OPERATING MANUAL

XR-100CR

X-RAY DETECTOR & PREAMPLIFIER

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1 CAUTION

1. ⚠ **CAUTION: READ MANUAL BEFORE USING the XR100CR.**
2. ⧈ **DOUBLE INSULATED. FOR INDOOR USE ONLY.**
3. **DO NOT DROP OR CAUSE MECHANICAL SHOCK TO THE XR-100CR DETECTOR.**
4. **DO NOT DAMAGE** the AXRCR detector element.
5. **DO NOT REMOVE** the red protective cap from the AXRCR detector until data is to be taken. The detector window is made from thin beryllium (0.001 in / 25 μm thick) which is extremely brittle and can shatter very easily. Do not have any object come in contact with the window. Also, do not touch the window because the oil from the fingers will cause it to oxidize. The window cannot be repaired. If the window shatters the detector assembly must be replaced. Keep the red protective cover nearby at all times and cover the AXRCR detector when the instrument is not in use.

   BERYLLIUM WINDOWS DAMAGED BY IMPROPER HANDLING WILL NOT BE COVERED BY THE WARRANTY.

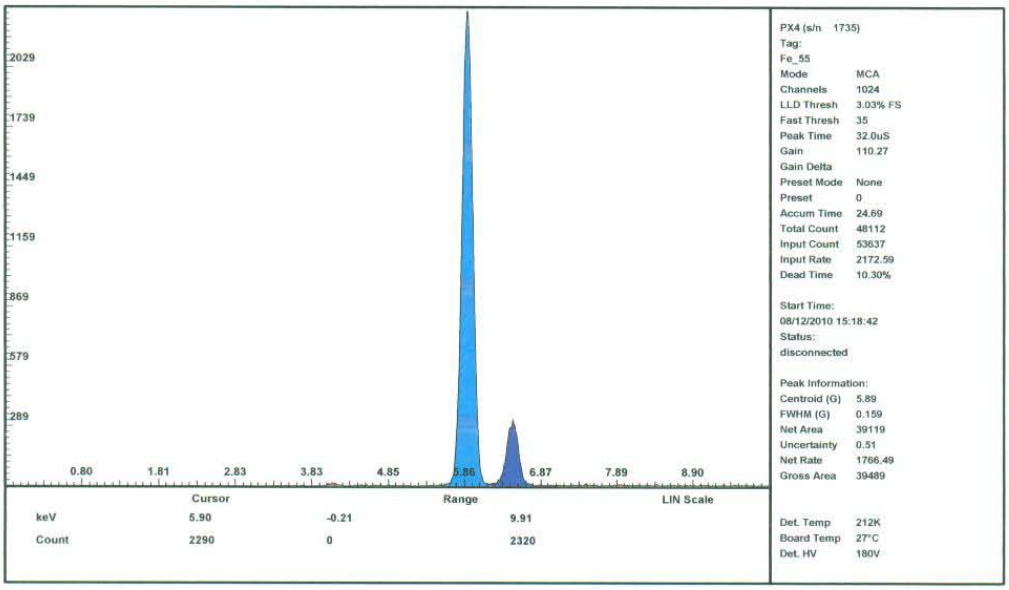
6. **AVOID** holding the XR-100CR in the hand. Heat from the body will increase the operating temperature of the detector and increase the leaking current. Increased leaking current in the detector will result in poor energy resolution. Keep the XR-100CR away from incandescent lamps to avoid overheating.
7. **BEST PERFORMANCE** of the XR-100CR can be achieved by mounting it by one or two of its mounting holes to a metal plate. This will increase the surface area and allow the detector to run 4 to 6 degrees colder. A colder detector will result in better energy resolution. As a rule, if the correct heat sinking has been provided, the XR-100CR should NOT be warm to the touch.
8. **RADIATION DAMAGE** to the detector will occur if it is exposed to a high flux environment. Synchrotron Radiation Beams should be modified with attenuators before they are allowed to strike the detector or the fluorescence target. Damage to the detector will be permanent if the flux from an X-Ray Tube, a strong nuclear radiation source, or an accelerator is not attenuated.

A RADIATION DAMAGED DETECTOR WILL NOT BE COVERED UNDER WARRANTY.

9. **PLACE THE XR100CR AWAY FROM** any computer terminal or CRT monitor. Keep the XR100CR detector away from magnetic fields.
10. **DISCONNECT DEVICE:** to disconnect power to the XR-100CR, unplug the PX4 AC/DC power supply adapter. If using the XR-100CR without the PX4 ensure that a disconnect device is readily available.

Z:\SPECTRA FOLDER\XR100cr-6mm2-500uM Spectra\XRA013215_6mm2_500uM_32.0uS_Fe_55_Elecsys, LLC.mcaFe_55 08/12/2010 15:18:42

Elecsys, LLC



PX4 (s/n	1735)
Tag:	
Fe_55	
Mode	MCA
Channels	1024
LLD Thresh	3.03% FS
Fast Thresh	35
Peak Time	32.0uS
Gain	110.27
Gain Delta	
Preset Mode	None
Preset	0
Accum Time	24.69
Total Count	48112
Input Count	53637
Input Rate	2172.59
Dead Time	10.30%

Start Time:
08/12/2010 15:18:42
Status:
disconnected

Peak Information:

Centroid (G)	5.89
FWHM (G)	0.159
Net Area	39119
Uncertainty	0.51
Net Rate	1766.49
Gross Area	39489

Det. Temp	212K
Board Temp	27°C
Det. HV	180V

XR-100CR S/N: A013215 AXRCR S/N: 84751 PX4 S/N: 1735
Be Window Thickness - 1 mil, Temperature Sensor - Diode, Collimator - Internal Multilayer,
Cooler Stage - 2 stage, Detector Thickness - 500uM, Detector Area - 6mm2, Detector Type - Silicon, Vacuum Grease added,
Feedback Type - CRF, Assembly Type - standard 1.5 in EXT
T = 212K, FWHM@5.89keV: 159eV, Reset Time: > 20 Seconds, Amplitude: 10 Volts(0-10 Volts),
Tested with 32.0uS Peak Time, HV Bias: 180.2 Volts, Sil-Pad Added Underneath Detector,
Cooler Current: 350mA, Amptek Code # XY-FSG32MD-G3SP, Preamp SN: 10260
Fe_55 Configuration

COM Port: USB
Rise: 32.0uS
Top: 1.6uS
Fast Threshold: 35
PUR Enable: PUROff
RTD ON/OFF: RTDOff
RTD Threshold: 3.13% FS
RTD Fast HWHM: 10
AutoBaseline: Off
BLR: BLR:ON DN:16 UP:4
Acquisition Mode: MCA
MCS Timebase: 10mS/channel
MCA Channels: 1024
Slow Threshold: 3.03% FS
Buffer Select: Buffer A
Gate Input (TTL): GateOff
Preset: None
Coarse Gain: 110.29x
Fine Gain: 0.9998
Input Polarity: Negative
Input Offset: 0.020V
Pole Zero: OFF
Det Rst Lockout: 1.64mS
TEC: 190.0K
HV: 180.2V
Preamp Power: 8.5V
Analog Out: Decimated Input
Offset: 0mV
Aux: ICR
Audio: Off

3 XR-100CR TYPICAL CONNECTION DIAGRAM

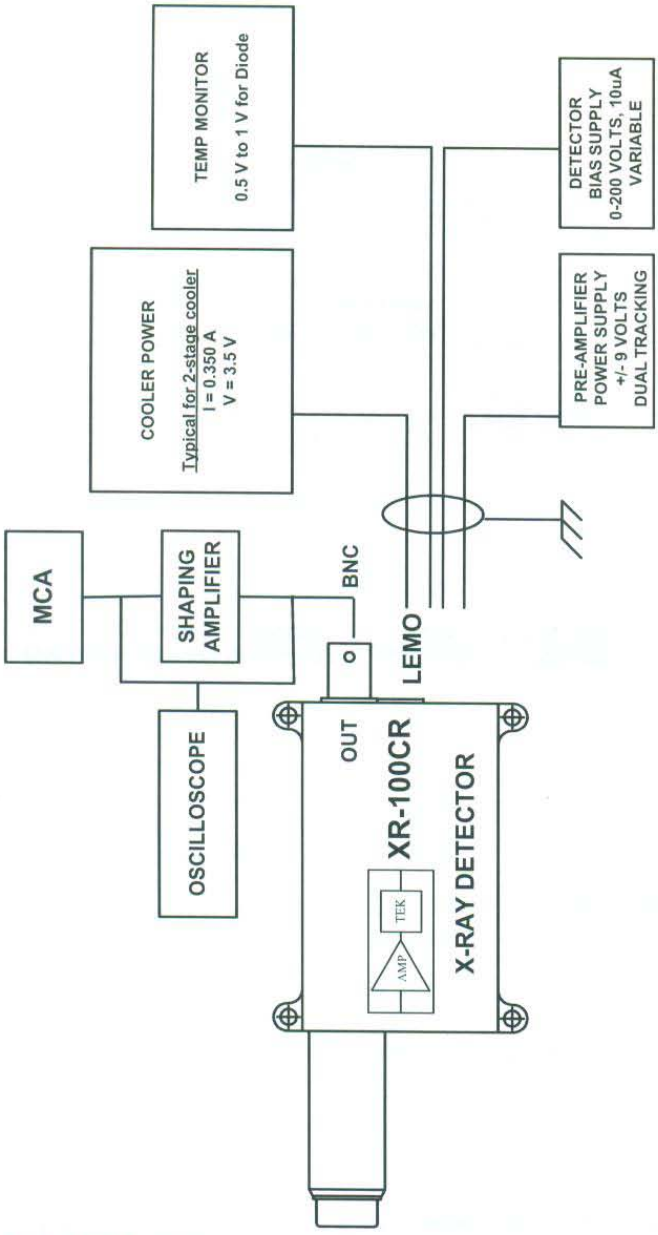


Figure 2. XR100CR typical connection diagram.

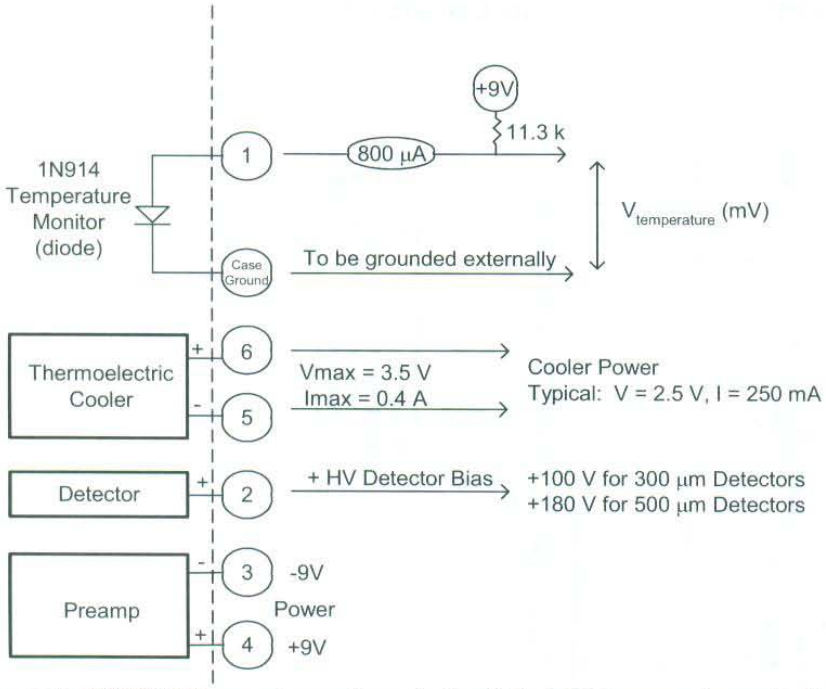


Figure 3. XR100CR Power Connections via the 6-Pin LEMO connector on the XR100CR box (2-stage cooler, diode temperature sensor). This diagram applies to users who are not using the PX4, the PC4-3, or the PX2.

4 OPERATING NOTES FOR THE XR-100CR

⚠ **CAUTION: SUPPLY VOLTAGES MUST BE PROPERLY CURRENT LIMITED** when using the XR-100CR without a PX2, PX4, or PC4-3 power supply. Current should be limited to values listed in section 4.1.

4.1 Equipment Required

1. Power Supplies
   a. A dual tracking +/-9 VDC @ 35 mA with voltage meter & current limit.
   b. A zero to +3 VDC @ 0.7 A adjustable with voltage and current meter.
   c. A zero to +200 VDC adjustable @ 10 µA (see detector HV requirements).
2. Multimeter with high input impedance (>1000 MΩ).
3. Shaping Amplifier (such as NIM standard Shaping Amplifier) with an input impedance of 1 kΩ. A "triangular" type of pulse with 25 µs peaking time (12 µs shaping time) and base line restoration will be needed to realize the resolution of the XR-100CR. Example: Amptek PX4, DP4, or PX2; Canberra Model 2025 or 2026.
4. Oscilloscope
5. Low energy radioactive x-ray source.
6. AC power outlet strip (preferably with surge suppression & EMI/RFI filtering).

4.2 Absolute Maximum Ratings

Cooler power.....+0.7 AMPS
Preamp power.....+/- 9 VOLTS
Detector Bias (HV)....+100 to +200 VOLTS (varies with detector type)

4.3 6-Pin Lemo Connector on the XR-100CR (Lemo Part# ERA.1S.306.CLL)

Pin 1: Temperature Monitor
Pin 2: + H.V. Detector Bias, +100 to 200 Volts
Pin 3: -9 Volt Preamp Power
Pin 4: +9 Volt Preamp Power
Pin 5: Cooler Power Return
Pin 6: Cooler Power (0 to +3.5 Volt @ 0.350 A max.)
CASE: Ground and Shield

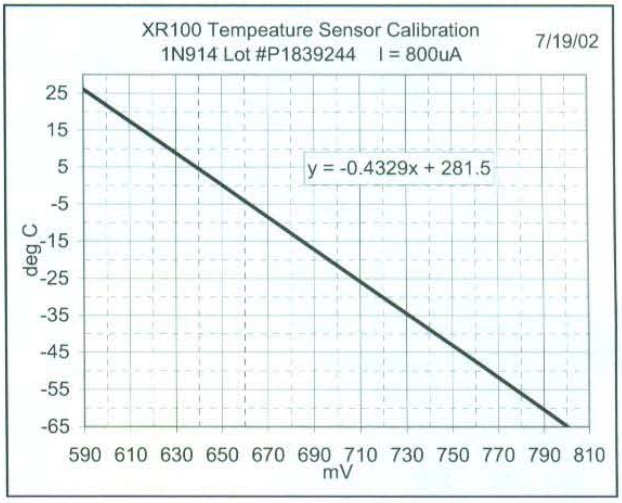
4.4 9-Pin Cable D-Connector to External Power (standard 9-Pin D)

Pin 1: +9 Volt Preamp Power
Pin 2: -9 Volt Preamp Power
Pin 3: Cooler Power (0 to +3.5 Volt @ 0.350 A max.)
Pin 4: + 9 Volt Temperature Monitor Power
Pin 5: + H.V. Detector Bias, +100 to +200 Volt (varies with detector type)
Pin 6: Ground and Case
Pin 7: Cooler Power Return
Pin 8: Ground and Case
Pin 9: Ground and Case

4.5 Connections and Turn-On Procedure (see figures 2 and 3)

1. Turn all power supplies OFF. Plug all equipment to be used into one common AC power outlet strip. This will help prevent ground loops, which is crucial in getting good performance from the XR-100CR.

2. Set voltages on all power supplies to ZERO. Set current limits on all power supplies to ZERO.
3. Connect the LEMO CONNECTOR cable to the XR-100CR. Apply power to the XR-100CR through the D-CONNECTOR end of the cable according to Figures 2 and 3 and the Pin assignments given above in this manual.
4. Turn ON the +/-9 VDC power supplies to power the charge sensitive preamplifier. Verify that both the + and - Volt outputs are between 8 and 9 Volts. NEVER EXCEED 9 VOLTS. Increase the current limit on the power supplies as required so that it can just obtain this output voltage but will not allow any excessive current to flow.
5. Make sure the High Voltage Supply is off and set to 0 V. Turn on the HV supply and slowly increase the voltage to between +35 and +45 volts.
6. Attach the OUTPUT of the XR-100CR to the INPUT of the shaping amplifier. A BNC connector is provided on the rear panel of the XR- 100CR. The output pulses of the XR-100CR are NEGATIVE. A NIM standard shaping amplifier compatible with a reset type preamplifier and an input impedance of 1 kΩ can be used. A shaping time constant of 12 μs or longer and "triangular" shaping with Base Line Restoration is optimum for this detector.
7. Attach the OUTPUT of the shaping amplifier to an oscilloscope. Observe that the output of the shaping amplifier is random noise. Make sure there is no repetitive signal such as the power line frequency or any type of RF signal. Any repetitive signal observed can be traced to ground loops or RFI generated from equipment such as computer monitors. If any repetitive signals are present, other than the "Reset Waveforms" described in this manual, the performance of the XR-100CR will degrade significantly.
8. Remove the red protective cover from the detector of the XR-100CR. Place the x-ray source in front of the detector.
9. Power the temperature sensor as shown in Figure 3 and monitor $V_{temperature}$ (mV) with a meter.
10. While observing the meter, slightly increase the cooler supply current until the temperature reading starts to change on the meter. Observe that the voltage is increasing, indicating that the temperature is decreasing. See plot to the right.



11. THE COOLER IS FRAGILE AND WILL BE PERMANENTLY DAMAGED IF EXCESSIVE CURRENT OR IF REVERSE POLARITY IS APPLIED. THE WARRANTY WILL BE VOID IF THE COOLER IS DAMAGED DUE TO EXCESSIVE CURRENT OR REVERSE POLARITY.
12. The temperature sensor has an offset associated with it. It is quite linear but it could have an offset of about 5 °C.
13. Once the temperature gets below -30 °C the performance of the XR-100CR system will not change with a temperature variation of a few degrees.
14. Increase the + H V supply to + 100 Volts (or appropriate voltage as indicated in section 5 of this manual). Now the XR-100CR is fully operational.

15. ALWAYS INCREASE THE + H V POWER SLOWLY TO PROTECT THE INPUT FET. WHEN TURNING OFF THE XR-100CR, DECREASE THE + H V SLOWLY TO ZERO VOLTS BEFORE TURNING OFF THE XR-100CR. IF THE FET IS DAMAGED DUE TO HIGH VOLTAGE TRANSIENTS, THE WARRANTY WILL BE VOID.
16. Once the temperature has stabilized (about one minute), start taking data on the MCA. For normal operation, there is no need to monitor the temperature.

5 LOWERING THE HIGH VOLTAGE BIAS IN THE DETECTOR

If the detector starts to breakdown or becomes noisy, it is probably the result of increased leakage current which may occur after exposure to accumulated radiation. The exact reason and the total radiation that will cause this increase of leakage current in the detector is very complex since it depends on the energy spectrum and intensity of radiation the detector was exposed to. Lowering the high voltage bias from the factory value can reduce the detector leakage. The actual set point will vary between the different detector types. Refer to the table for nominal voltage settings and begin by lowering the voltage by 10 V. Contact the factory for further instructions.

Detector Type	Typical + H.V.
7mm2/300µm	100
13mm2/300µm	100
5mm2/500µm	100
5mm2/680µm	150
6mm2/500µm	180
13mm2/500µm	180
20mm2/680µm	150
25mm2/500µm	180

6 COOLER TEMPERATURE CONTROL

The XR100CR includes a closed loop temperature control that regulates the cooler temperature. By default it is enabled and set for maximum cooling and therefore does not regulate on its own.

The PX4 cooler supply has its own temperature control and set point, so when used with the PX4 it is best to leave the XR100CR set to maximum cooling and set the control point with the PX4. It is possible to set the PX4 for maximum cooling and then set the set point with the XR100CR, but this is not recommended. Whichever set point is set the warmest will control the detector temperature.

When the XR100CR is shipped with the PX2CR, this control is set for maximum cooling and because the PX2 has no closed loop control, does not regulate the temperature. This is fine for laboratory conditions where room temperature (20-25 °C) does not change by more than a few degrees. If room temperature varies or if the XR100CR is being used in OEM applications, the control should be set to regulate the temperature. To set the temperature control with the PX2 follow these steps:

1. Open the XR100CR box and locate R39.
2. Probe the TMP SET test point right below R39 with a volt meter. The meter will read mV. Use the plot in section 4.5 to convert mV to temperature. This is the temperature that the control is regulating to.
3. Use the plot in section 4.5 to convert the desired temperature to mV.
4. Probe the TMP SET point while adjusting R39 until the voltmeter reads the desired number.
5. Probe the TMP MON test point and verify that the number is the same as that at TMP SET. If TMP MON reads a higher temperature than TMP SET, then the cooler is not able to regulate or cool to that set point. Set the set point to a warmer temperature and measure again.

NOTE: A 2-stage cooler will typically cool to between 210 and 230 K when set for maximum cooling.

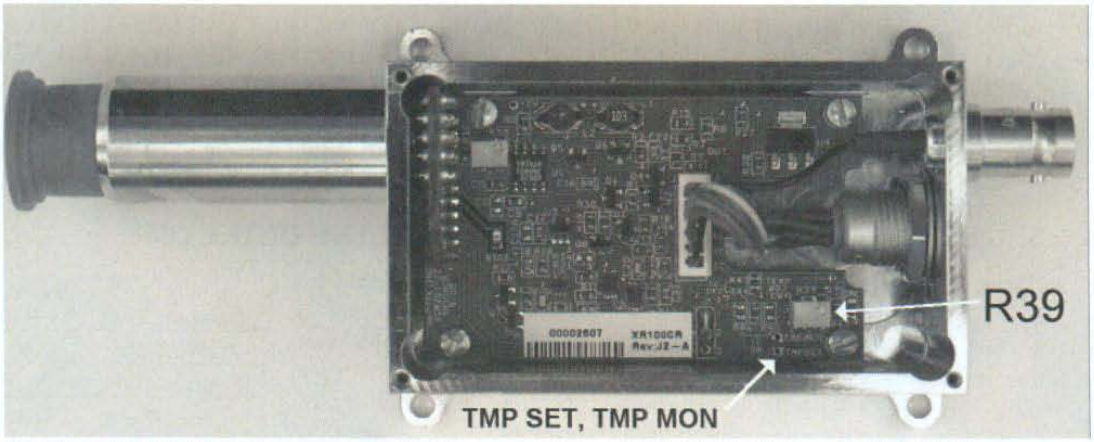


Figure 5. XR100CR with top cover off. Shows location of R39, TMP SET, and TMP MON.

7 XR100CR RESET WAVEFORMS

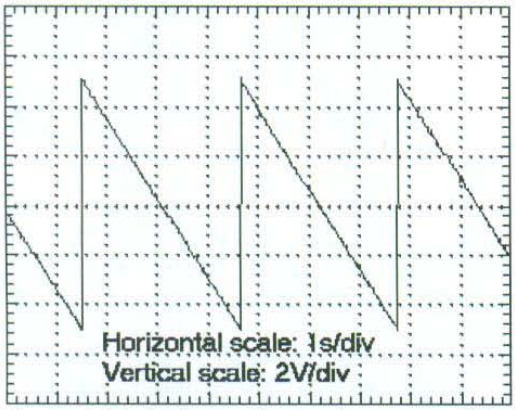


Figure 6. Typical waveform at the output of the XR-100CR

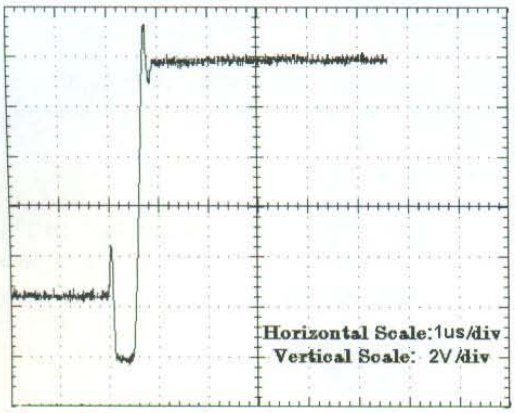


Figure 7. Reset pulse at the output of the XR-100CR

8 XR-100CR TROUBLESHOOTING

The XR-100CR has undergone extensive testing and burn-in before leaving the factory. If the performance of the system is not similar to the one recorded at the factory before shipping (see enclosed plot), please perform the following tests:

IMPORTANT:
AT ALL TIMES, CONNECTIONS FROM THE XR-100CR SHOULD BE MADE DIRECTLY AND **NOT** WITH A 50 Ω TERMINATION.

PLACE THE XR-100CR AWAY FROM ANY COMPUTER TERMINAL OR CRT MONITOR. KEEP THE XR100CR DETECTOR AWAY FROM MAGNETIC FIELDS.

1. Remove all X-Ray sources.
2. Connect the XR-100CR output to a high impedance input of an oscilloscope. Verify that the output waveform is resetting as shown in Figure 6 of Section 7.
3. Connect the XR-100CR output to a shaping amplifier. Connect the shaping amplifier output to a high impedance input of an oscilloscope. Look for periodic noise pick-up on the scope by changing the time-base dial on the scope back and forth. If you find any periodic signal on the scope (other than at the time of reset), try to eliminate its source or place the XR-100CR away from the pick-up area. Any periodic signal detected on the scope will degrade the resolution of the XR-100CR.
4. Check grounding, heat-sinking, and all connections.
5. Measure the detector temperature and verify that the detector is being cooled appropriately. See Section 6.
6. Inspect the beryllium (Be) window. If there are any cracks in the Be window then the seal has been broken and the detector will need to be returned for repair. Broken Be windows are not covered under warranty.

CONTACT THE FACTORY FOR FURTHER ASSISTANCE AND RETURN PROCEDURES

9 TECHNICAL QUESTIONS AND CONTACT INFORMATION

For all technical questions, please contact the factory.

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10 WARRANTY

AMPTEK, INC. warrants to the original purchaser this instrument to be free from defects in materials and workmanship for a period of one year from shipment. AMPTEK, INC. will, without charge, repair or replace (at its option) a defective instrument upon return to the factory. This warranty does not apply in the event of misuse or abuse of the instrument or unauthorized alterations or repair. AMPTEK, INC. shall not be liable for any consequential damages, including without limitation,

damages resulting from the loss of use due to failure of this instrument. All products returned under the warranty must be shipped prepaid to the factory with documentation describing the problem and the circumstances under which it was observed. The factory MUST be notified prior to return shipment. The instrument will be evaluated, repaired or replaced, and promptly returned if the warranty claims are substantiated. A nominal fee will be charged for unsubstantiated claims. Please include the model and serial number in all correspondence with the factory.

11 INTERNAL CONNECTIONS BETWEEN AXRCR AND XR-100CR

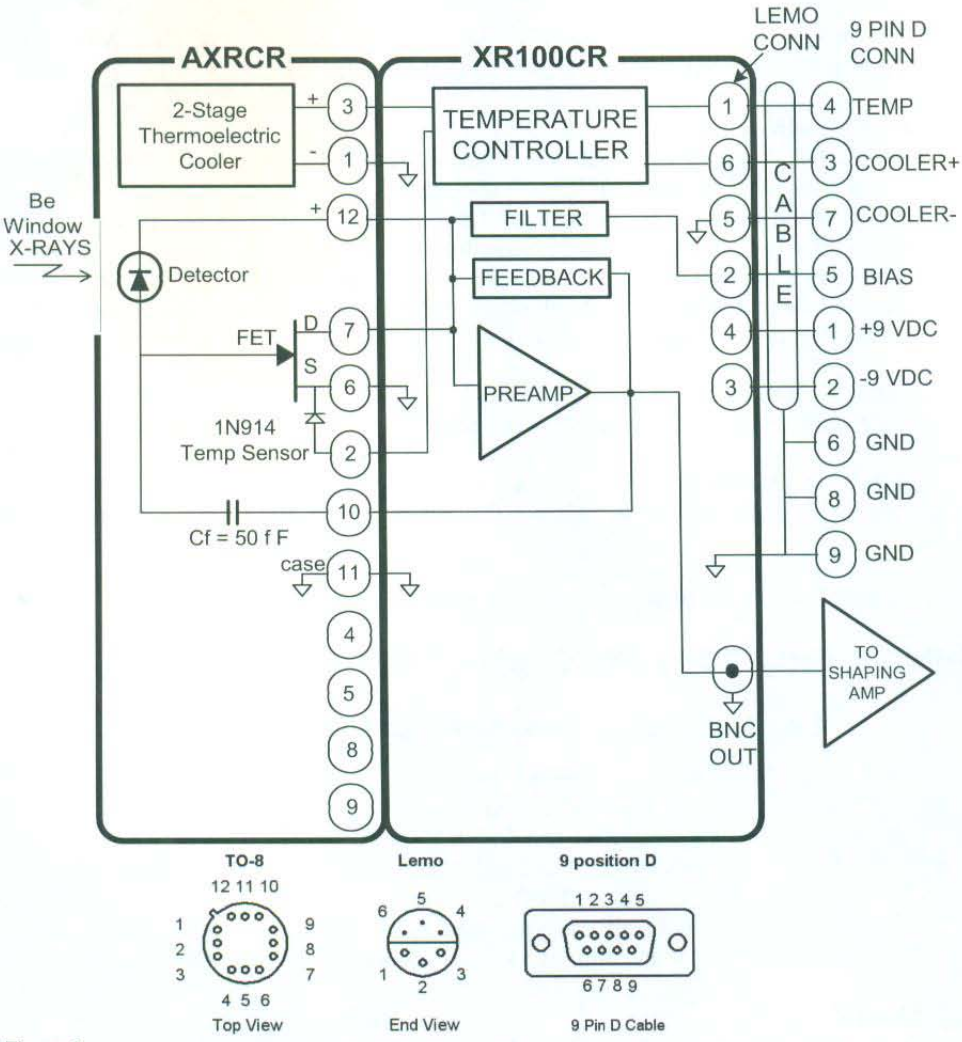
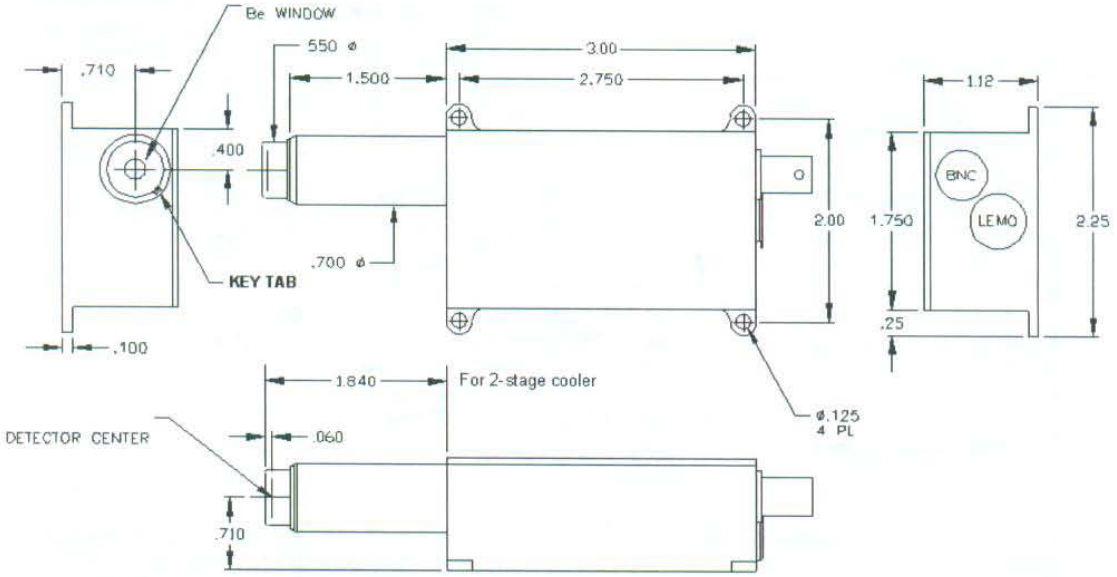


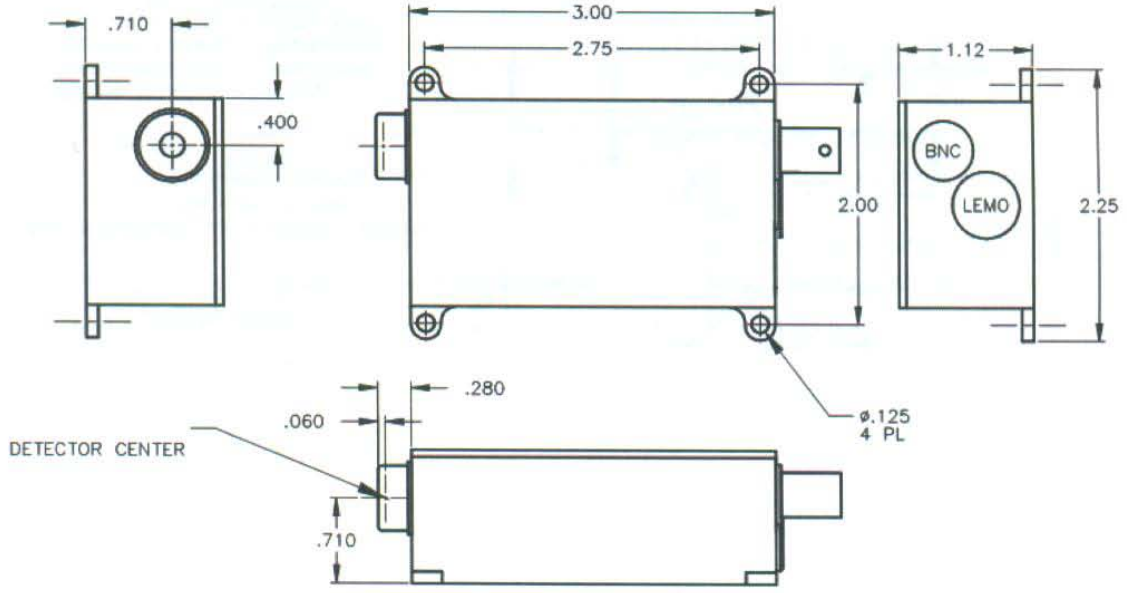
Figure 8.

12 MECHANICAL DIMENSIONS

12.1 XR-100CR-EX1.5



12.2 XR-100CR NO EXT



12.3 AXR Detector Element