CR-Z-SiPM CSP instrument: application guide

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Overview

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

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 **	(0.09 • C_d(pF))+15	ns
Decay time constant	50	µs
Maximum charge detectable per event	1.3 x10^{10} 2.1	electrons 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. Capacitance at the preamplifier input will slow the rise time at a rate of 0.09 ns / pF

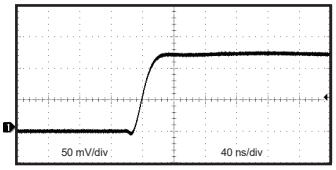
Preamplifier operation

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

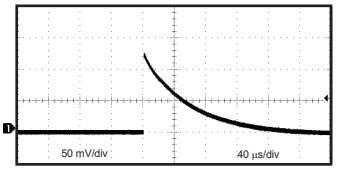
SiPM detectors generally have large capacitance, and the rise time of the voltage step at the CSP output is slowed by the input capacitance at a rate of 0.09 ns/pF. For very large capacitance SiPM detectors the rise time of the signal may exceed a couple hundred ns. Check the specifications of your SiPM photodiode to determine the capacitance if this concerns you. Assuming a shaping amplifier is used after the preamplifier, slow rise times should not be a concern unless the rise time exceeds the shaping time.

The output rise time may also be limited by the length of the optical signal pulse. For example, the detection current pulse from a CsI(Tl)/SiPM photodiode scintillation detector has a duration of approximately a couple µs, so in this case the expected rise time of the charge sensitive preamplifier output will be at least that long.

The output waveform of the CR-Z-SiPM using an electronic test pulser is shown below. At short time domains the output signal resembles a step function (shown to the left). At long time domains the output decays with an RC time constant of 50 µs and is shown below to the right. 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



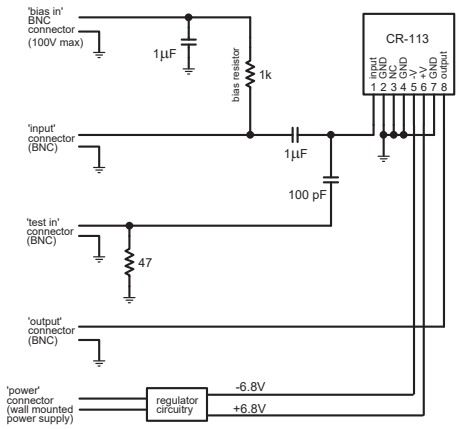
output waveform: slow time scale

To use an electronic pulser as a test input, apply a square wave (~100 Hz, 50% duty cycle, ~5V p-p) to the 'test in' connection on the instrument. The output should be a series of tail pulses (such as shown in the scope trace above) of alternating positive and negative polarity.

Making Connection

Connect the SiPM photodiode to the 'input' BNC connector. Connect your SiPM detector bias supply to the 'bias in' connector (maximum bias voltage: +/-100V). Polarity may be positive or negative, however the chosen polarity needs to 'reverse bias' the SiPM detector connected to the preamplifier input. Applying positive bias to 'bias in' will result in positive output pulses from the preamplifier, negative bias to 'bias in' will produce negative pulses.

The CR-Z-SiPM uses 'AC-coupling' to connect the detector to the input of the CR-113 preamplifier module as is shown in the simplified circuit diagram 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. We do not recommend that other types or models of power supplies be used in place of this model.

front view

back view

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