 shows the single photo electron spectrum taken from a multi-channel analyzer compared to a conventional photomultiplier (Fig. 3).

Choice of entrance window

The CPM is available with different window materials, which are:

MgF₂, Quartz, UV-glass, and Borosilicate glass. The combination of different photocathodes and entrance windows results in a spectral range from 115 nm to 900 nm. Other window materials and photocathode combinations are available on a custom basis (Fig. 4.1 and 4.2).

Fig. 4.1: Typical spectral response

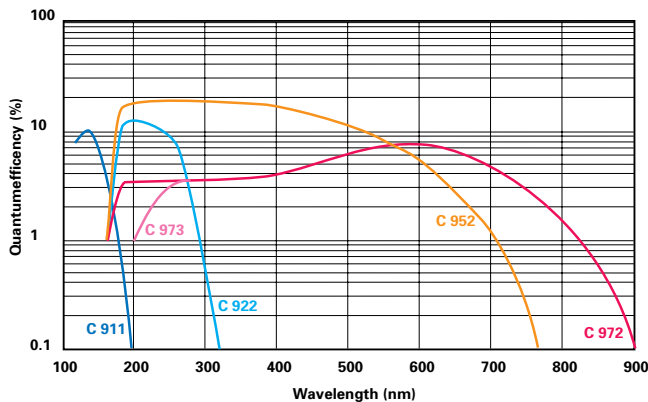
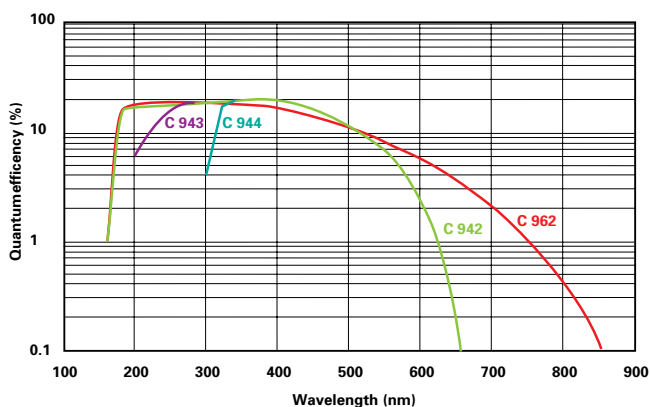


Fig. 4.2: Typical spectral response



Available related products

• High Voltage supply

CHV 30N (supplies 1 CPM, negative output voltage),
CHV 30P (supplies 1 CPM, positive output voltage),
J4-3N (supplies 10 to 15 CPMs)

• CPM Modules

MP900-series: Photoncounting module with
TTL output, including CPM,
electronic and high voltage

MD900-series: DC module including high
voltage supply, amplifier,
I/U converter, output 0 to 10 V,
bandwidth 1kHz

MH900-series: High voltage module,
including CPM and
high voltage power supply

• CPM Formats

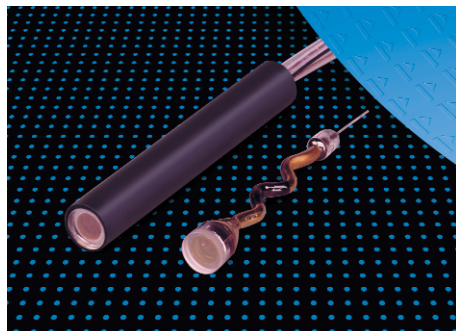
1/3" C900-series

1/2" C1300-series

3/4" C1900-series

Datasheets on request

CPM C900 Series 1/3" CPM Channel Photomultipliers

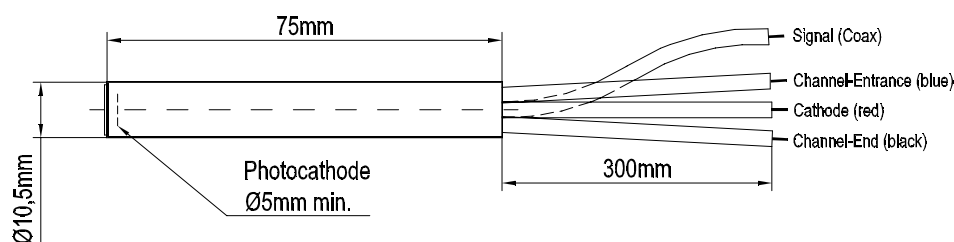


- High Sensitivity Optical Detector
- Extremely High Gain
- Ultra Low Noise
- 1/3 Inch, Head-On Type

Technical Specifications

| Technical Specifications | | | | | | | | | | | | | | | | | | | |
|--------------------------|------------------------|-----------------------|-----------------------|------------------|-----------------------------|--------------------|-----------------------|-------------------|---------------------------------|-------------------|--|----------------------|---|-----------------------------------|--------------------|----------------------------|-------------------|----------------|-------------------------------|
| Type | Spectral response (nm) | Photocathode material | Min. useful area (mm) | Window material | Electron multiplication | Supply voltage (V) | Current amplification | Dark current (pA) | Equivalent Noise Input, ENI (W) | Bias current (μA) | Max. linear anode current | Max. anode current* | Response time Rise time (ns) Pulse width / FWHM (ns) | Special types for Photon Counting | Supply voltage (V) | Single photo electron gain | Dark counts (cps) | Peak to valley | Max. ambient temperature (°C) |
| C911 | 115-200 | CsI | 5 | MgF ₂ | Channel Electron Multiplier | 2400 (max. 3000) | 6x10 ⁵ | 2 | 1x10 ⁻¹⁷ | 50 | (DC linearity limit) 10% of bias current | 10 μA (max. 30 sec.) | 3 6 | C911P | 3000 (max. 3000) | 3x10 ⁵ | 0.1 | 10:1 | 50 |
| C921 | 115-320 | CsTe | | MgF ₂ | | | 1x10 ⁶ | 10 | 1x10 ⁻¹⁷ | | | | | C921P | | | 1 | | |
| C922 | 165-320 | CsTe | | Quartz | | | 1x10 ⁶ | 10 | 1x10 ⁻¹⁷ | | | | | C922P | | | 1 | | |
| C942 | 165-650 | Bial kali | | Quartz | | | 3x10 ⁶ | 80 | 1x10 ⁻¹⁷ | | | | | C942P | | | 10 | | |
| C943 | 185-650 | | | UV glass | | | 3x10 ⁶ | 80 | 1x10 ⁻¹⁷ | | | | | C943P | | | 10 | | |
| C944 | 300-650 | | | Borosil. | | | 3x10 ⁶ | 80 | 1x10 ⁻¹⁷ | | | | | C944P | | | 10 | | |
| C952 | 165-750 | Low noise Multialk. | | Quartz | | | 3x10 ⁶ | 250 | 2.5x10 ⁻¹⁷ | | | | | C952P | | | 40 | | |
| C953 | 185-750 | | | UV glass | | | 3x10 ⁶ | 250 | 2.5x10 ⁻¹⁷ | | | | | C953P | | | 40 | | |
| C962 | 165-850 | Multialk. | | Quartz | | | 2x10 ⁶ | 1000 | 4x10 ⁻¹⁷ | | | | | C962P | | | 100 | | |
| C963 | 185-850 | | | UV glass | | | 2x10 ⁶ | 1000 | 4x10 ⁻¹⁷ | | | | | C963P | | | 100 | | |
| C972 | 165-900 | Extend. red Multialk. | | Quartz | | | 2x10 ⁶ | 5000 | 1.5x10 ⁻¹⁶ | | | | | C972P | | | 500 | | |
| C973 | 185-900 | | | UV glass | | | 2x10 ⁶ | 5000 | 1.5x10 ⁻¹⁶ | | | | | C973P | | | 500 | | |
| C982 | 165-650 | Low noise Bialk. | | Quartz | | | 3x10 ⁶ | 25 | 6x10 ⁻¹⁸ | | | | | C982P | | | 3 | | |
| C983 | 185-650 | | | UV glass | | | 3x10 ⁶ | 25 | 6x10 ⁻¹⁸ | | | | | C983P | | | 3 | | |

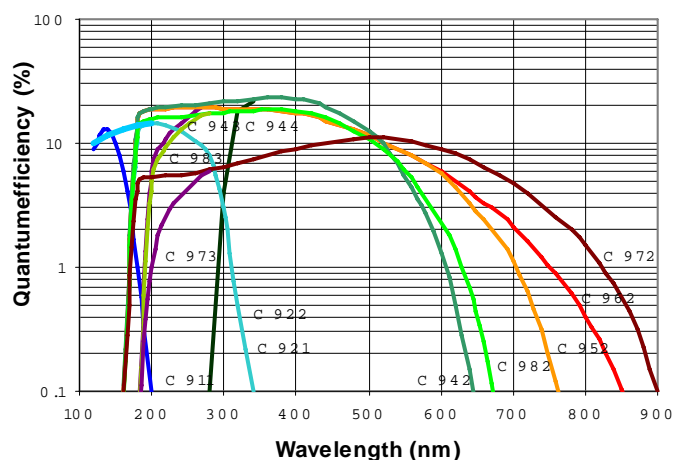
Dimensions (mm)



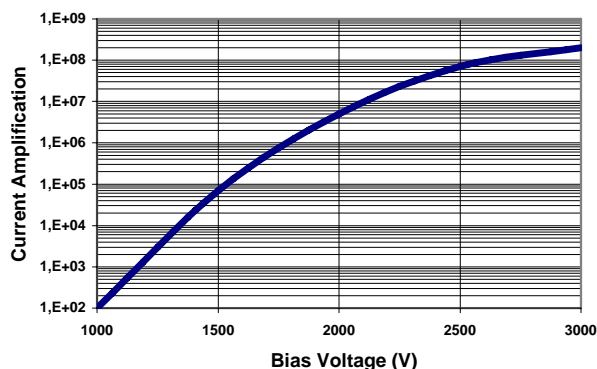
CPM C900 Series 1/3" CPM Channel Photomultipliers

CPM C900 Performance Specifications

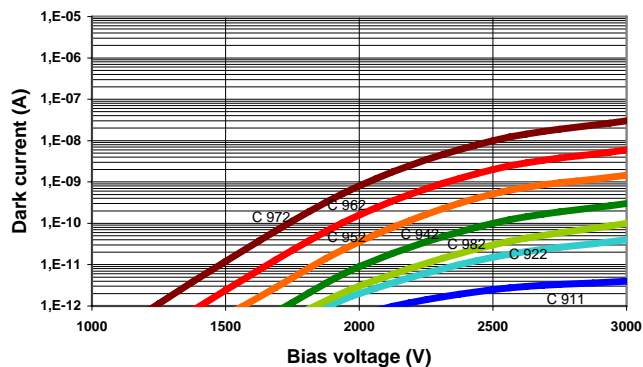
Spectral response



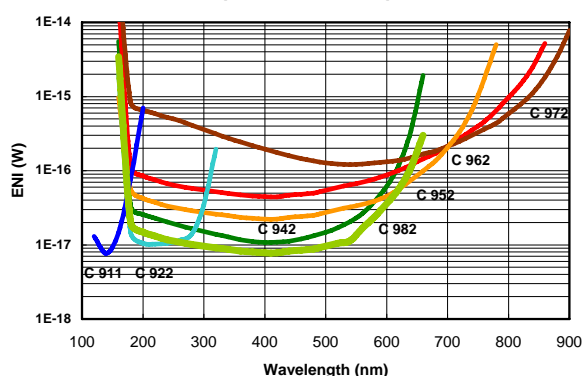
Current Amplification



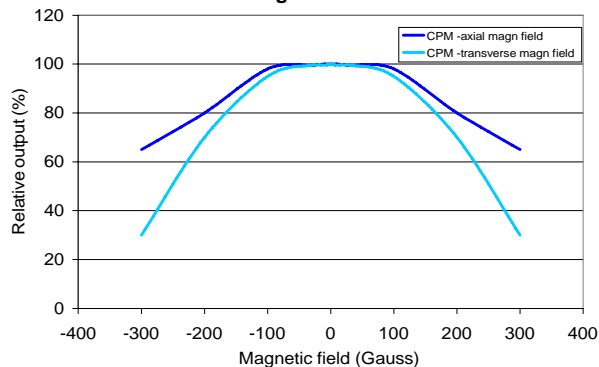
Dark Current



Equivalent Noise Input



Magnetic Field Effects

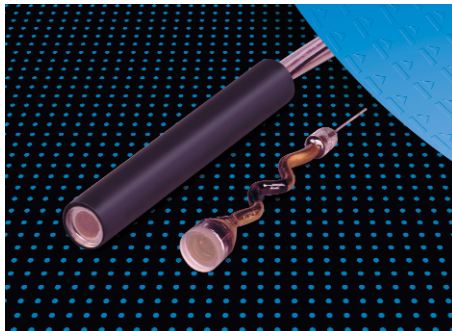


CAUTION: High Voltage Warning!

This product is operated at high voltage. Extreme care must be taken to ensure operator safety and to avoid damage to other instruments. Avoid direct contact with the photomultiplier when high voltage is applied. Avoid placing conductive material close to the cathode.

All given values are nominal/typical @ 20 °C ambient temperature; specifications subject to change without notice.

CPM C1300 Series 1/2" CPM Channel Photomultipliers

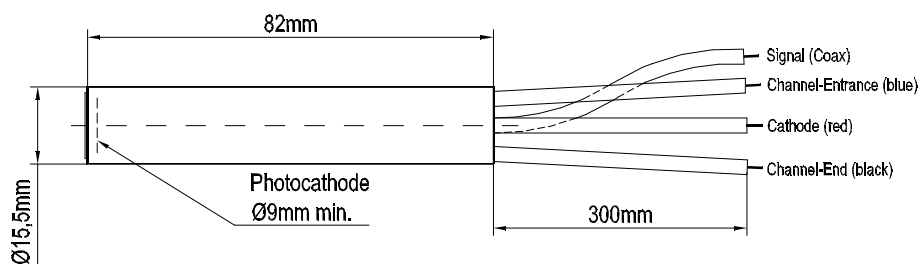


- High Sensitivity Optical Detector
- Extremely High Gain
- Ultra Low Noise
- 1/2 Inch, Head-On Type

Technical Specifications

| Type | Spectral response (nm) | | Photocathode material | | Min. useful area (mm) | | Window material | | Electron multiplication | | Supply voltage (V) | | Current amplification | | @ 140 nm (A/W) | | @ 200 nm (A/W) | | @ 400 nm (A/W) | | @ 560 nm (A/W) | | Dark current (pA) | | Equivalent Noise Input, ENI (W) | | Bias current (μA) | | Max. linear anode current | | Max. anode current* | | Response time Rise time (ns) | | Pulse width / FWHM (ns) | | Special types for Photon Counting | | Supply voltage (V) | | Single photo electron gain | | Dark counts (cps) | | Peak to valley | | Max. ambient temperature (°C) | |
|-------|------------------------|-------------|-----------------------|-----------|-----------------------|-----------|---------------------|-------------------|-------------------------|---|---------------------|----|--|----------------------|----------------|---|----------------|-------------------|-------------------|------|----------------|-----|-------------------|---|---------------------------------|----|-------------------|----|---------------------------|-----|---------------------|-----|------------------------------|------|-------------------------|----|-----------------------------------|-------------------|--------------------|---------------------|----------------------------|----|-------------------|--|----------------|--|-------------------------------|--|
| C1311 | 115-200 | CsI | 9 | Bial kali | Multialk. | Low noise | 2400 (max. 3000) | 5x10 ⁷ | 6x10 ⁵ | 8 | 2x10 ⁻¹⁷ | 50 | (DC linearity limit) 10% of bias current | 10 μA (max. 30 sec.) | 3 | 6 | C1311P | 3000 (max. 3000) | 3x10 ⁸ | 10:1 | 50 | 0.4 | 4 | 4 | 40 | 40 | 40 | 40 | 160 | 160 | 400 | 400 | 2000 | 2000 | 10 | 10 | | | | | | | | | | | | |
| C1321 | 115-320 | CsTe | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | MgF ₂ | 1x10 ⁶ | 40 | 2x10 ⁻¹⁷ | C1321P | 4 | | | | | | |
| C1322 | 165-320 | CsTe | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Quartz | 1x10 ⁶ | 40 | 2x10 ⁻¹⁷ | C1322P | 4 | | | | | | |
| C1342 | 165-650 | Bial kali | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Quartz | 3x10 ⁶ | 320 | 2x10 ⁻¹⁷ | C1342P | 40 | | | | | | |
| C1343 | 185-650 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | UV glass | 3x10 ⁶ | 320 | 2x10 ⁻¹⁷ | C1343P | 40 | | | | | | |
| C1344 | 300-650 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Borosil. | 3x10 ⁶ | 320 | 2x10 ⁻¹⁷ | C1344P | 40 | | | | | | |
| C1352 | 165-750 | Low noise | Multialk. | Quartz | 3x10 ⁶ | 1000 | 4x10 ⁻¹⁷ | C1352P | 160 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1353 | 185-750 | | | UV glass | 3x10 ⁶ | 1000 | 4x10 ⁻¹⁷ | C1353P | 160 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1362 | 165-850 | Multialk. | 9 | Quartz | 2x10 ⁶ | 4000 | 8x10 ⁻¹⁷ | C1362P | 400 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1363 | 185-850 | | | UV glass | 2x10 ⁶ | 4000 | 8x10 ⁻¹⁷ | C1363P | 400 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1372 | 165-900 | Extend. red | Multialk. | Quartz | 2x10 ⁶ | 20000 | 3x10 ⁻¹⁶ | C1372P | 2000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1373 | 185-900 | | | UV glass | 2x10 ⁶ | 20000 | 3x10 ⁻¹⁶ | C1373P | 2000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1382 | 165-650 | Low noise | Bialk. | Quartz | 3x10 ⁶ | 100 | 1x10 ⁻¹⁷ | C1382P | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C1383 | 185-650 | | | UV glass | 3x10 ⁶ | 100 | 1x10 ⁻¹⁷ | C1383P | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

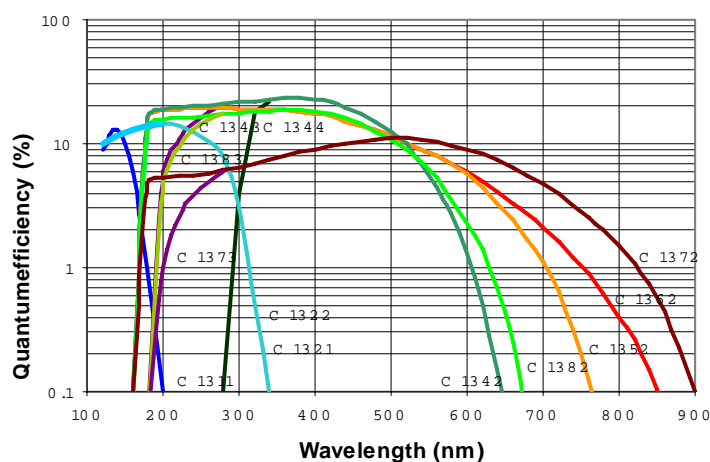
Dimensions (mm)



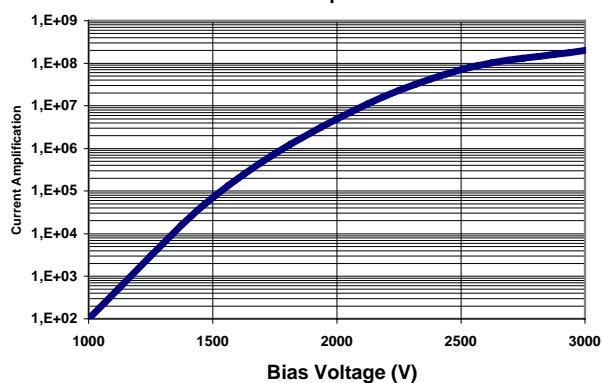
CPM C1300 Series 1/2" CPM Channel Photomultipliers

CPM C1300 Performance Specifications

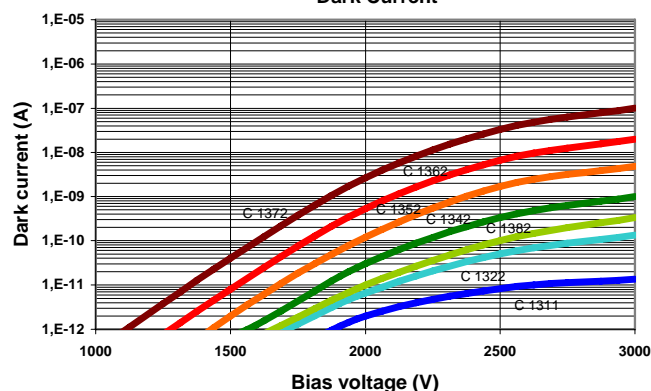
Spectral response



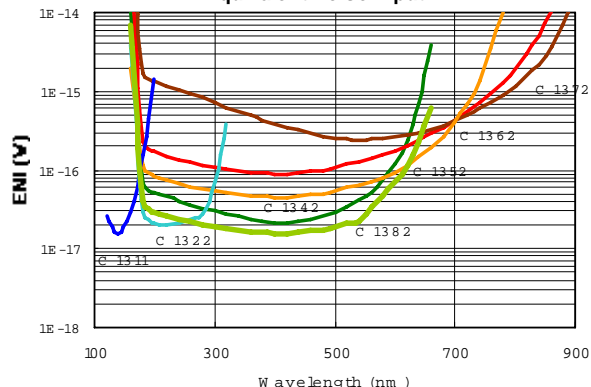
Current Amplification



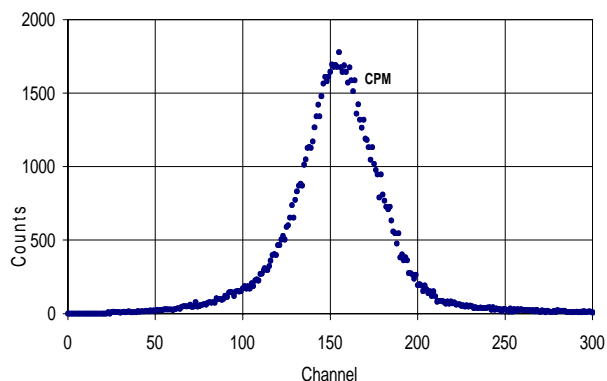
Dark Current



Equivalent Noise Input



Typical Photo Electron Spectrum

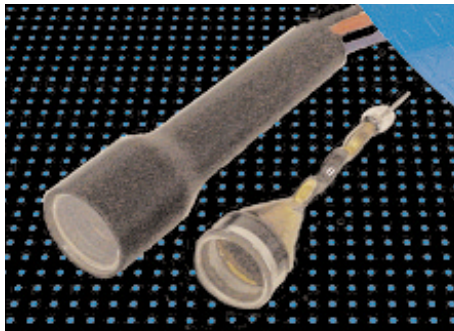


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All given values are nominal/typical @ 20 °C ambient temperature; specifications subject to change without notice.

CPM C1900 Series 3/4" CPM Channel Photomultipliers

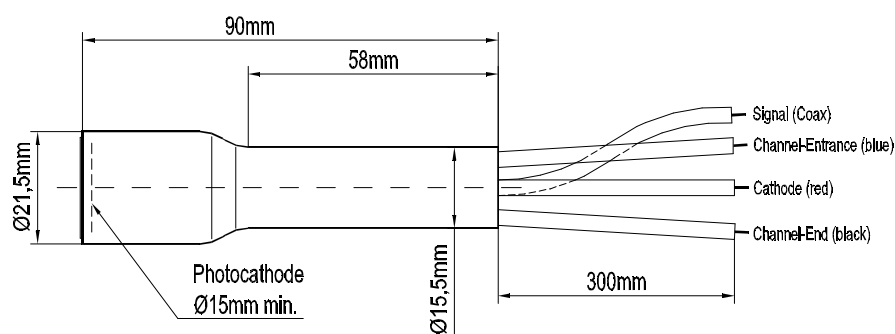


- High Sensitivity Optical Detector
- Extremely High Gain
- Ultra Low Noise
- 3/4 Inch, Head-On Type

Technical Specifications

| Type | Spectral response (nm) | Photocathode material | Min. useful area (mm) | Window material | Electron multiplication | Supply voltage (V) | Current amplification | @ 140 nm (A/W) | @ 200 nm (A/W) | @ 400 nm (A/W) | @ 560 nm (A/W) | Dark current (pA) | Equivalent Noise Input, ENI (W) | Bias current (μA) | Max. linear anode current | Max. anode current* | Response time Rise time (ns) Pulse width / FWHM (ns) | Special types for Photon Counting | Supply voltage (V) | Single photo electron gain | Dark counts (cps) | Peak to valley | Max. ambient temperature (°C) |
|-------|------------------------|-----------------------|-----------------------|------------------|-----------------------------|--------------------|-----------------------|-------------------|----------------|---------------------|----------------|---------------------|---------------------------------|-------------------|--|----------------------|---|-----------------------------------|--------------------|----------------------------|-------------------|----------------|-------------------------------|
| C1911 | 115-200 | CsI | 13 | MgF ₂ | Channel Electron Multiplier | 2400 (max. 3000) | 5x10 ⁷ | 6x10 ⁵ | | | 20 | 3x10 ⁻¹⁷ | | 50 | (DC linearity limit) 10% of bias current | 10 μA (max. 30 sec.) | 3 6 | C1911P | 3000 (max. 3000) | 3x10 ⁶ | 1 | 10:1 | 50 |
| C1921 | 115-320 | CsTe | | MgF ₂ | | | | 1x10 ⁶ | 100 | 3x10 ⁻¹⁷ | C1921P | 10 | | | | | | | | | | | |
| C1922 | 165-320 | CsTe | | Quartz | | | | 1x10 ⁶ | 100 | 3x10 ⁻¹⁷ | C1922P | 10 | | | | | | | | | | | |
| C1942 | 165-650 | Bialkali | | Quartz | | | | 3x10 ⁶ | 800 | 3x10 ⁻¹⁷ | C1942P | 100 | | | | | | | | | | | |
| C1943 | 185-650 | | | UV glass | | | | 3x10 ⁶ | 800 | 3x10 ⁻¹⁷ | C1943P | 100 | | | | | | | | | | | |
| C1944 | 300-650 | | | Borosil. | | | | 3x10 ⁶ | 800 | 3x10 ⁻¹⁷ | C1944P | 100 | | | | | | | | | | | |
| C1952 | 165-750 | Low noise Multialk. | | Quartz | | | | 3x10 ⁶ | 2500 | 8x10 ⁻¹⁷ | C1952P | 400 | | | | | | | | | | | |
| C1953 | 185-750 | | | UV glass | | | | 3x10 ⁶ | 2500 | 8x10 ⁻¹⁷ | C1953P | 400 | | | | | | | | | | | |
| C1962 | 165-850 | Multialk. | | Quartz | | | | 2x10 ⁶ | 10000 | 1x10 ⁻¹⁶ | C1962P | 1000 | | | | | | | | | | | |
| C1963 | 185-850 | | | UV glass | | | | 2x10 ⁶ | 10000 | 1x10 ⁻¹⁶ | C1963P | 1000 | | | | | | | | | | | |
| C1972 | 165-900 | Extend. red Multialk. | | Quartz | | | | 2x10 ⁶ | 50000 | 5x10 ⁻¹⁶ | C1972P | 5000 | | | | | | | | | | | |
| C1973 | 185-900 | | | UV glass | | | | 2x10 ⁶ | 50000 | 5x10 ⁻¹⁶ | C1973P | 5000 | | | | | | | | | | | |
| C1982 | 165-650 | Low noise Bialk. | | Quartz | | | | 3x10 ⁶ | 250 | 2x10 ⁻¹⁷ | C1982P | 25 | | | | | | | | | | | |
| C1983 | 185-650 | | | UV glass | | | | 3x10 ⁶ | 250 | 2x10 ⁻¹⁷ | C1983P | 25 | | | | | | | | | | | |

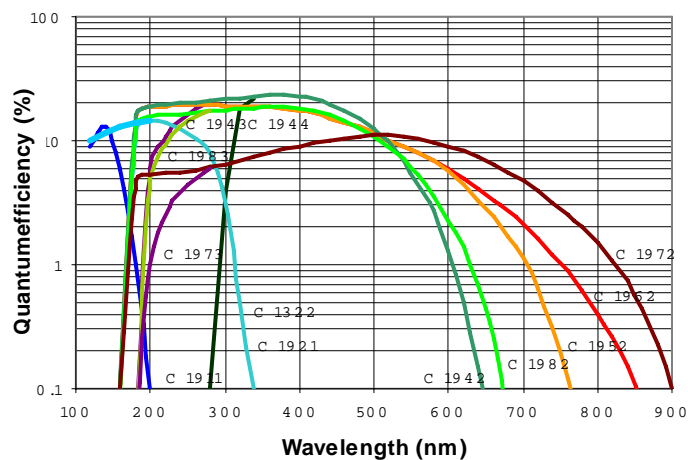
Dimensions (mm)



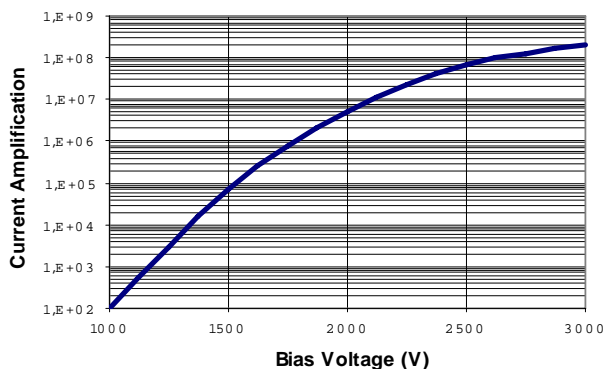
CPM C1900 Series 3/4" CPM Channel Photomultipliers

CPM C1900 Performance Specifications

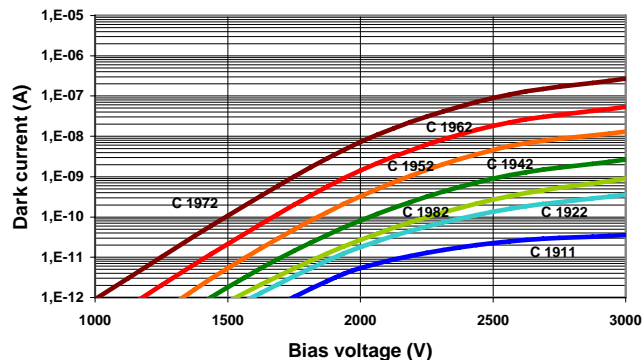
Spectral response



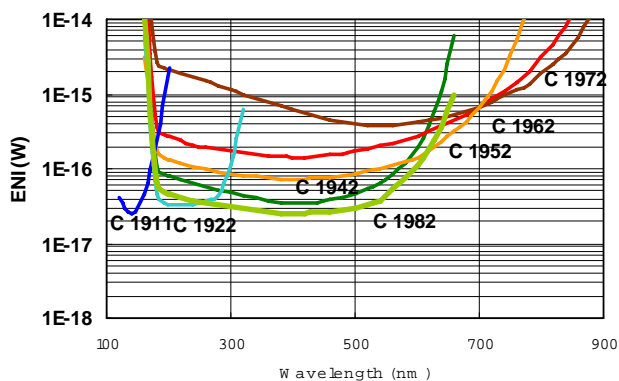
Current Amplification



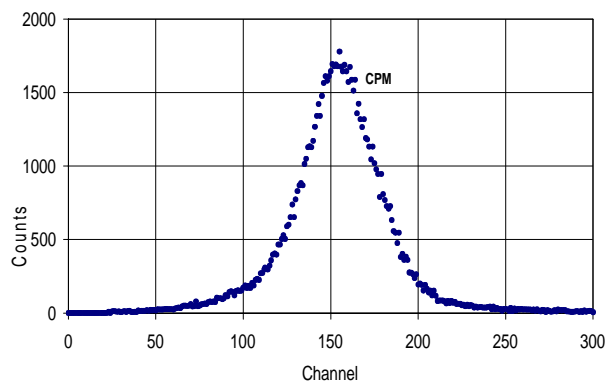
Dark Current



Equivalent Noise Input



Typical Photo Electron Spectrum



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All given values are nominal/typical @ 20 °C ambient temperature; specifications subject to change without notice.

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Germany
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Singapore 139947
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