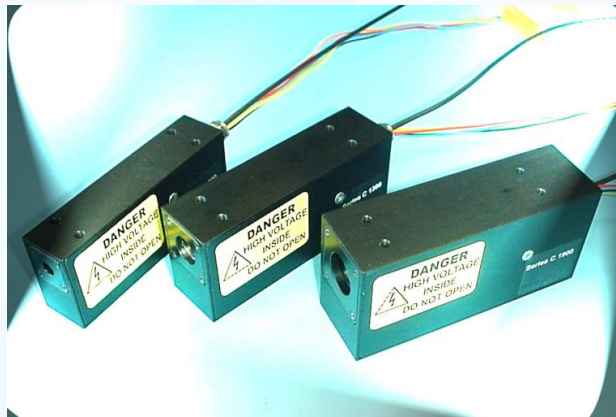


# Customized Photon Multiplier Module Head PV- HM 9XZ / 13XZ /19XZ series

*Preliminary Operating Instructions*



## Operating Manual

### APPLICATIONS

- ❖ Photon counting
- ❖ Luminescence & fluorescence spectroscopy
- ❖ Microplate readers
- ❖ Clinical diagnostics
- ❖ DNA & cell analysis
- ❖ Particle measurements
- ❖ Industrial spectroscopy
- ❖ Nucleic acid amplification (PCR)

### FEATURES

- ❖ Extremely low background noise
- ❖ Best low light level detection limits
- ❖ High dynamic range & gain
- ❖ Low microphonic & magnetic sensitivity
- ❖ Compact size & rugged design
- ❖ Multiple photocathode and window selections
- ❖ Plug and play for shortest design-in and time-to-market
- ❖ Customizations and added features available

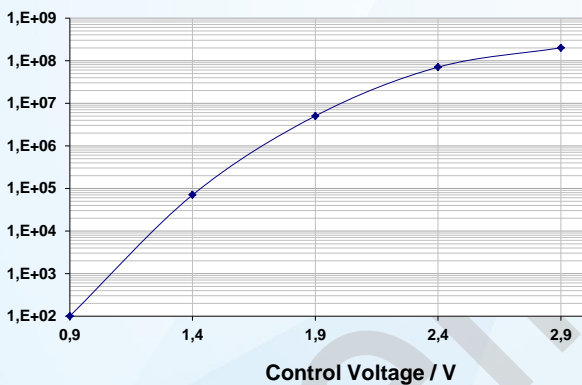
The Channel Photomultiplier module HM - series is designed for an easy to use application for both photoncounting and analogue dc operating modes.

It contains an adjustable high voltage supply and a Customized Photo Multiplier of the C - series. The module offers also the possibility to apply an external gate function for time correlated photon counting or active quenching control.

Strong variations in light levels are possible due to the high dynamic range of the installed CPM.

The exceptional low noise and high sensitivity facilitates detection of extremely weak light levels.

Current Amplification/vs Control Voltage



The modules can be equipped with various Customized Photo Multipliers in respect to window photocathode-material and active area.

### Specification Parameters

| Parameter   | Min | Typ                                 | Max                 | Unit |
|---|-----|-------------------------------------|---------------------|------|
| Supply Current  |     |                                     | 0.2                 | A    |
| Supply Voltage  | 4.9 | 5.0                                 | 5.5                 | V    |
| Settling Time (time to stabilize HV after supply voltage applied) |     |                                     | 1                   | s    |
| Gain <sup>(1)</sup>   |     |                                     | 1 x 10 <sup>8</sup> |      |
| GATE settling time t <sub>gate</sub><br>-> high to low            |     | 150                                 |                     | µs   |
| GATE settling time t <sub>gate</sub><br>-> low to high            |     | 150                                 |                     | µs   |
| High Voltage pre-adjusted   |     | 2400                                |                     | V    |
| High Voltage ADJUST <sup>(2)</sup>                                | 0   |                                     | 2900                | V    |
| Monitor Voltage Out   |     | V <sub>ChannelEntrance</sub> / 1000 |                     | V    |
| Operating Temperature   | 5   |                                     | 40                  | °C   |
| Storage Temperature   | -20 |                                     | 50                  | °C   |

<sup>1)</sup> by internal potentiometer (or by external control voltage 0...3 V via ext. OpAmp circuit, see Fig.2)

<sup>2)</sup> adjusted voltage refers to V<sub>ChannelEntrance</sub>

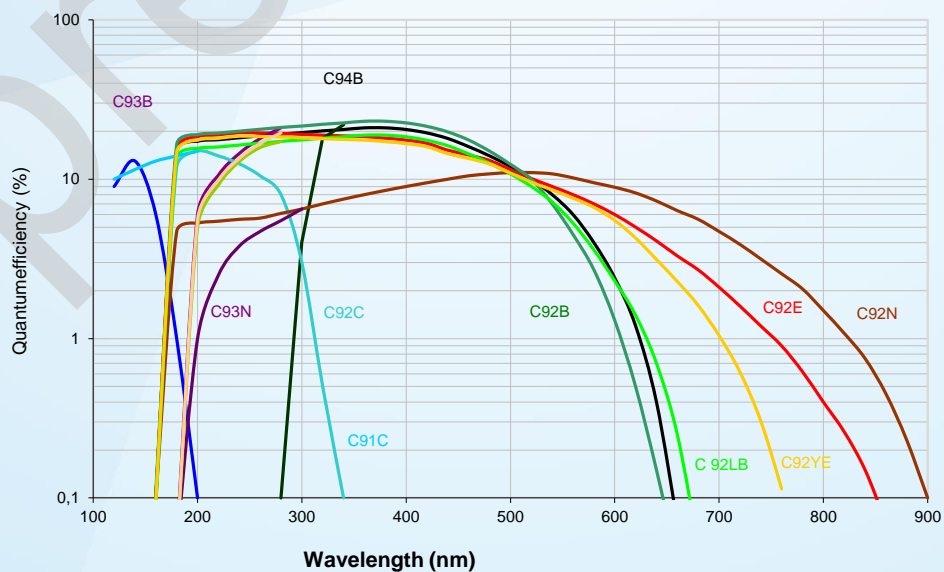
### Absolute Maximum Ratings

|                       |   |
|-----------------------|---|
| Input Voltage         | +5.5V   |
| Max. Anode Current    | 10µA for max. 30 seconds                            |
| Operating Temperature | +5 to +40°C   |
| Storage Temperature   | -20 to +50°C  |
| Weight                | ~ 225g /290g / 370g<br>(HM 9XZ / HM 13XZ / HM 19XZ) |

List of Module Variations

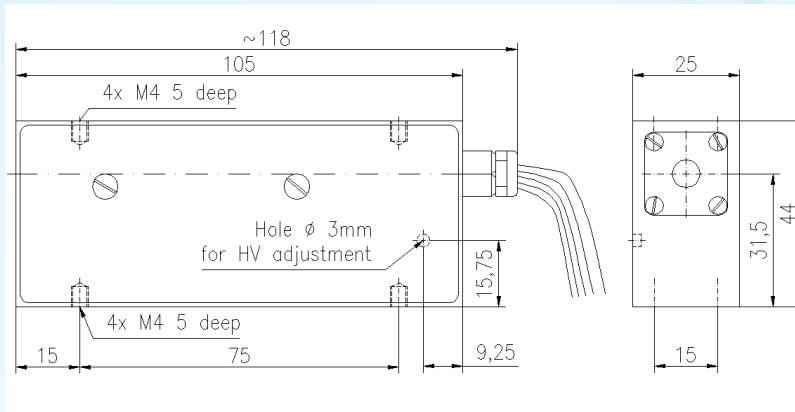
| Model<br>(also order no.)     | Detector type                     | Photocathode diameter | Window material      | Photocathode material   | Spectral response / nm  | Quantum efficiency                             | Typ. dark counts per second (cps) | Typ. dark current (pA) @ 5x10 <sup>7</sup> Gain |                           |
|-------------------------------|-----------------------------------|-----------------------|----------------------|-------------------------|-------------------------|--|-----------------------------------|---|---------------------------|
| HM 91CI<br>HM131CI<br>HM191CI | Customized Photo Multiplier (CPM) | HM 9XZ<br>min. 5mm    | MgF <sub>2</sub> (1) | Csl (CI)                | 115-200                 | Peak Value 20% typical (ext. red MA: 10% typ.) | 0.1<br>0.4<br>1                   | 2<br>8<br>20                                    |                           |
| HM 92B<br>HM132B<br>HM192B    |                                   |                       | Quartz (2)           | Bialkali (B)            | 165-650                 |  | 10<br>40<br>100                   | 80<br>320<br>800                                |                           |
| HM 93B<br>HM133B<br>HM193B    |                                   |                       | UV Glass (3)         | Bialkali (B)            | 185-650                 |  | 10<br>40<br>100                   | 80<br>320<br>800                                |                           |
| HM 92E<br>HM132E<br>HM192E    |                                   |                       | Quartz               | S20 (E)                 | 165-850                 |  | 100<br>400<br>1000                | 1.000<br>4.000<br>10.000                        |                           |
| HM 93E<br>HM133E<br>HM193E    |                                   |                       | UV Glass             | S20 (E)                 | 185-850                 |  | 100<br>400<br>1000                | 1.000<br>4.000<br>10.000                        |                           |
| HM 92N<br>HM132N<br>HM192N    |                                   |                       | HM 13XZ<br>min. 9mm  | Quartz                  | S25 (N)                 |  | 165-900                           | 500<br>2000<br>5000                             | 5.000<br>20.000<br>50.000 |
| HM 93N<br>HM133N<br>HM193N    |                                   |                       | UV Glass             | S25 (N)                 | 185-900                 |  | 500<br>2000<br>5000               | 5.000<br>20.000<br>50.000                       |                           |
| HM 92LB<br>HM132LB<br>HM192LB |                                   |                       | HM 19XZ<br>min. 15mm | Quartz                  | Low Noise Bialkali (LB) |  | 165-650                           | 3<br>10<br>25                                   | 50<br>100<br>250          |
| HM 93LB<br>HM133LB<br>HM193LB |                                   |                       | UV Glass             | Low Noise Bialkali (LB) | 185-650                 |  | 3<br>10<br>25                     | 50<br>100<br>250                                |                           |
| HM 92YE<br>HM132YE<br>HM192YE |                                   |                       | Quartz               | Yellow Enhanced (YE)    | 165-750                 |  | 10<br>40<br>100                   | 80<br>320<br>800                                |                           |
| HM 93YE<br>HM133YE<br>HM193YE |                                   |                       | UV Glass             | Yellow Enhanced (YE)    | 185-750                 |  | 10<br>40<br>100                   | 80<br>320<br>800                                |                           |

Spectral response of various CPM types

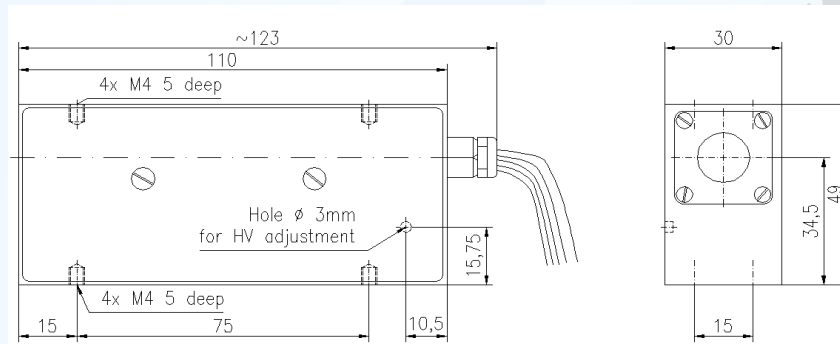


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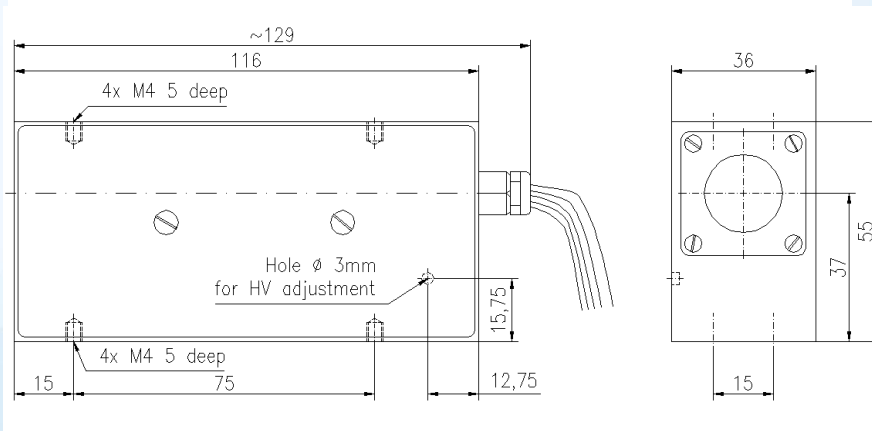
Module Dimensions (mm) for Different CPM Formats



PV-HM 9XZ



PV-HM 13XZ



PV-HM 19XZ

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| <b>Window Material = X</b> |    | <b>Photocathode Type = Z</b> |     |
|----------------------------|----|------------------------------|-----|
| MgF <sub>2</sub>           | =1 | Cesium Iodid                 | =CI |
| Quartz                     | =2 | Cesium Tellurid              | =C  |
| UV Glass                   | =3 | Bialkali                     | =B  |
| Borosilicat                | =4 | LowNoise Bialkali            | =LB |
|                            |    | S20                          | =E  |
|                            |    | S25                          | =N  |
|                            |    | YellowEnhanced               | =YE |

### Important Notes

- When not operating the CPM-module, always keep cathode covered or in darkness
- Turn off all power supplies immediately, if the module does not work properly
- Review all connections of the power supply and signal output
- When installing the CPM-module, avoid any material - especially conductive material- close to the front window (approx. 5 mm).

### Testing/Measurements

- Ensure that power supply of your voltage source is switched off
- Connect red wire to a 5 V supply source
- Connect black wire to ground of voltage source
- Connect yellow wire to the voltage input of a voltmeter
- Connect ground input of voltmeter to common ground (black wire of module)
- Connect output signal of module via a 50 Ohms coaxial cable to a high speed oscilloscope, a counter (for both, termination is 50 Ohms in order to observe fast output pulses) or to your electronic system (without additional termination).
- Optional: Connect external gate input (orange) to your gating signal source (Gating: TTL-level high)
- For adjusting high voltage, use miniature screwdriver, observe monitor voltage received with yellow output wire and adjust high voltage level as desired, starting with max. 1 volts  $V_{mon}$  or 1000 volts  $V_{out}$ .
- **Before switching on supply voltage, make sure the Channel Photomultiplier is in total darkness (Turn off any light source).**
- While switching on supply voltage, monitor output signal. In total darkness, count rate is max. about 20 to 30 (bialkali types) . Measuring the output current, depending on CPM type and adjusted gain, dark current should be in the low pico ampere range (bialkali type) or in the low nano ampere range (multialkali, max gain).
- If the CPM was exposed to high light levels before operating started, number of counts can exceed 1kcps or dark current can exceed some nA. In that case, store CPM in darkness for one hour before re-operating.
- Using the Gating function, a TTL level of about 4 V is required. The cathode is switched off only for the time the input level is at high. Then, no anode signal will be obtained. With gate input open or ground, the module will be in standard operating mode

### External Gain Control

Operating the MH-module with an external control voltage requires

- a) direct input of 0 to 3 Volts dc when the internal control potentiometer has been removed or
- b) using an external Operational Amplifier circuit (Fig. 2) for impedance adoption when control potentiometer has not been removed.

### Connections

| Color       | Function                  | In-/Output | Signal Level                                  |
|-------------|---------------------------|------------|---|
| blue        | HV Shutdown (kill)        | Input      | > 2.6 inactive, < 2.4 V active                |
| green       | Vset (Gain cont. volt.)   | Input      | 0 to 3 volts (please refer to fig.1)          |
| orange      | ext. Gate-Input           | Input      | < 3.1V or open : inactive,<br>> 3.2V : active |
| red         | +5Vdc(Power supply)       | Input      | Max. 5.5 V                                    |
| yellow      | Monitor Voltage $V_{mon}$ | Output     | 0 to 3 volts                                  |
| black       | GND(power supply)         | Input      | Common Ground                                 |
| Coax, black | Signal Output             | Output     | Current Pulse, negative                       |

Table 1: Input / Output Connections



Fig.1: Cable Output of MH-Module

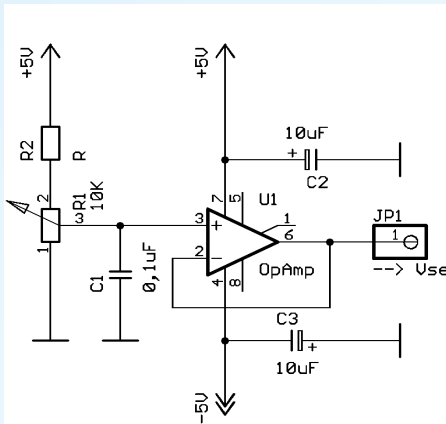


Fig. 2: Recommended OpAmp circuit for external Gain control (when internal potentiometer is not removed)

### Calculation of output current

The anode output current can easily be calculated by using the following equation:

Elementary Charge ( $1.6 \times 10^{-19}$  As)  $\times$  CPM-Gain  $\times$  Photoelectrons/s = Anode output current ( $I_a$ )

Example:

Assuming, Gain is  $10^7$  and amount of photons per second is 200,000, the Anode current is:

$1.6 \times 10^{-19} \text{As} \times 10^7 \times 200,000 \text{ 1/s} = 320 \times 10^{-9} \text{ A}$  or 320nA

In this case, output anode current is 320nAmps.

Please also use this equation for determining the dark current of the CPM.

### Life time considerations

Life time of a CPM is considered as being "Half Life" of the device.

Half Life defines the quantity of charge, the CPM has provided, until the anode current has decreased to 50% of its initial value at constant light- and power supply conditions.

The typical value for Half Life is 4 As (or 4 Coulomb).

Example:

Initial Anode current: 20nA, Half life assumed with 4 As:

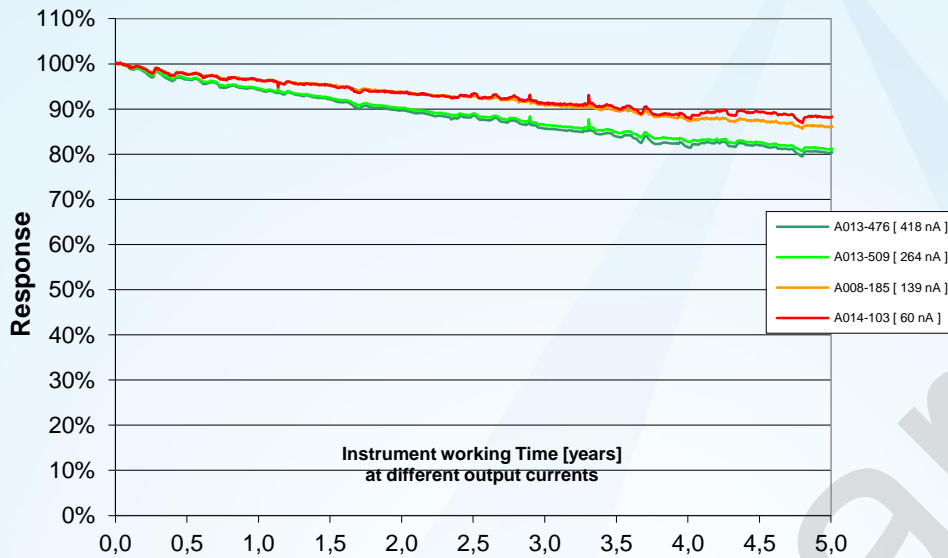
Calculation:  $4 \text{As} / 20 \times 10^{-9} \text{A} = 200 \times 10^6 \text{ sec.}$  or  $56 \times 10^3 \text{ hrs}$  or 2333 days or 6.4 years.

In this case, after more than 6 years, the output anode current has decreased by 50% of the initial value.

The anode current can easily be re-adjusted to its initial value, by increasing the supply voltage.

Operating the CPM in Counting mode, half time is even beyond 3-5As, since running the CPM on the Single Photo Electron Plateau allows CPM-gain reduction (factor 2) without effecting the count rate significantly.

### Longtime Stability



### High Voltage Warning

- Warning: HIGH VOLTAGE
- This product operates at high voltage. Extreme care must be taken to ensure operator safety and to avoid damage to other instruments. Avoid direct contact with the CPM when high voltage is applied.
- If the photocathode is operated at negative high voltage, avoid to place any material close to the cathode. It is advantageous to keep any material 5 to 10 mm away from the biased cathode. If materials are used close to the cathode operated at high voltage electrical fields might create unwanted noise.
- Ensure that no light levels are applied, generating higher anode currents than specified.
- All given values are nominal/typical @ 20 °C ambient temperature; specification subject to change without notice

### ESD warning

CPM Modules should only be handled at an ESD-safe work station.

### Warranty

A standard 12-month warranty following shipment applies. Any warranty is null and void if the module case has been opened unauthorized