CR-S2-X Gaussian shaping amplifier instrument: application guide

Dec. 2018

The CR-S2-X is a Gaussian shaping amplifier instrument, meant for processing signals from charge sensitive preamplifiers. Most radiation detection instrumentation employing charge sensitive preamplifiers use shaping amplifiers to transform the shape of the pulses from a tail-pulse function (voltage step with an expontial decay) to a Gaussian-like function (bell-shaped). The purposes of the shaping stage is not only to provide a quick return to the baseline, but also to filter noise and to further amplify the small signals.

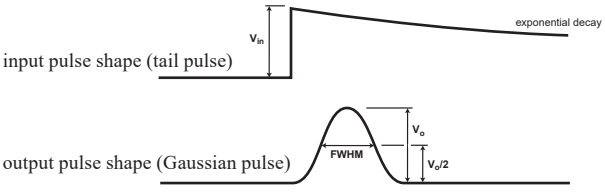
The CR-S2-X consists of a Cremat CR-160-R8 evaluation board with a CR-200-X shaping amplifier module and a CR-210-R0 baseline restoration module installed. The housing is a die-cast aluminum box similar to the CR-160-BOX-R4. A wall mounted power supply provides the necessary power (CR-24V, included).

Input and Output Pulse Shapes

Input signals to the CR-S2-X should take the form of a 'tail pulse', which is the pulse shape provided by most charge sensitive preamplifiers. The output signals from the CR-S2-X are 'Gaussian' pulses, so named because they take the form of the well-known Gaussian distribution.

The shaping time of the CR-S2-X is fixed by the CR-200-X shaping amplifier module installed within it. The shaping time of the instrument can be changed to a different value by swapping out the CR-200-X module inside the unit with one of a different shaping time.

As per the industry standard, the 'shaping time' is related to the full-width-at-half-maximum (FWHM) by a factor of 2.4. The output pulse widths are described in the table on the right. More information on the shaping amplifiers can be found in the CR-200-X specification sheet: https://www.cremat.com/CR-200-R2.1.pdf



Comparison of input and output pulse shapes

Gain Adjustment

The fine gain of the amplifier can be continuously adjusted (down to zero, if need be) using a small trim-pot placed between the input and output connectors (see photo on the right). The coarse gain may be adjusted by implementing one, both, or neither of the two separate amplification stages, each of which has a gain of 10 when 'on' (down). When the piano switch is 'off' (up), the gain of the stage is 1. Keep in mind that, in addition to the gain of the amplifiers on the CR-160-R8 evaluation board, the CR-200-X shaping amplifier module itself has gain. The total gain range of the instrument is listed in the specifications table.

Signal Polarity

Signal polarity can be changed using one of the 'piano style' switches located between the input and output connectors (see the photo on the right). A switch position of 'on' (down) inverts the signal from the input. The CR-S2-X output pulses must be positive for proper operation of the baseline restorer subcircuit. The polarity switch should be used to obtain positive output pulses if the pulses from the preamplifier are negative.

Baseline Restoration

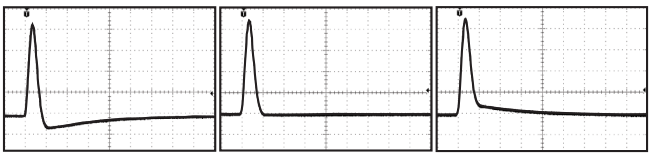
The CR-S2-X comes with a CR-210-R0 baseline restoration module installed. This module corrects for the depression of the output baseline voltage which normally occurs at medium to high count rates. More information regarding the baseline restoration can be found on the CR-210-R0 spec sheet: https://www.cremat.com/CR-210-R0.pdf

Internal Adjustments: Pole/Zero Correction and Output Offset

The long decay time of the input pulse creates a small overshoot in the shape of the output pulse unless a pole/zero correction is utilized. This pole/zero correction is made using an on-board potentiometer ($R_{P/Z}$) located internally, as shown in the board photo. This adjustment is more important when using long shaping times - less important otherwise.

The CR-S2-X is sold with $R_{P/Z}$ adjusted for the CR-200-X shaping module installed. In the event that the user switches shaping modules to a different shaping time, $R_{P/Z}$ should be readjusted.

The effect of adjusting the pole/zero correction potentiometer ($R_{P/Z}$) on the pulse shape can be seen in the pulse waveforms shown in the figures below:



$R_{P/Z}$ resistance too high | $R_{P/Z}$ resistance proper | $R_{P/Z}$ resistance too low

In addition to the pole/zero correction potentiometer, there is also a potiometer for adjusting the output offset.

Specifications

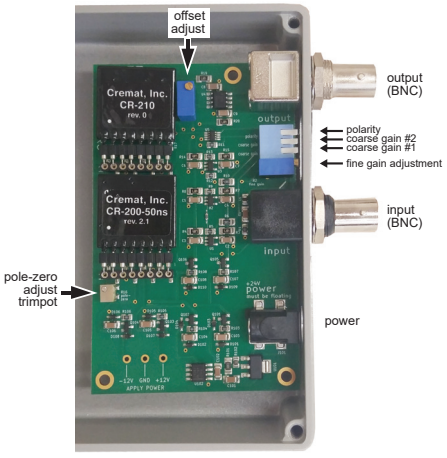
Assume temp =20°C, unloaded output

box dimensions	4.69 x 3.69 x 1.34 inches	
Amplification channels	1	
gain	variable, from 0 to maximum gain (below)	
input polarity	can be either, output must be positive	
operating temp. range	-40°C to 85°C	
output impedance	2	Ω
maximum output range	0 to +3.5	volts

model number	noise voltage (μV RMS)*	output pulse width (FWHM)	maximum gain
CR-S2-50ns	11	150 ns	800
CR-S2-100ns	7	250 ns	1000
CR-S2-250ns	5	590 ns	1000
CR-S2-500ns	3.4	1.2 μs	1000
CR-S2-1μs	2.3	2.4 μs	1000
CR-S2-2μs	1.8	4.7 μs	1000
CR-S2-4μs	1.4	9.4 μs	1000
CR-S2-8μs	1.1	19 μs	1000

* quoted noise figures are refered to the input, and represent the case when the two auxilliary amplification stages are set to gain=10 and the fine gain set to the maximum.

A schematic diagram of the CR-S2-X can be found at: https://www.cremat.com/CR-160-R8-schematic.pdf



Wall mounted power supply (included). Suitable for international use.

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