CR10

Combined Charge-sensitive Pre-amplifier and Shaping Amplifier

User Manual

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3 Safety Information

This unit is designed for compliance with harmonized electrical safety standard EN61010-1:2000. It must be used in accordance with its specifications and operating instructions. Operators of the unit are expected to be qualified personnel who are aware of electrical safety issues. The customer's Responsible Body, as defined in the standard, must ensure that operators are provided with the appropriate equipment and training.

The unit is designed to make measurements in **Measurement Category I** as defined in the standard.

Although the CR10 does not generate dangerous voltages, nor is it designed to measure directly such voltages, it may be supplied with high voltage bias up to +/- 3kV from an external supply. This voltage is then present inside the case. Appropriate precautions must be taken.

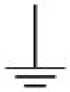
The unit must not be operated unless correctly assembled in its case. Only Service Personnel, as defined in EN61010-1, should attempt to work on the disassembled unit, and then only under specific instruction from Pyramid Technical Consultants, Inc. or their authorized distributors.

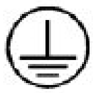
The unit is designed to operate from +/- 12 VDC power rails, with a maximum current requirement of 50mA on each rail. Up to four CR10s can be powered and provided with high voltage bias by one C400 pulse counting detector controller.

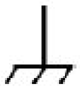
The unit must be grounded by secure connection to a grounded conducting surface. If the unit is mounted on an insulating surface, then one of the four mounting screws must be re-assigned as a grounding connection.

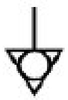
Some of the following symbols may be displayed on the unit, and have the indicated meanings.


Direct current

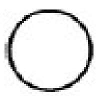

Earth (ground) terminal


Protective conductor terminal


Frame or chassis terminal


Equipotentiality

Supply ON


Supply OFF


CAUTION – RISK OF ELECTRIC SHOCK


CAUTION – RISK OF DANGER – REFER TO MANUAL

4 Models

CR10	Combined charge-sensitive pre-amplifier and shaping amplifier.

Configuration selections

-GN	Input stage conversion gain selection: N=0 1400 mV pC^{-1} (CR-110) N=1 130 mV pC^{-1} (CR-111) N=2 13 mV pC^{-1} (CR-112) N=3 1.3 mV pC^{-1} (CR-113)
-TN	Shaping amplifier stage time constant selection: N=0 50 ns (CR-200-50ns) N=1 100 ns (CR-200-100ns) N=2 250 ns (CR-200-250ns) N=3 500 ns (CR-200-500ns) N=4 1000 ns (CR-200-1µs) N=5 2000 ns (CR-200-2µs) N=6 4000 ns (CR-200-4µs) N=7 8000 ns (CR-200-8µs)
-BR	Baseline restorer option (recommended for high count rate applications)
-Detector/Bias	Connector options: Detector: BNC or SHV or Lemo 00.250 Bias: BNC or SHV
-SHLD	Internal shield option. Recommended and included by default for -G0 gain selection. Optional for other gain selections.

The following options can be factory set on request and are adjustable in the field by trained service personnel by internal jumper settings.

-N/P	Negative or positive input signal polarity selection (default is positive)
-IG1/10/100	Intermediate stage gain selection x1, x10, x100 (default is x10)

Examples

CR10-G1-T2-BR-SHV/SHV CR10 configured with 130 mV pC-1 pre-amp conversion gain, 250 nsec shaping time constant, baseline restorer module, SHV connectors for detector and bias.

CR10-G0-BNC/BNC CR10 configured with 1400 mV pC-1 pre-amp conversion gain, no shaping or baseline restoration, BNC connectors for detector and bias.

5 Scope of Supply

CR10 model configuration as specified in your order.

USB memory stick containing:

- Data sheet
- User manual
- Test results

Optional items as specified in your order.

OEM customers may not receive all the items listed.

6 Optional Items

6.1 Power supplies

PSU24-25-1. Line to +24 VDC universal power supply 25W, IEC C8 inlet, S761K 2.1mm threaded jack outlet.

PSU1212-1L. +24 VDC to +/-12 VDC converter, input for 2.1mm threaded jack, output Lemo 0B.304 male.

PSU1212-1N. +24 VDC to +/-12 VDC converter, input for 2.1mm threaded jack, output DSub 9-pin with NIM standard pin assignment for +/-12 V and ground.

PSU1212-1C. +24 VDC to +/-12 VDC converter, input for 2.1mm threaded jack, output DSub 9-pin with Pyramid C400 pin assignment for +/-12 V and ground.

Note: If the CR10 is used with a C400, +/-12V power is provided by the C400.

6.2 Cables and adaptors

CAB-SHV-2-SHV HV cable assembly, 2' (0.6 m). For signal input and HV bias input.

CAB-SHV-3-SHV HV cable assembly, 3' (0.9 m). For signal input and HV bias input.

CAB-BNC-COLN2-NC Coax cable assembly low noise, 2' (0.6 m). For signal input and bias (BNC connector option).

CAB-BNC-COLN3-NC Coax cable assembly low noise, 3' (0.9 m). For signal input and bias (BNC connector option).

CAB-SHV-10-SHV HV cable assembly, 10' (3 m). For detector and bias voltage inputs.

CAB-L00-10-L00 Lemo 00 coax cable assembly, 10' (3 m). For test pulse input and signal output.

CAB-L00-30-L00 Lemo 00 coax cable assembly, 30' (9 m). For test pulse input and signal output.

CAB-L304M-10-D9M Power cable assembly, 10' (3 m). To power CR10 from PSU1212-1C or C400.

CAB-L304M-30-D9M Power cable assembly, 30' (9 m). To power CR10 from PSU1212-1L or C400.

ADAP-LEMO-BNC Adaptor, Lemo 00 coax plug to BNC jack. For test pulse input and signal output if using BNC-terminated cables.

Other lengths available on request.

6.3 DIN rail mount

MTG-DIN35-11462. Mounting adaptor for 35mm standard DIN rail. CR10 can be mounted along or across the rail.

7 Intended Use and Key Features

7.1 Intended Use

The CR10 is intended to amplify and condition small charge pulses generated in radiation detectors such as diodes and proportional counters. With suitable gain configuration it can also handle larger pulses from detectors such as Geiger counters, photomultipliers and channel electron multipliers. It is intended for use in moderate count rate applications where the amount of charge in each pulse must be measured, for example by an multi-channel analyser, or where the pulse must be counted by a discriminator/counter such as the C400.

The CR10 may be used to readout detectors that require bias voltage, either applied to the signal readout electrode or another electrode. Bias to the signal readout electrode is connected from the bias input internally in the CR10, and must be limited to +/- 3 kV which is the rating of the decoupling capacitors.

The -BR option adds a baseline restorer module which is recommended for applications where the average count rate can exceed about 10 kHz, especially if accurate pulse height analysis is the objective.

If no shaping amplifier module or baseline restorer is installed, then the CR10 acts as a pulse charge integrator only. The output can be connected to an external independent shaping amplifer.

The CR10 has design features which make it tolerant of electrically noisy environments, but the place of use is otherwise assumed to be clean and sheltered, for example a laboratory or light industrial environment. Users are assumed to be experienced in the general use of precision electronic circuits for sensitive measurements, and to be aware of the dangers that can arise in high-voltage circuits.

7.2 Key Features

Single compact unit containing AC-coupling and bias network, charge-sensitive pre-amplifier, intermediate gain stages, shaping amplifier, optional baseline restorer and line driver output.

Gaussian output pulse shape for optimum pulse height measurement with wide selection

Uses proven amplifier modules from Cremat, Inc.

Multiple build configurations available to suit many radiation detector types.

Built-in high voltage bias network rated up to +/- 3 kV.

Configurable for positive or negative input charge pulses.

Choice of SHV or BNC connectors for detector and bias inputs.

Test pulse input.

Adjustable gain.

Optional baseline restoration module for higher rate applications.

Available without shaping amplifier for use with external electronics.

Compatible with Pyramid C400 pulse counting detector controller.

8 Specification

Overall	
Cremat modules fitted	One of CR110, CR111, CR112, CR113 preamplifier One CR200 shaping amplifier with either 50 nsec, 100 nsec, 250 nsec, 500 nsec, 1 µsec, 2 µsec, 4 µsec, 8 µsec shaping time constant. One CR210 baseline restorer (optional)
Example overall gain	2.5 V pC^{-1} into 50 ohms (-G1-T2-IG10 configuration, fine gain 50% setting).
Example noise	Unloaded: < 0.5 mV RMS, < 3.5 mV peak to peak into 50 ohms DC (-G1-T2-IG10 configuration fine gain 50% setting) to 5 MHz. Noise increases with capacitive load on input. Equivalent noise charge < 0.3 fC RMS
Charge-sensitive input stage	
Conversion gain (nominal)	-G0 (CR-110) 1.4 V pC^{-1} -G1 (CR-111) 0.13 V pC^{-1} -G2 (CR-112) 0.013 V pC^{-1} -G3 (CR-113) 0.13 V pC^{-1}
Rise and decay time (zero input capacitance load)	-G0 (CR-110) 3 nsec / 140 µsec -G1 (CR-111) 2 nsec / 150 µsec -G2 (CR-112) 3 nsec / 50 µsec -G3 (CR-113) 1 nsec / 50 µsec
AC coupling	10 nF 3 kV series capacitor
Protection	Standard configuration 1 kohm series resistor and back-to-back fast diodes.
Bias input	
Input circuit	5 Mohm / 10 nF RC filter 67 Mohm series resistor to prevent signal loss
Test input	
Input circuit	47 ohm terminated, charge injection via a 1 pF (nominal) capacitor. One volt step across 47 ohm gives 1 pC charge injection (nominal).
Intermediate gain stage	

Polarity	Jumper setting for overall inverting or non-inverting.
Gain	Jumper setting for intermediate coarse gain x1 / x10 / x100 setting Potentiometer for fine adjustment 0 to 100% of the coarse gain setting.
Shaping amplifier	
Output pulse	Gaussian unipolar, positive or negative going.
Shaping time constant	Build time configuration selection for CR-200 module: -T1 100 nsec (240 nsec FWHM) -T2 250 nsec (590 nsec FWHM) -T3 500 nsec (1.2 µsec FWHM) -T4 1 µsec (2.4 µsec FWHM) -T5 2 µsec (4.7 µsec FWHM) -T6 4 µsec (9.4 µsec FWHM) -T7 8 µsec (18.8 µsec FWHM)
Baseline restorer	
Function	Build time configuration option (CR-210). Removes negative DC offset on the output resulting from AC-coupled signals at high rates. Output signal pulses must be positive polarity.
Output line driver	
Compliance	4.5 V into 50 ohms, 9 V into high impedance
Maximum line length	Able to drive at least 10 m of RG-58, RG-174 or RG-318 coaxial cable.

Controls and displays	
Controls	21-turn trimpot (DC offset) 21-turn trimpot (pole-zero compensation) 21-turn trimpot (fine gain control) Internal jumpers for polarity and coarse gain setting.
Displays	One LED (power on).

Power	
Power input	+12 (+2/-4) VDC, -12 (+4/-2) VDC 50 mA typical, each rail.

Physical	
Case	Stainless steel with mounting flange.
Case protection rating	The case is designed to rating IP43 (protected against solid

	objects greater than 1 mm in size, protected against spraying water).
Weight	0.29 kg (0.63 lb).
Operating environment	0 to 35 C (15 to 25 C recommended to reduce drift and offset) < 80% humidity, non-condensing vibration < 0.2 g all axes (1 to 100 Hz)
Shipping and storage environment	-10 to 50C < 80% humidity, non-condensing vibration < 2 g all axes, 1 to 100 Hz
Dimensions	(see figures 1 - 3).

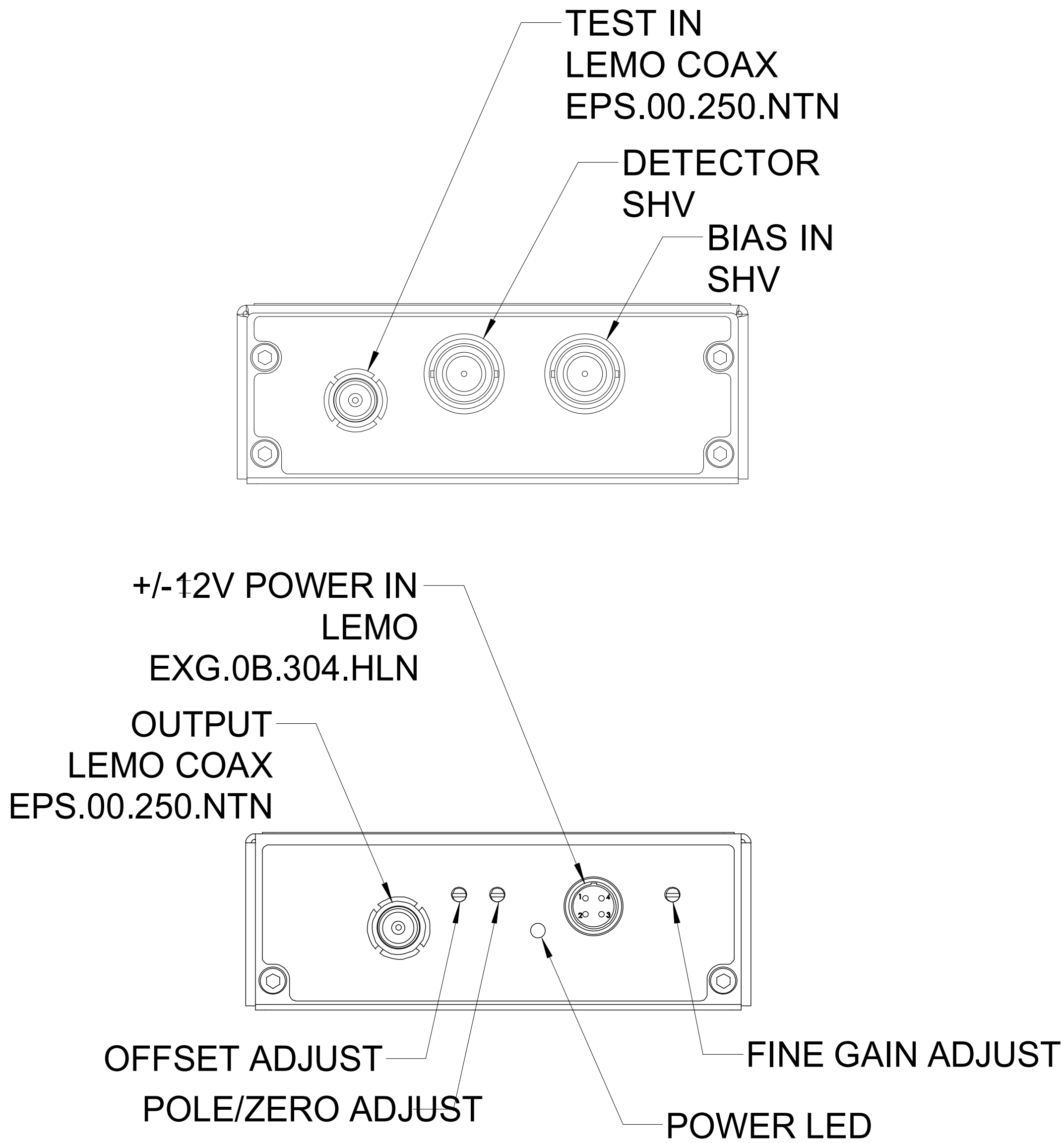


Figure 1. CR10 chassis end panels (SHV connectors). Dimensions mm.

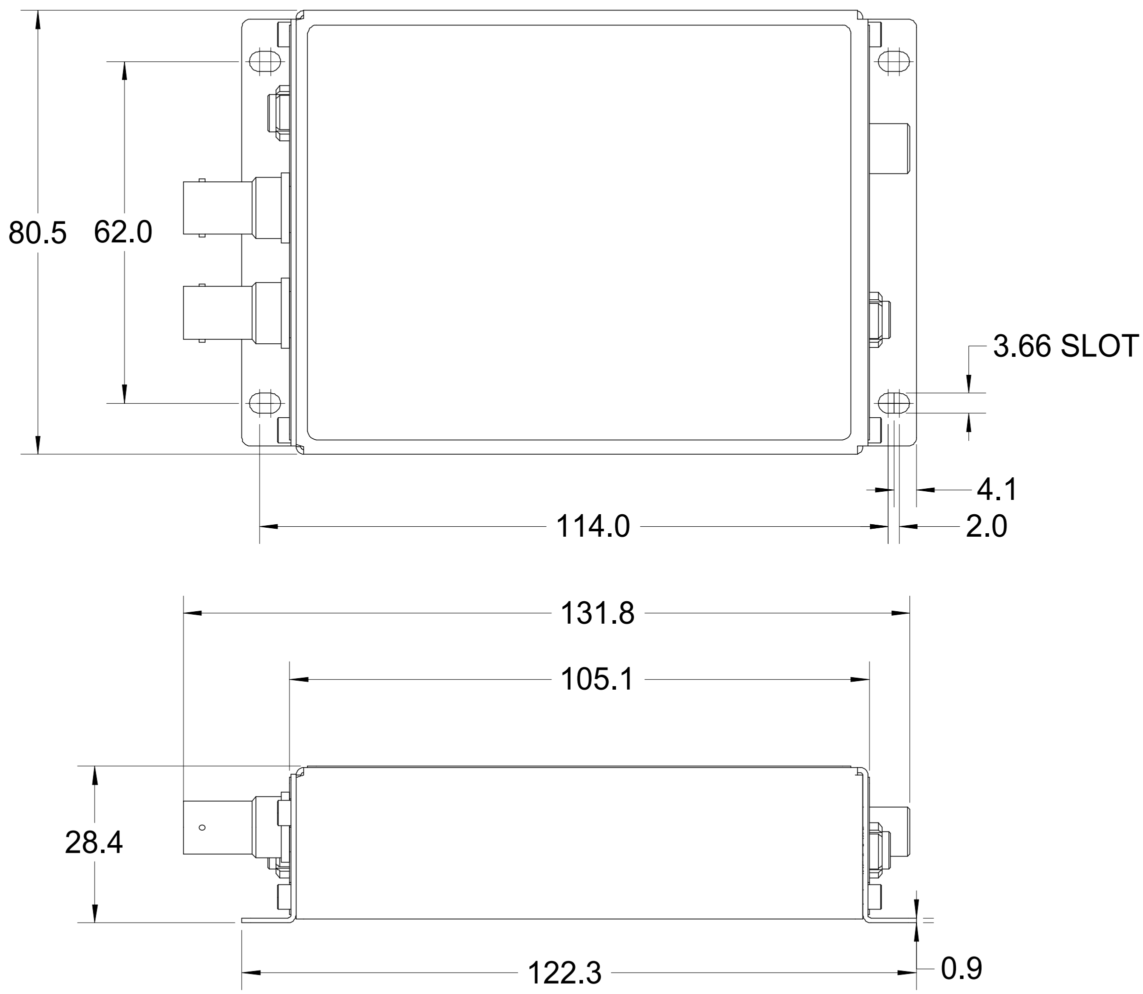


Figure 2. CR10 case plan and side views (SHV connectors). Dimensions mm.

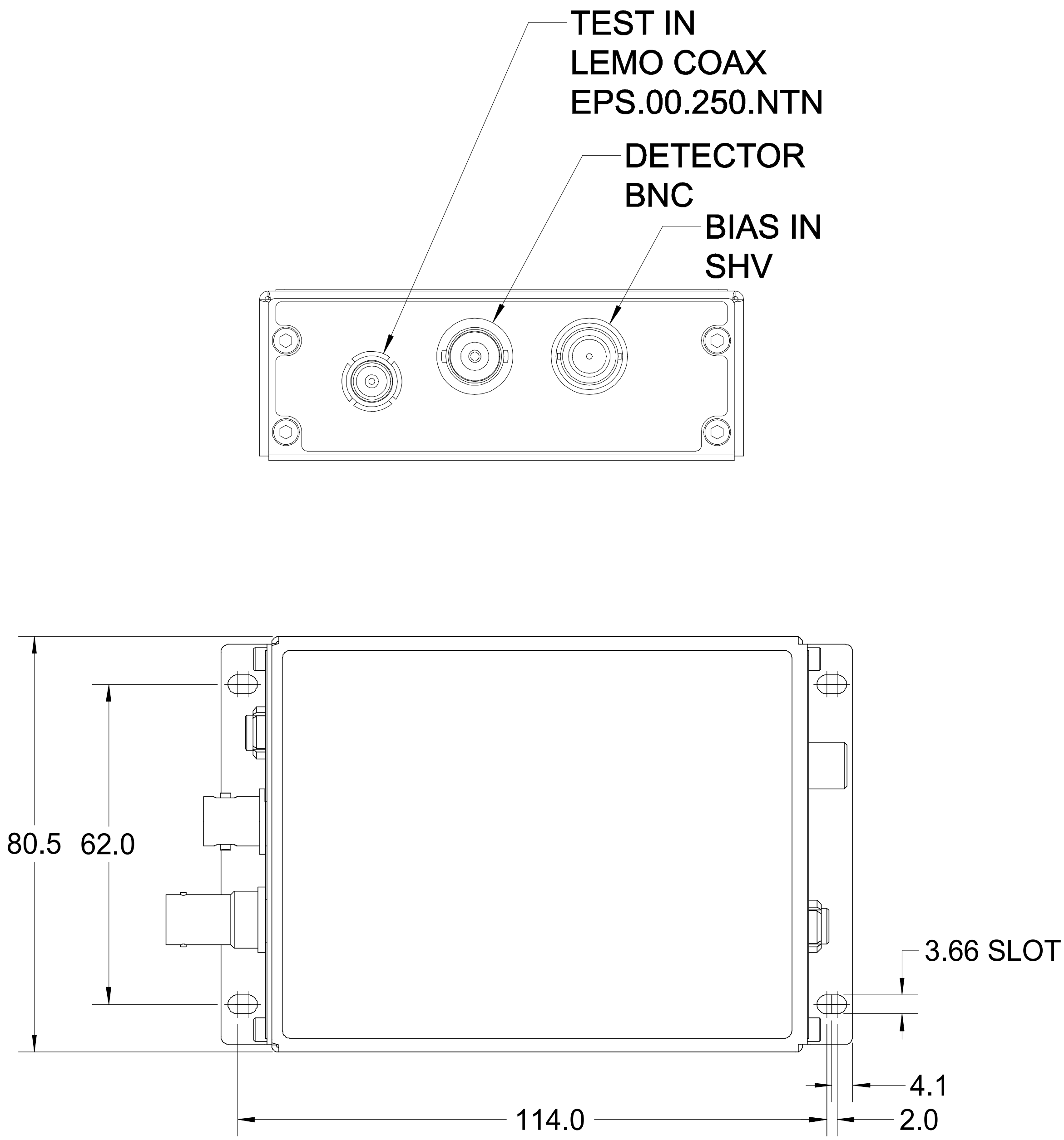


Figure 3. CR10 case (BNC signal connector option) end panel and plan view. Dimensions mm.

9 Installation

9.1 Mounting

The CR10 must be located close to the radiation detector to minimize the effect of cable capacitance on noise levels. This is most important for detectors that create very small charge pulses (a 20,000 electrons or less), where the -G0 conversion gain configuration is used. If the charge pulse is larger, and/or where pulses are being simply counted rather than pulse height analysed, then around three feet (one meter) of coaxial cable can be used to connect the detector. This can be done to remove the CR10 from an area of high radiation for example, or to simplify mounting and cable connections.

The CR10 may be mounted in any orientation, or may be simply placed on a level surface. A fixed mounting to a secure frame is recommended in a permanent installation for best low current performance, as this can be degraded by movement and vibration. Four M3 clear holes are provided in the base flange on a 62 mm by 114 mm rectangular pattern. An adaptor for 35 mm EN 50022 DIN rail is available.

Figure 4. DIN rail mounting.

The mounting position should allow sufficient access to connectors and cable bend radii. Leave 60mm clearance at either end for mating connectors and cable radii.

Best performance will be achieved if the CR10 is in a temperature-controlled environment. No forced-air cooling is required, but free convection should be allowed around the case.

9.2 Grounding and power supply

A secure connection should be made via the mounting flange to local ground potential. If the unit is mounted on an insulating surface, then one of the four mounting screws must be re-assigned as a grounding connection.

+12 VDC and -12 VDC power should be provided from a suitably-rated power supply with the following minimum performance:

Output voltage	+12 (+4/-2) VDC -12 (-2/+4) VDC
Output current	50 mA typical, 100 mA maximum each rail
Ripple and noise	< 100 mV pk-pk, 1 Hz to 1 MHz
Line regulation	Better than 240 mV

9.3 Connection to equipment

9.3.1 Making connections

CAUTION

The CR-10 circuits are sensitive and may be damaged if connections are made while high voltage is present. Observe the following precautions when connecting cables:

- Ensure HV supplies are turned off and any charge has drained away
- Ensure the CR-10 case is grounded
- Connect the power supply cable
- Connect the signal output and test input cable (if used)
- Connect the detector cable
- Connect the bias in cable (if used)

9.3.2 Typical setup

Figure 5 shows a typical installation to read out a proportional counter in schematic form. The central wire of the chamber is where the signal is created, and it must be biased to positive high voltage to produce the electron avalanche. The signal has negative polarity (electrons are collected). The initial charge sensitive pre-amplifier stage is inverting so it outputs a positive going step as a result. It is typical to have a positive polarity output pulse because this suits most multichannel analysers and pulse counting circuits. The -BR baseline restoration option also requires positive pulses. In order to keep the signals positive polarity through the rest of the CR10 circuit, the internal polarity jumper should not be fitted in this scenario.

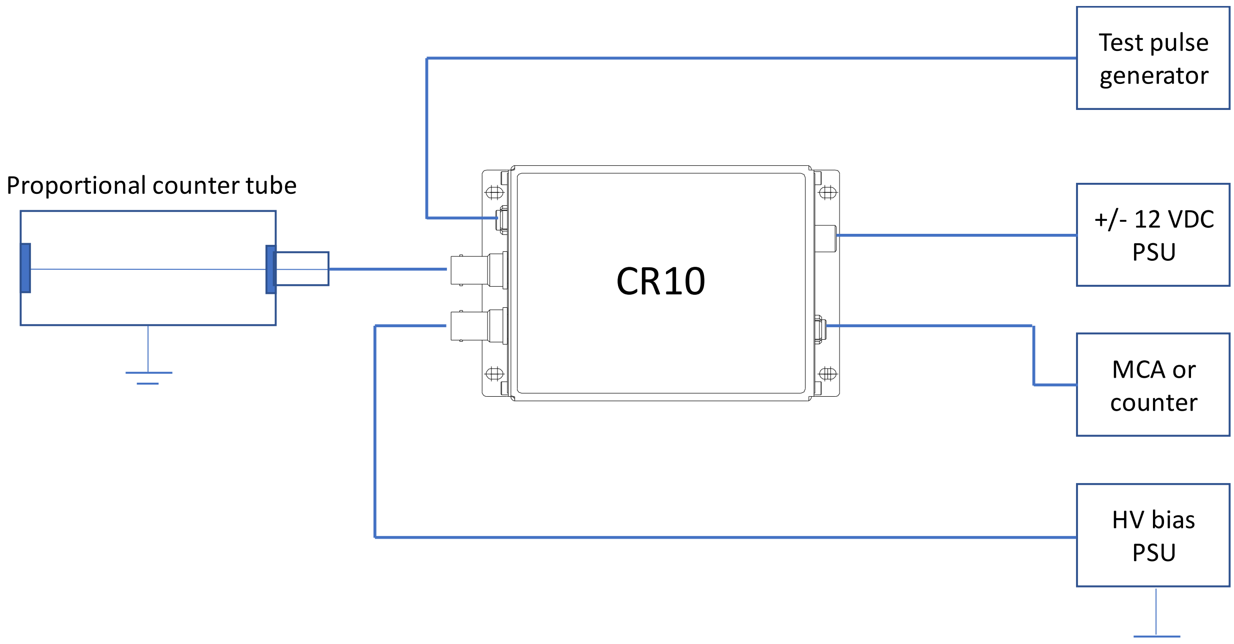


Figure 5. Schematic CR10 installation for readout of a proportional chamber

9.3.3 Cables

Try to locate the CR10 as close to the detector as practicable, as far as space and radiation levels permit. Screened cable between the CR10 and the detector loads the input with capacitance, which affects both the noise level and the risetime of the input stage. Using a lower capacitance coaxial cable such as RG-59 or RG-62 will allow longer cable to be used. Anti-triboelectric cable is recommended to avoid interference from cable movement.

The following figure shows the measured wideband noise as a function of input capacitance for two input conversion gain options (-G0 1400 mV C-1, -G1 130 mV C-1), and two shaping time constants (-T2 250 nsec, -T4 1 µsec). The capacitive load was applied by connecting increasing lengths of RG-58 coaxial cable, with nominal capacitance 0.95 pF cm-1. The measured voltage noise at the output was converted to input charge based on measured pulse height of a known detector charge signal.

The plots show that increased shaping time constant gives lower noise across the load curve, and that the most sensitive input amplifier configuration is the least tolerant of capacitive loading.

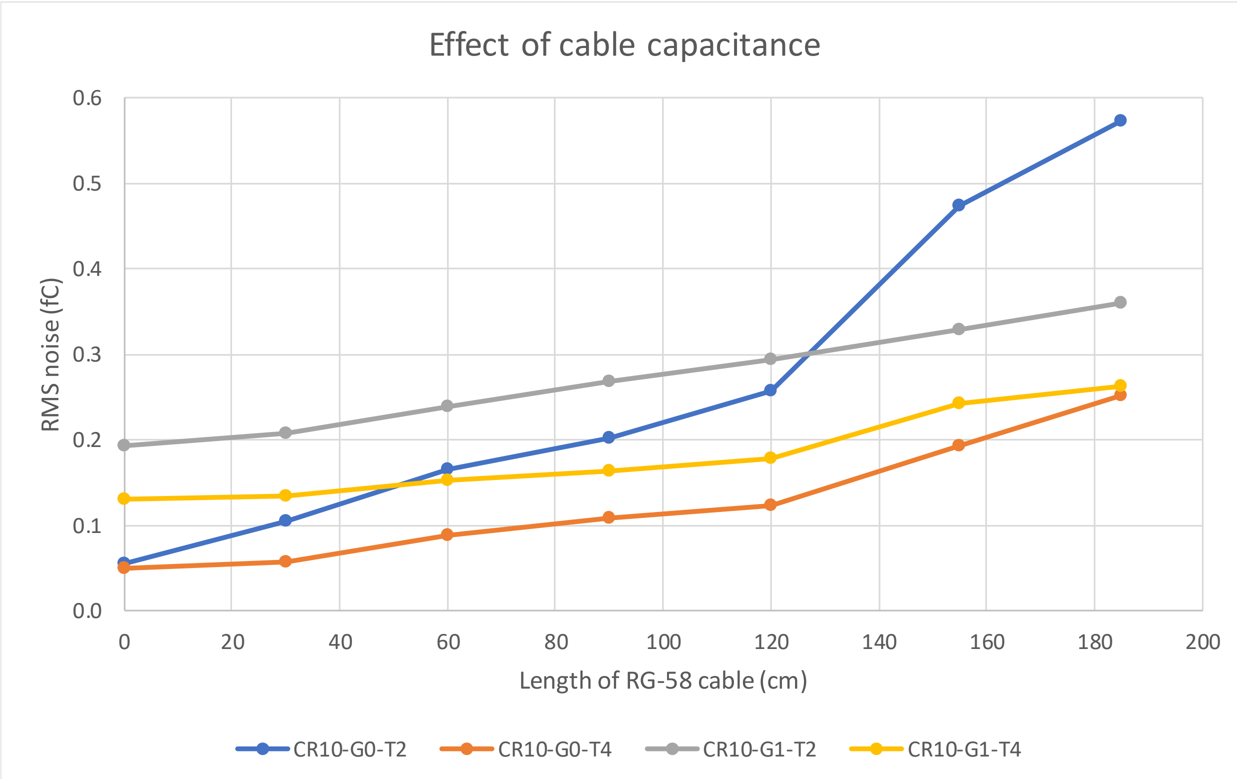


Figure 6. Effect of cable capacitive load on noise

10 Circuit overview

The CR10 is based on proven reference circuit designs from Cremat, Inc. which have been integrated into a single compact device. The simplified schematics below show the functional blocks for the revision 1 circuit and the revision 3 circuit (introduced in 2022). Revision 2 was not put into production. Typical signals present at stages A, B and C are shown in figure 9.

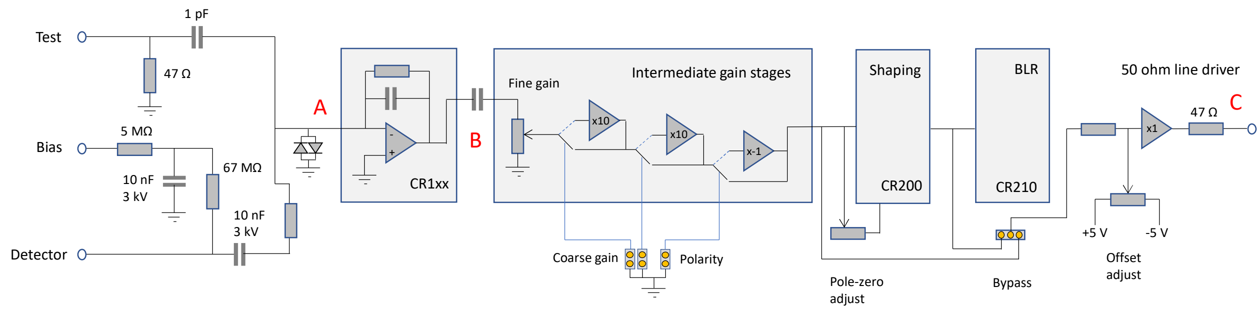


Figure 7. CR10 block schematic (revision 1 circuit)

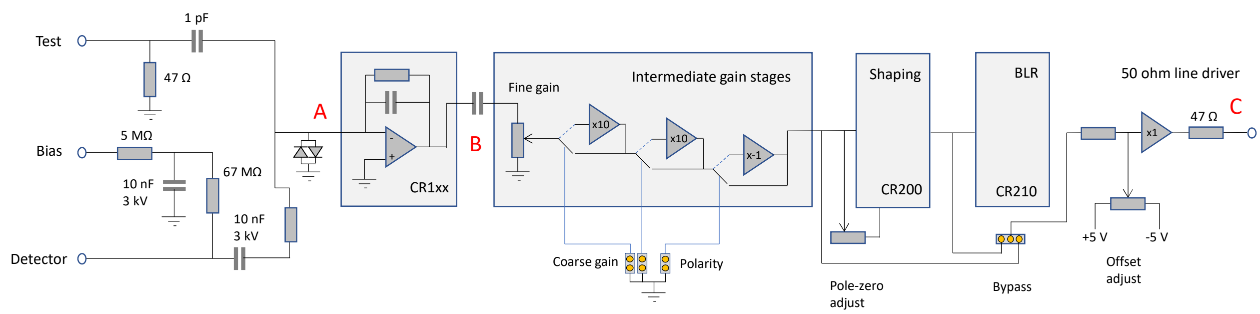


Figure 8. CR10 block schematic (revision 3 circuit)

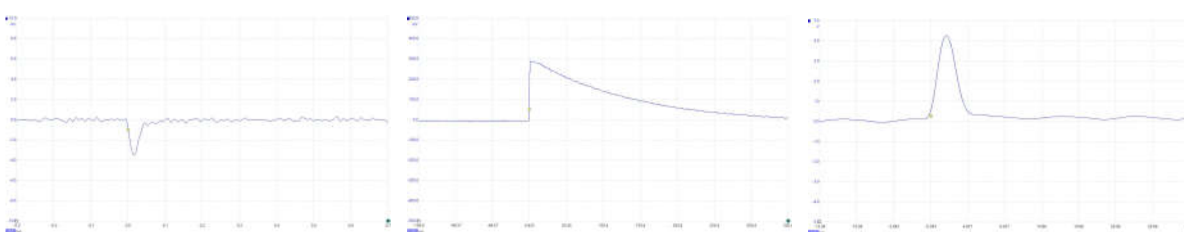


Figure 9. Signals at A (2 mV, 200 nsec / div), B (100 mV, 50 µsec / div), C (1 V, 5 µsec / div)

Incoming bias voltage is filtered and delivered to the signal input node via a high resistance which limits loss of signal input the bias supply. The signal is AC-coupled into the charge-sensitive pre-amplifier module via an HV-rated capacitor. The revision 3 circuit includes a series resistor and back-to-back fast diodes to protect the input. They can be removed upon request for special applications. In the revision 1 circuit the protection devices can be added as a modification.

The test input allows an injected voltage step to create a small charge pulse through the test capacitor.

The charge-sensitive pre-amplifier module is an inverting feedback amplifier with small capacitor and high value resistor in the feedback circuit. The fast incoming charge pulse from the detector creates a voltage step at the output. The voltage is discharged back to zero by the resistor with an exponential decay time constant of around 150 µsec. According to the -G0, G1 or G2 conversion gain configuration, the module will be a Cremat CR-110, CR-111 or CR-112, giving charge to voltage conversion gain of 1.4, 0.13 and 0.013 V pC^{-1} respectively.

The output is AC coupled to the intermediate gain stages which comprise a fine gain voltage divider followed by two switchable coarse gain stages and a switchable inverting stage. These optional stages are enabled by fitting jumpers. The combination of fine and coarse gain gives intermediate gain ranges of around 0 to x1, 0 to x10 and 0 to x100.

The shaping amplifier is a Cremat CR-200 module with one of a choice of time constants between 100 nsec and 4 µsec. Generally, a longer time constant gives better signal to noise ratio at the expense of degraded count rate capability. The full width half maximum of the Gaussian output pulses is 2.35 times the shaping time. The pole-zero adjustment compensates the pole in the response caused by the charge sensitive preamplifier feedback resistor. It is adjusted during manufacturing test to give a clean, symmetric pulse shape.

The optional CR-210 baseline restoration module prevents downward shift of the DC baseline at high count rates. It requires the shaped pulses to have positive polarity. If it is not fitted, a jumper passes the signal to the output stage. The revision 3 circuit has a second jumper position that allows both the CR200 and CR210 stages to be bypassed so that the unfiltered signal (the middle pulse in figure 9) is passed to the output.

Since the charge-sensitive pre-amplifier stage is inverting, a negative incoming charge pulse will give a positive output, and no further inversion is required to give a positive final pulse. If the incoming charge pulse is positive, then the inverting stage of the intermediate amplifier should be enabled by fitting the POL jumper to give positive output pulses.

The final output stage is a unity gain line driver with 47 ohm series output impedance. A trimpot allows residual DC offset in the output to be removed.

Incoming +/-12 V power is filtered and Zener diodes with transistor regulators produce the additional +/- 6.8 V and +/- 6.1 V rails required. A LED confirms that the +12 V supply is present.

11 Setup and Calibration

11.1 Gain setting

The overall gain should be set so that the largest pulses of interest do not saturate the output. Saturation occurs at around 4.5 V when driving a 50 ohm load, or 9 V into a high impedance load. The overall conversion gain is the result of the selection of charge-sensitive preamplifier module (-G#), the coarse gain setting (-IG#) and the fine gain trimpot, plus the effect of the load connected to the output. The nominal overall gain (output pulse height / input integrated pulse charge) in volts per picocoulomb into 50 ohm load is

G * IGC * IGF * 10 * 0.5

and into a high impedance load is

G * IGC * IGF * 10

where
G is the charge sensitive preamplifier module conversion gain as determined by the selection of Cremat CR-11x module -G#

-G0 (CR-110): G = 1.4 V pC^{-1}
-G1 (CR-111): G = 0.13 V pC^{-1}
-G2 (CR-112): G = 0.013 V pC^{-1}
-G2 (CR-113): G = 0.0013 V pC^{-1}

IGC is the nominal intermediate stage coarse gain set by internal jumper JPR2

G#1 = 0, G#2 = 0: IGC = 1
G#1 = 1, G#2 = 0: IGC = 10
G#1 = 1, G#2 = 1: IGC = 100

IGF is the intermediate stage fine gain set by the fine gain trimpot

IGF = 0 to 1

The gain factor 10 is provided by the CR-200 shaping amplifier, for any of the time constant selections. It is the ratio of the shaped pulse peak height to the height of the step that comes out of the charge-sensitive pre-amplifier stage. The gain factor 0.5 results from charge division when driving a 50 ohm load.

A practical measurement of the overall gain can be determined using a precision capacitor driven by a square wave. For example a 1.0 pF capacitor will deliver q_{in} =1.0 pC to the input when driven by a 1.0 V step in voltage from the square wave. The corresponding output pulse amplitude V_{out} then determines the conversion gain as V_{out}/q_{in} volts per pC.

The test input (Section 12) is terminated in 47 ohm and has a nominal 1.0 pF capacitor. The same measurement can be performed, taking care to consider the effect of the input terminator on the driving signal.

11.2 Example of gain stages

The voltage at the stages of the circuit is illustrated in a practical example. A 200 Hz voltage square wave with peak-to-peak voltage from 1.0 to 2.5 V was used to drive a 1.0 +/- 0.05 pF capacitor in series with the input of a CR10-G1-T4. The intermediate gain jumper was set for x1 coarse gain and the fine gain set to maximum. Voltages were measured internally at the output of the input charge sensitive amplifier (CR111), at the input to the CR200 1 µsec shaping amplifier, and at the output of the shaping amplifier. The output was measured with and without 50 ohm termination. The plots show the internal voltages and the output pulse amplitudes.

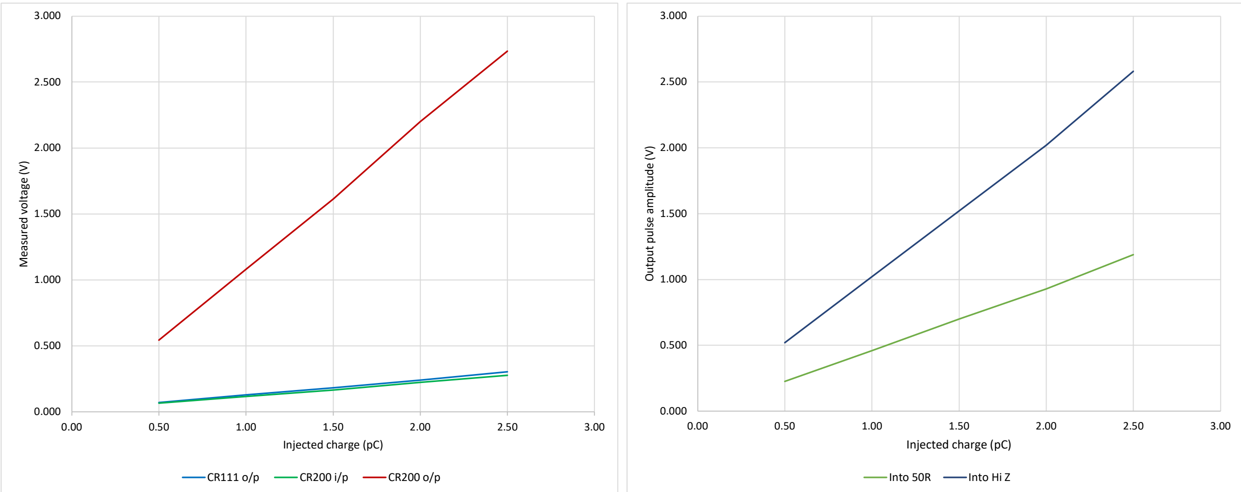


Figure 10. Left: internal voltages as a function of injected charge.
Right: output voltages as a function of injected charge with and without 50 ohm termination

The measurements showed input amplifier conversion gain of 0.13 V pC^{-1}, intermediate stage voltage gain of 0.91 and shaping amplifier voltage gain of 9.7. The overall conversion gain was 0.46 V pC^{-1} with 50 ohm termination and 1.02 V pC^{-1} without termination.

11.3 Pole-zero setting

The pole-zero control is used to compensate the slow decay of the pulse from the charge-sensitive preamplifier so that the output of the shaping amplifier returns to baseline cleanly and quickly, to create a symmetric pulse that is almost Gaussian in shape. In control system terms, a “pole” in the transfer function created by the preamplifier feedback resistor is cancelled by a “zero” created by the trimpot resistance in parallel with a capacitor inside the shaping amplifier. The potentiometer is set during manufacture to suit the combination of preamplifier and shaping amplifier, and generally should not require further adjustment. However, if the amplifier configuration is changed, or if the shape of the charge pulse from the detector changes significantly, it may be necessary to adjust the setting. Simply adjust the control until the output pulse has a good symmetric shape.

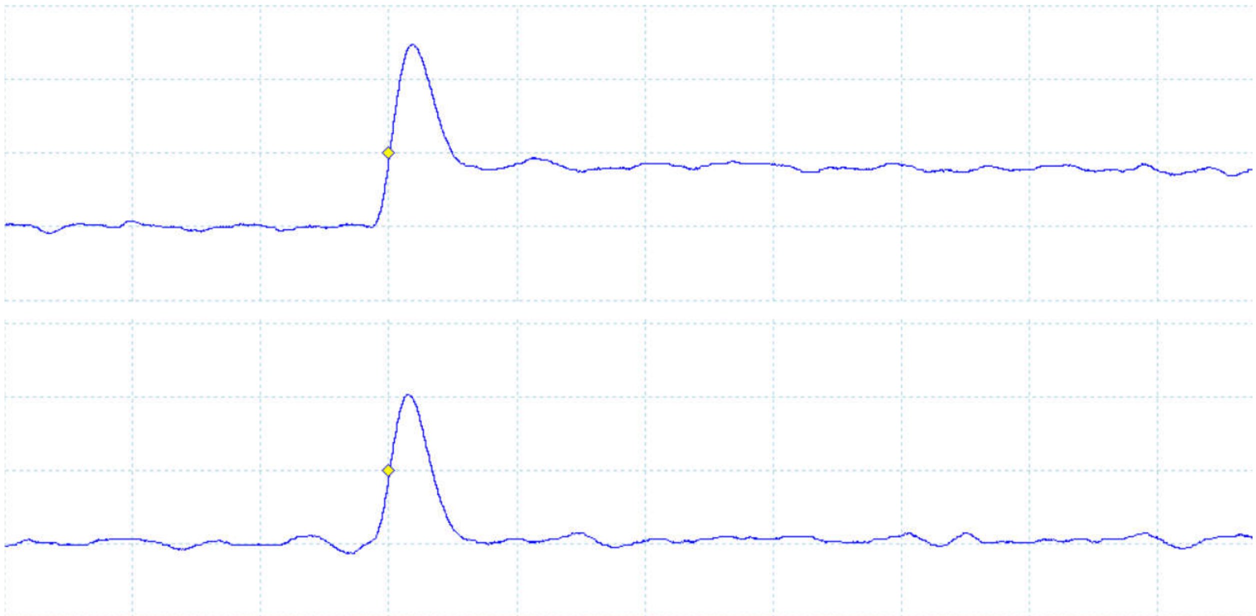


Figure 11. Incorrect pole-zero setting (top), correct pole-zero setting (bottom)

11.4 Offset correction

The offset trimpot should be adjusted as necessary to remove any residual DC offset on the output.

11.5 Charge and energy calibration

The amplitude of the output shaped signal will be linear with the charge in the input pulse. If the amount of charge from the detector is also linear with the energy of the radiation, then the system can be calibrated as an energy analyser. You will need to know at least one point to establish the calibration.

As an example, you can calibrate a system comprising a silicon diode detector and the CR10 using a suitable monochromatic X-ray source. A convenient source is the Am-241 isotope which generates a 59.5 keV gamma ray which will create a measurable peak in a pulse height spectrum. Because the average energy to create an electron-hole pair in silicon is known (3.6 eV) this gamma ray corresponds a known amount of measured charge, namely (59500/3.6) = 16500 electrons, or 2.6 fC.

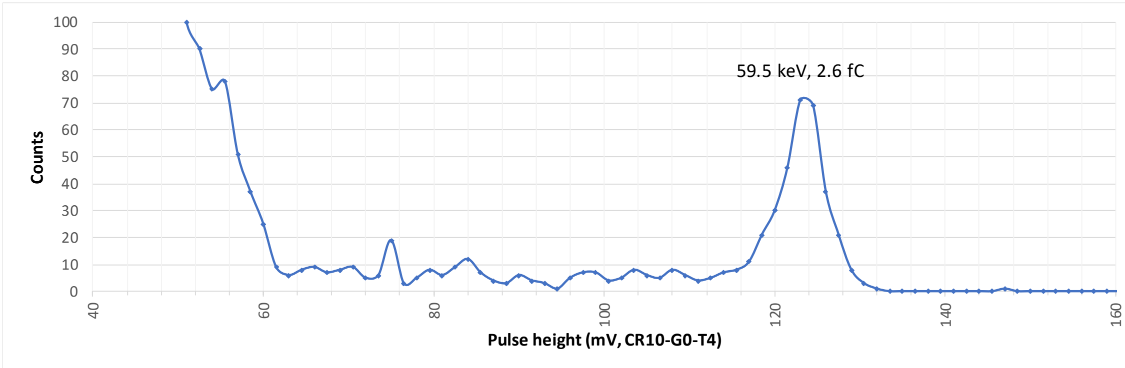


Figure 12. Measured pulse height spectrum for Am-241 gamma line, CR-110 and 1 µsec shaping

Unknown X-ray peaks can then be assigned their energy by simple scaling.

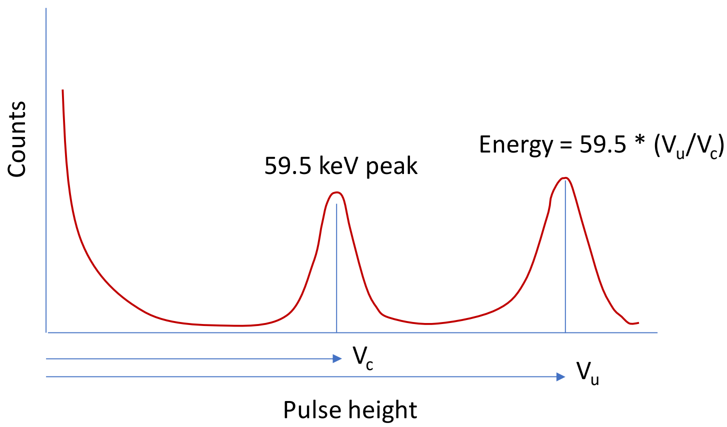


Figure 13. Determination of gamma energy by scaling

12 Using the Test Input

The test input allows the function of the circuit to be tested at any time. Injecting a voltage step to the test input injects a pulse of charge to the input via the 1 pF test capacitor. A one volt step gives 1 pC nominal injected charge. The test signal source can be left connected, except where the lowest possible noise is required.

It is simple to inject a square wave, but this produces both positive and negative polarity output charge pulses, which may be confusing.

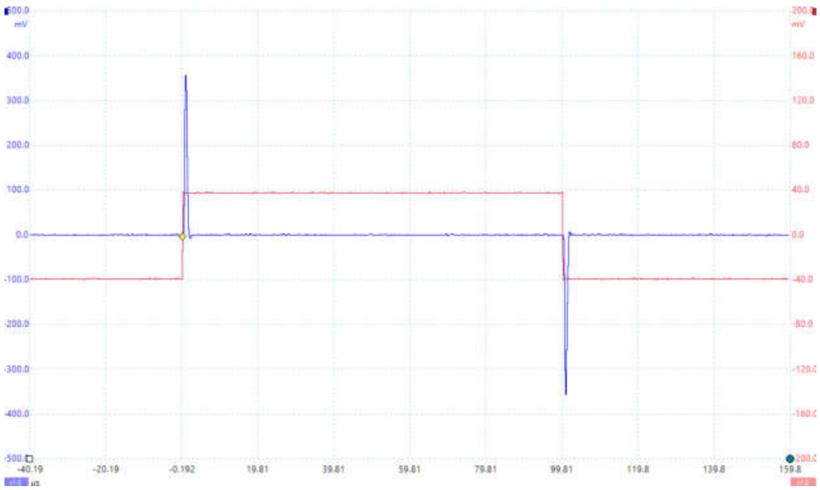


Figure 14. Effect of voltage square wave (red) injected into test input

A unipolar pulse output can be achieved if the test signal has a tail pulse shape (fast step followed by slow exponential decay).

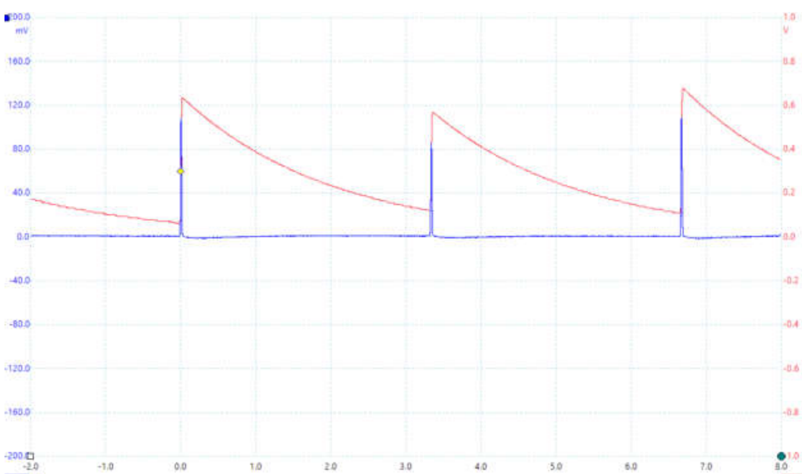


Figure 15. Injecting tail pulses to achieve a unipolar response to the test input

13 Connectors

13.1 Front panel connectors

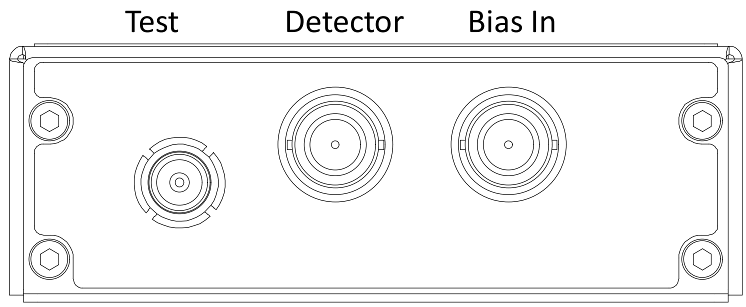


Figure 16. Front panel connectors

13.1.1 Bias in

SHV jack coaxial connector for high voltage input. Optional substitution of BNC connector for systems with low bias voltages (less than 500 V).

13.1.2 Detector

SHV jack coaxial connector for detector signal input. Optional substitution of BNC connector for systems with low bias voltages (less than 500 V).

13.1.3 Test

Lemo 00 coaxial connector for test voltage input. Typical mating free connector Lemo FFA.00.250.

13.2 Rear panel connectors

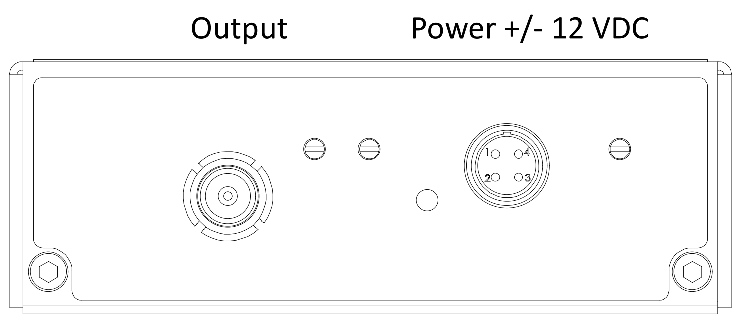


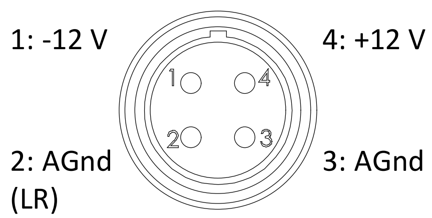
Figure 17. Rear panel connectors

13.2.1 Output

Lemo 00 coaxial connector for signal output. Typical mating free connector Lemo FFA.00.250.

13.2.2 Power

Lemo 0B four pin female, typical mating free connector FGG.0B.304.



Connector body and pin 3 connect directly to CR10 analog ground. Pin 2 connects to analog ground via ferrite bead.

14 Controls and Indicators

14.1 Front panel controls

None.

14.2 Rear panel controls and indicators

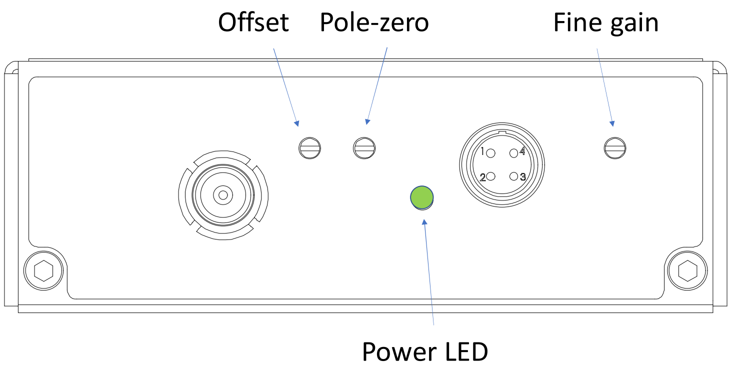


Figure 18. Rear panel controls and indicators

14.2.1 Offset

21-turn potentiometer for output offset voltage setting.

14.2.2 Pole-zero

21-turn potentiometer for pole-zero adjustment.

14.2.3 Fine gain

21-turn potentiometer for fine gain adjustment.

14.3 Front panel indicators

None.

14.4 Rear panel indicators

Green LED indicates that incoming +12 VDC power is present.

14.5 Internal settings

We do not recommend that you open the CR10 case unless specifically instructed to do so by your supplier or Pyramid Technical Consultants, Inc. It is possible to damage the circuits or degrade noise performance if correct handling precautions are not employed.

14.5.1 Handling precautions

CAUTION

The internal circuitry and pre-amplifier circuit in particular are very sensitive and can be easily damaged by electrostatic discharge or if the circuit is disconnected or handled when there is charge on the high voltage capacitors. Observe the following precautions:

Before opening the case:

- Turn off the high voltage bias source and wait for the indicated voltage to fall to zero, or for five minutes

- Disconnect the detector cable

- Disconnect the high voltage bias cable

- Disconnect the test input and signal output cables

- Disconnect the power cable

- Move the CR-10 to an ESD-safe work environment before opening the case

14.5.2 Accessing internal components

The following information is provided for reference. To open the case, remove four M2.5 hex head screws from the front panel, and the clamping nut from the output on the rear panel. Loosen but do not remove the two M2.5 screws on the rear panel to allow the base plate to drop down. The front panel and circuit can then be removed from the case.

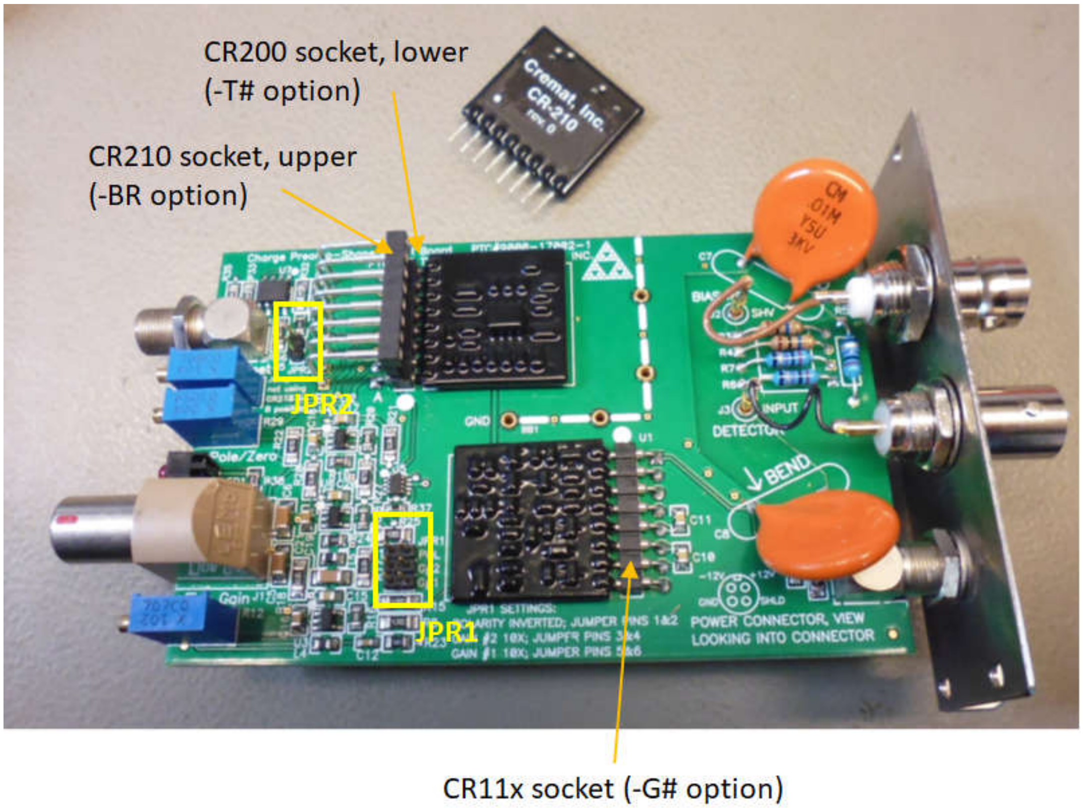


Figure 19. Location of internal jumpers (revision 1 board).

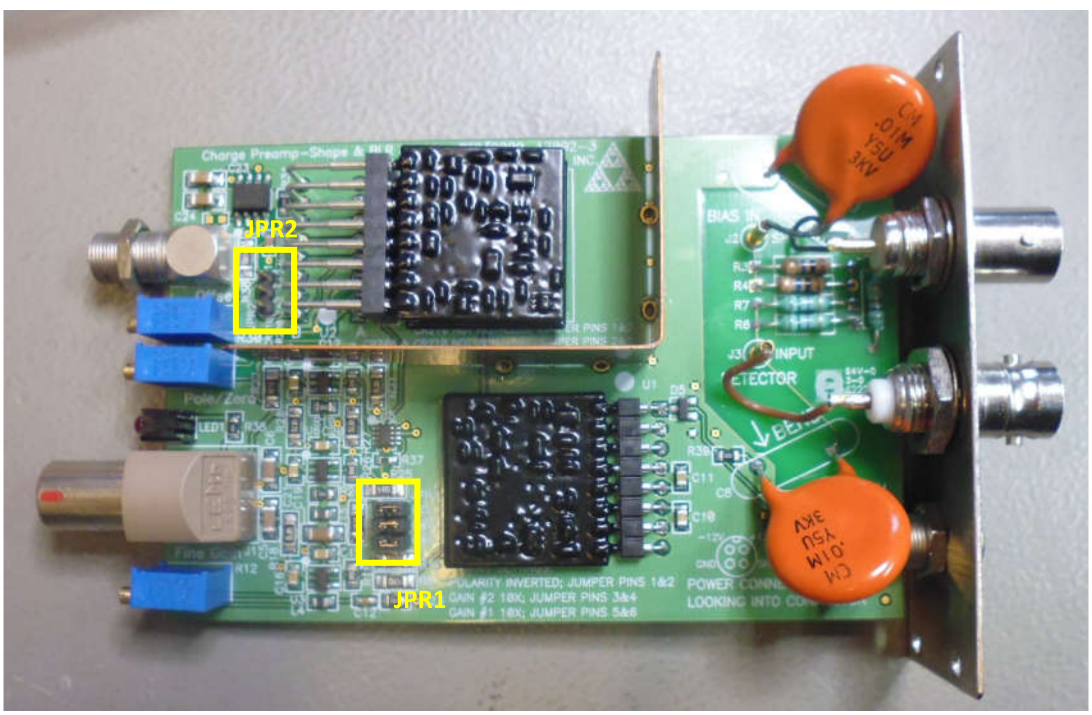


Figure 20. Location of internal jumpers (revision 3 board).

14.5.3 Cremat modules

The modules are fitted to the marked locations, label downwards, to establish the required conversion gain and shaping time configuration. The CR-210 baseline restorer is optional in the upper (U2b) position. If it is not fitted, then JPR2 must be installed to connect the shaping amplifier to the output driver stage.

14.5.4 Jumpers

JPR1

POL: fit 2 mm jumper to switch in inverting intermediate amplifier stage. Use as appropriate to obtain positive polarity shaped output pulsed.
Do not fit if the charge signals coming into the CR10 are negative polarity.
Fit if the incoming charge signals are positive polarity.

G#1: fit 2 mm jumper to switch in first x10 gain intermediate amplifier stage.

G#2: fit 2 mm jumper to switch in second x10 gain intermediate amplifier stage.

If neither G#1 or G#2 are fitted the intermediate coarse gain is 1.

JPR2 (revision 1 board)

Fit 2 mm jumper if no CR-210 baseline restorer is installed.

Fit no jumper if CR200 and CR210 are both installed.

JPR2 (revision 3 board)

Fit 2 mm jumper to position 1-2 if no CR210 baseline restorer is installed.

Fit 2 mm jumper to position 2-3 if no CR200 or CR-210 baseline restorer is installed.

Fit no jumper if CR200 and CR210 are both installed.

15 Screening fence option

At maximum overall gain, using the -G0 (CR110) input amplifier, x100 intermediate gain setting and high fine gain setting, there can be feedback from the output of the circuit to the input, producing unwanted ringing on the output. This can be eliminated with the screening fence. This is installed by default for the -G0 gain option and can be installed if desired for other gain choices. When fitted, additional care is required to remove and install the shaping amplifier and baseline restorer.

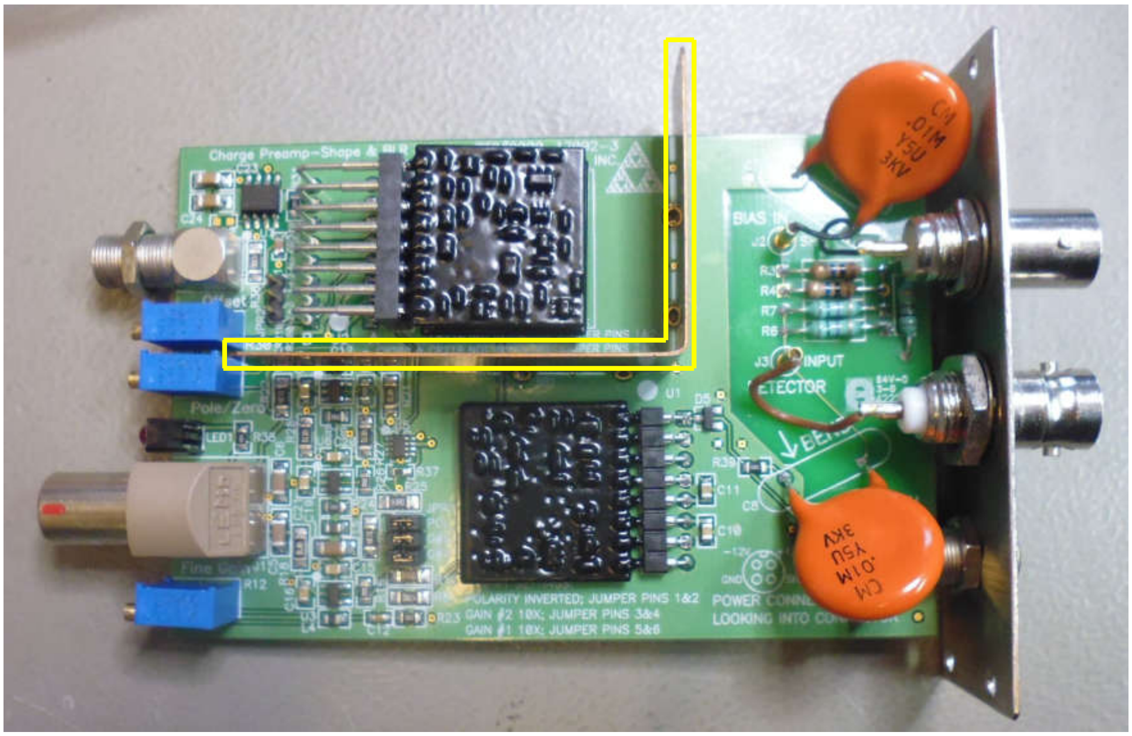


Figure 21. Location of screening fence.

16 Fault-finding

Symptom	Possible Cause	Confirmation	Solution
No output pulses seen	No signal from detector.	Connect known good signal source.	Correct any detector or radiation source issue
	Very low pulse rate	Set up oscilloscope to capture individual events.	Increase signal level if possible.
	Insufficient gain	Look for pulses with increased gain or more sensitive device connected to CR10 output.	Use appropriate charge-sensitive preamplifier module and intermediate gain settings. Reduce threshold of pulse counting discriminator circuits if possible.
	Wrong output pulse polarity – scalers and MCAs generally require positive polarity shaped pulses.	Check output pulse polarity with oscilloscope	Change detector bias configuration or CR10 internal polarity jumper setting.
	No power to CR10.	Check power LED, check voltages	Correct power supply.
	Missing HV bias voltage	Check voltage.	Supply correct bias voltage for the radiation detector.
	Charge-sensitive amplifier module damaged.	Use test input to inject a signal.	Arrange for repair.
	Baseline restorer module is not fitted but JPR1 not installed.	Check jumper.	Fit jumper.

Output pulses distorted or asymmetric	Output saturating.	Reduce gain or reduce input signal size.	Use appropriate gain setting.
	Reflections in long output cable.	Check cable termination.	Use 50 ohm termination at receiving device if cable is long.
	Incorrect pole-zero setting	Adjust pole-zero setting.	Adjust pole-zero setting.
	Feedback in CR10	Check input amplifier module and gain setting.	Install internal screening fence if using the CR110 and high intermediate gain setting.
	Bypass jumpers JPR2 are not fitted to match the installed shaping amp and baseline restorer.	Visual check.	Fit the correct jumpers.
Pulse heights differ by a factor of two from expected values.	Incorrect terminating resistance on readout device for CR10 pulse output.	Check impedance at readout device.	Use correct impedance. 50 ohms is recommended for long transmission lines.
Output has DC offset	Offset trim is incorrect.	Adjust trimpot to remove offset.	Adjust trimpot to remove offset.
	High count rate.	Reduce count rate.	Use -BR option.
	Polarity incorrect for baseline restoration.	Check output pulse polarity – must be positive.	Change detector bias configuration or CR10 internal polarity jumper setting.
Unexpected pulses	Voltage steps are being injected at the test input.	Disconnect test input cable or disable test pulse source.	Turn off test pulses when not in use.
	Cosmic rays or other background seen by detector.	Turn off detector bias to see that pulses stop. Move away from radiation	Move detector or add shielding if possible. If cosmic ray rate is

		background.	significant for the measurement, add a coincidence detector system to reject cosmic ray events.

17 Maintenance

The CR10 does not require routine maintenance or calibration. There is risk of contamination which may degrade performance if the case is opened. If you need to access the unit to change amplifier modules or jumper settings, check first with your supplier or direct with Pyramid for guidance.

18 Returns procedure

Damaged or faulty units cannot be returned unless a Returns Material Authorization (RMA) number has been issued by Pyramid Technical Consultants, Inc. If you need to return a unit, contact Pyramid Technical Consultants at support@ptcusa.com, stating

- model
- serial number
- nature of fault

An RMA will be issued, including details of which service center to return the unit to.

19 Support

Documentation updates are available for download from the Pyramid Technical Consultants website at **www.ptcusa.com**. Technical support is available by email from support@ptcusa.com.   Please provide the model number and serial number of your unit, plus relevant details of your application.

20 Disposal

We hope that the CR10 gives you long and reliable service. The CR10 is manufactured to be compliance with the European Union RoHS Directive 2002/95/EC, and as such should not present any health hazard. Nevertheless, when your device has reached the end of its working life, you must dispose of it in accordance with local regulations in force. If you are disposing of the product in the European Union, this includes compliance with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC. Please contact Pyramid Technical Consultants, Inc. for instructions when you wish to dispose of the device.

21 Declaration of Conformity

Declaration of Conformity

Issued by: Pyramid Technical Consultants, Inc.
1050 Waltham Street, Lexington MA 02421, USA

The undersigned hereby declares, on behalf of Pyramid Technical Consultants, Inc. that the referenced product conforms to the provisions as listed. Refer to the document: *Extension of testing and analysis to the PTC product line, December 10, 2007,* and its continuations, and the *1400 Technical Construction File* for detailed testing information.

Product:	CR10 combined charge-sensitive preamplifier and shaping amplifier
Year of initial manufacture:	2017
Applicable Directives:	73/23/EEC Low Voltage Directive: Laws for electrical equipment within certain voltage limits 89/336/EEC – EMC Directive: Laws relating to electromagnetic compatibility
Applicable Standards:	IEC 610101:2002 (2nd Edition) UL 61010-1:2004 EN 61326: 1997+A1:1998+A2:2001 EN 55011:1998, A2:2002 EN 61000-6-2:2001 – Electromagnetic Compatibility Generic Standard, Immunity for Industrial Applications
Issuing Agencies:	Safety: TUV Rheinland North America. 12 Commerce Rd, Newtown, CT 06470 USA EMC: TUV Rheinland North America. 12 Commerce Rd, Newtown, CT 06470 USA
Applicable Markings:	TUV, FCC, CE
Authorized by:	[signature] President, Pyramid Technical Consultants, Inc.
Date:	8 January 2018

The Technical Construction File required by theses Directives are maintained at the offices of Pyramid Technical Consultants, Inc, 1050 Waltham Street, Lexington MA 02421, USA
A copy of this file is available within the EU at the offices of Pyramid Technical Consultants Europe, Ltd, Suite 3 Unit 6-7 Henfield Business Park, Henfield BN5 9SL, United Kingdom.

22 Revision History

The release date of a Pyramid Technical Consultants, Inc. user manual can be determined from the document file name, where it is encoded yymmdd. For example, M10_UM_080105 would be a M10 manual released on 5 January 2008.

Version	***Changes***
CR10_UM_180112	First general release
CR10_UM_180115	Clarified use of polarity jumper. Clarified that shaping amplifier has x10 gain.
CR10_UM_180312	Added cautions about connecting cables and accessing internal parts
CR10_UM_230202	Additions as needed for revision three circuit board. Add more detail on circuit gain. Add section on screening fence for high gain operation.