# CR-Z-PMT CSP instrument: application guide

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## Overview

The CR-Z-PMT is a charge sensitive preamplifier (CSP) instrument, based on Cremat's CR-113 CSP module. The CR-Z-PMT has BNC connections for detector input, test input, and preamplifier output. The CR-Z-PMT is intended for use with photomultiplier detectors (PMTs). Cremat also offers another instrument based on the CR-113 module (CR-Z-SiPM) which is intended for use with SiPM photodiodes.

## Preamplifier Specifications

Assume temp =20 °C, unloaded output

| | | units |
|---|---|---|
| Equivalent noise charge (ENC)* | 3 | femtoCoul. RMS |
| ENC increase per added input capacitance | 0.005 | femtoCoul RMS /pF |
| Gain | 1.3 | mV / picoCoul. |
| Rise time ** | 15 | ns |
| Decay time constant | 50 | µs |
| Maximum charge detectable per event | $1.3 \times 10^{10}$<br>2.1 | electrons<br>nanoCoul. |
| Operating temperature | -40 to +85 | °C |
| Output impedance | 50 | ohms |
| Output voltage swing | -3 to +3 | volts |

* Measured with input unconnected, using Gaussian shaping amplifier with shaping time =1 µs. With a detector attached to the input, noise induced by the detector capacitance, leakage current, and dielectric losses will add to this figure.

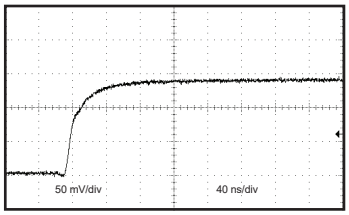
** Pulse rise time defined as the time to attain 90% of maximum value. The value cited in the table assumes zero added input capacitance. Capacitance at the preamplifier input will further slow the rise time at a rate of 0.09 ns / pF

## Preamplifier operation

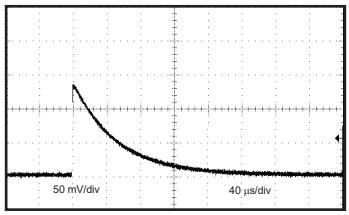
Charge sensitive preamplifiers (CSPs) can be used with PMT detectors when radiation is detected as a series of discrete detection events. These events produce brief pulses of current flowing from the PMT anode into the CSP input. CSPs are integrating in nature and integrate the current from each pulse to produce a positive output voltage step proportional to the charge from the PMT anode from each detection event.

The voltage step from the output will have a rise time that is at least 15ns and may be lengthened by the duration of the signal pulse. A pulse from the PMT lasting a couple microseconds (as in the example of a CsI(Tl) scintillator) will produce a CSP output having a rise time of a couple microseconds.

The output voltage step waveform of the CR-Z-PMT CSP using a plastic scintillator/PMT detector is shown below. At longer time domains, this output decays with the before-mentioned time constant of 50 µs and is also shown below. The pulse decay serves to reset the preamplifier. Although subsequent pulses may ride up on top of this decaying tail, this generally does not present a problem because the preamplifier output is usually not analyzed directly; it is usually routed through a shaping amplifier which considerably quickens the pulse decay. More information on this can be found in the product literature for Cremat's shaping amplifiers at http://cremat.com/CR-200.htm




output waveform: fast time scale



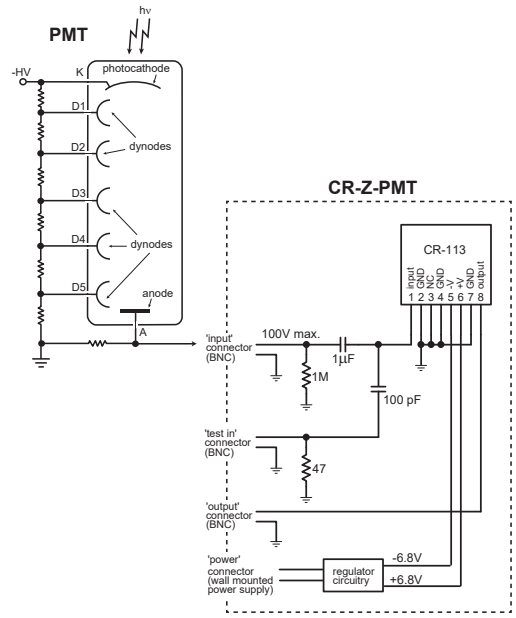

output waveform: slow time scale


front view

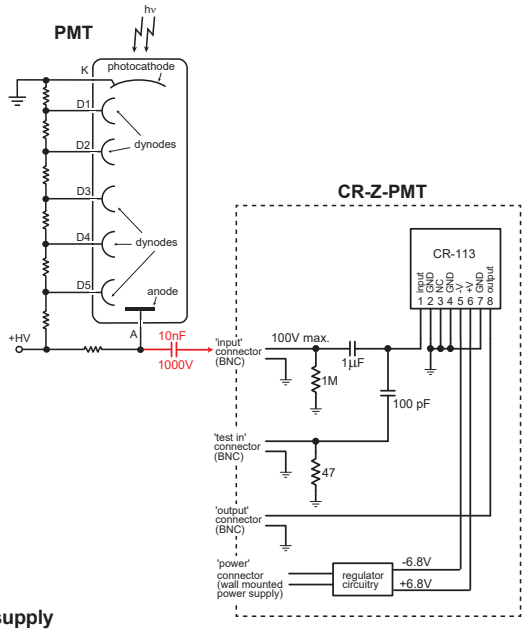

back view

## Making Connection

The connections from a PMT to a CR-Z-PMT CSP are shown below for a PMT biased with negative high voltage on the PMT photocathode and the anode near ground potential.:




If the PMT needs to be used with the photocathode grounded and the anode at positive high voltage, then a high voltage blocking capacitor (~10,000pF) should be placed in series with the CR-Z-PMT input to protect the input from high voltage as shown below:




## Power supply

Included with all CR-Z series charge sensitive preamplifiers is a wall mounted power supply. This supply has 5 different interchangeable input blades in order to accommodate various wall sockets and wall voltages found internationally. Cremat does not recommend that other types or models of power supplies be used in place of this model.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