

## TROUBLESHOOTING SUGGESTIONS FOR DETECTOR/DIGITAL PROCESSOR

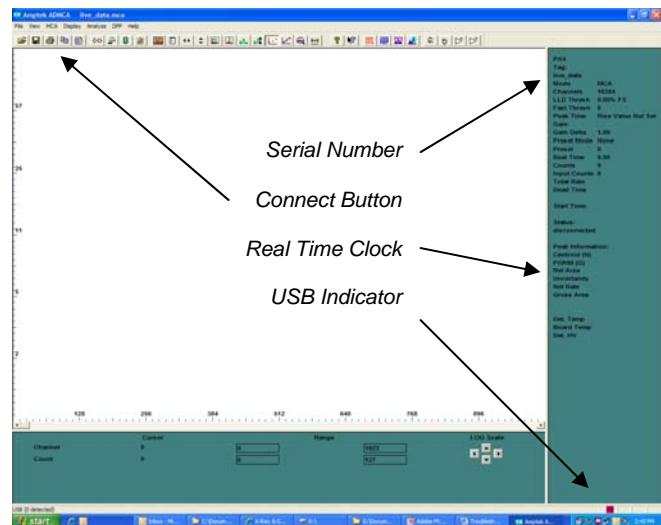
The purpose of this guide is to help solve the most common problems which are seen with Amptek's family of products based on the digital processors (DPP). This includes all variants of the X-123, the XR100 with PX4, the DP4, the DP5, and the PX5. The problems usually fall into one of the five categories below. The sections below describe how to approach the problems within these categories.

1. The system cannot run at all. The hardware does not turn on, the software does not run, or the software does not communicate with the hardware.
2. The software successfully communicates, but there are no counts appearing on the screen.
3. The software communicates, and there are some counts, but the spectrum is grossly distorted and the count rates are far from what I expect.

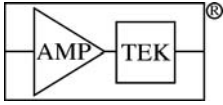
### 1 The system cannot run at all.

Most often, this occurs because (1) an improper connection, (2) power was not applied, (3) the software was not commanded to connect, or (4) software was not properly installed. These problems are usually easily solved.

The plot to the right shows a screen in which the software did not connect to the DPP. Note that (1) in the lower right-hand corner of ADMCA, the USB symbol is red, and (2) ADMCA does not show a serial number in the status pane.



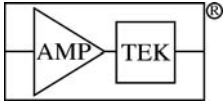
- Click the "Connect Button" in ADMCA again.
- Verify all connectors.
  - Are both power and communications connectors installed in correct ports?
  - Are all connectors seated properly?
  - Was power properly applied? If you have a PX4 or PX5, check that the green light on the front is on. Check the power connector and the switch on any surge protector.
  - Click the "Connect Button" in ADMCA again.
- Was the software properly installed?
  - The software cannot be run from the installation CD. It must be installed on your local hard drive.
  - On occasion, the USB drivers supplied with the DPP get corrupted. If you can communicate but then it drops communication after a few seconds, uninstall the USB drivers, then reinstall them.
  - Note: The ADMCA software will run on 64-bit versions of Windows but the USB driver that controls the digital processors is NOT 64-bit compatible.
- If all the connections look good, power is applied, and the software seems okay, then shut the computer down and turn off the system (PX4, X123, etc). Pause a minute, reboot, apply power to the system, re-launch ADMCA, and try again to connect. If you still cannot communicate, then contact Amptek.



## 2 There are no counts appearing on the screen.

When this happens, you get the green USB symbol and a serial number, you press the “start” button to start acquisition, the “Real Time” starts to increment, but there is no spectrum and no counts. Although this seems distressing, it usually happens because either (1) something was not connected properly or (2) the configuration parameters are set incorrectly.

- Verify all connectors. If the computer communicates with the digital processor (DPP), then there must be both power and communication to the DPP. However, with an XR100 the signal or power connection to the preamp may be absent.
  - Are all necessary connectors installed? Refer to the manual for your product.
  - Are all connectors seated properly? If you have an XR100, verify especially the six-pin LEMO which provides power. These pins may be bent if the connector is inserted incorrectly.
- Verify that the radiation source is present.
- Verify that the software is communicating with the processor (ADMCA indicates a connection).
- Verify that you started acquisition. Stop the acquisition, clear data and time, and start again.
- Check the configuration. If the software looks good (it is communicating, acquisition has been started, and you know a source is present) but still no counts are seen, then the configuration is likely to be set wrong. There are many parameters which can be set such that no data are recorded, although no damage will occur to the detector. The dead time may read 0 or 100%. The “Input Count” number may be zero or may be very large with no counts visible.
  - Load Amptek’s standard default configurations for the detector in use. Click “Acquisition Setup”, “Read Amptek detector configuration”, and select the appropriate file. If you do not know which to select, refer to the datasheet and spectrum supplied with your system. Under the spectrum is a label indicating the detector type which corresponds to the listed configurations. The resulting configuration may not be optimal but should enable the system to work.
  - Check the input polarity. It should be negative for Si-PIN and CdTe, positive for SDD.
  - Reset the thresholds (incorrect thresholds are the source of many troubles). First, reset the input offset, by opening “acquisition setup”, “Gain and Pole Zero”, and clicking “Tune Input Offset”. On the “Shaping” tab, verify that the BLR is “on”. Then remove the source, and click the “Tune fast/slow thresholds” button on the tool bar.
  - If you have a PX4, DP5, or PX5, then check the “detector temp”, “board temp”, and “Det HV” at the bottom of the status pane. These parameters will vary from one unit to the next, but the detector temperature should be in the range of 210 to 235K. The HV should be around 150-200V for most Si-PIN, 250V for SDD, and 500V for CdTe. If these are not correct, check their settings in the “acquisition setup”, “power” tab. Note: these values are read while the software is reading data, so acquisition must be started to see these change.
  - If you have a DP5, PX5, or X-123SDD, then check the polarity of the HV supply. Click the “acquisition setup” button, and in the white box to the right, check the “requested HV polarity”. If you have an SDD, this should be “negative”, otherwise it should be “positive”. Note: The system includes a hardware check of this polarity. If you have a negative polarity module (i.e. for an SDD) and ADMCA is set for positive, then the DP5 detects this and all power supplies are turned off.
  - If there are still no counts, turn off pile-up rejection and risetime discrimination, in the “Shaping” tab of “DPP Properties”. These reject counts which the system regards as invalid so can reject everything.
- Check for physical damage.
  - Look for visible damage to the Be window on the front of the detector or a crease in the package.
  - If you have an XR100, check the output of the preamplifier. Connect an oscilloscope to the output of the XR100 (with the LEMO between the XR100 and the PX4). A Si detector should display a saw

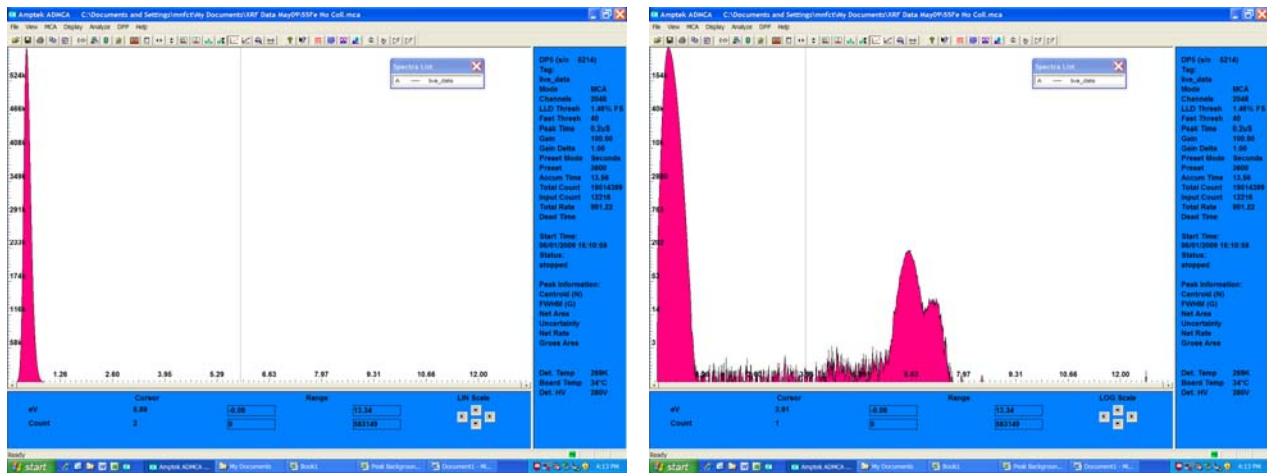


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 tooth pattern, swinging over a range of  $\pm 2V$  to  $\pm 5V$  or more, with a period of at least tens of milliseconds. For a CdTe detector, the XR100 output should go to around  $-0.5VDC$  and will have tail pulses of tens of millivolts superimposed (if a source is present)

- If you still cannot get a spectrum, or if you suspect physical damage, then contact Amptek.

### 3 The spectrum is grossly distorted.

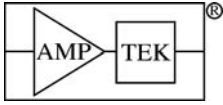
Your system should produce spectra similar to those found on Amptek's website: a few sharp, Gaussian photopeaks corresponding to the incident energies. The exact resolution will depend on the detector selected, on the source used, and on the configuration parameters, of course,. Sometimes, the spectrum is greatly distorted. The plots below show screen captures in such a case (they show the same data, but the one on the left uses a linear scale while that on the right uses a log scale). The problem is too much noise. This is usually caused by either (1) an incorrect configuration or (2) electromagnetic interference.



#### 1. Is an incorrect configuration leading to noise exceeding the threshold?

If the configuration is incorrect, then the intrinsic noise may exceed the thresholds. This may broaden the peak or it may cause the system to trigger nearly constantly on noise, mistaking random noise peaks as valid counts. Some common configuration errors include:

- *Thresholds are too low.* Remove the radiation source, then press the “Tune fast/slow thresholds” button on the toolbar. The software will automatically adjust both thresholds to a level just above the noise. Place the source in front of the detector and take more data.
- *Gain is too high:* If the gain is too high, then the voltage of the noise is large relative to the signal. The system sometimes defaults to a gain not expected by the user. Try reducing the gain, using the > and < buttons on the toolbar. After the gain is adjusted, “Autotune” the thresholds again.
- *Input offset is incorrect:* A DAC provides an offset voltage so that the signal is in the correct range. Go to “acquisition setup”, “Gain and Pole Zero”, and click “Tune Input Offset”.
- *Peaking time is too short:* Short peaking times are useful for operation at high count rates, but the electronic noise increases at short peaking times. Try going to a longer peaking time, to see if the noise improves. If you must operate at a short peaking time, raise the thresholds commensurately.
- *Temperature is too high.* Noise increases with temperature. Check the temperature reported by the unit, which is displayed in the status bar. Under normal conditions, we recommend a temperature around 230K. If it is significantly above this, open the acquisition menu, power tab, and check the temperature set point. If the set point is high, and you need to reduce noise, then reduce the set point. If the detector does not reach a set point of 230K, contact Amptek.
- *HV bias is wrong.* Noise can be caused by a bias voltage which is either too high (excess leakage current) or too low (incomplete depletion leading to additional capacitance). Check first that the HV

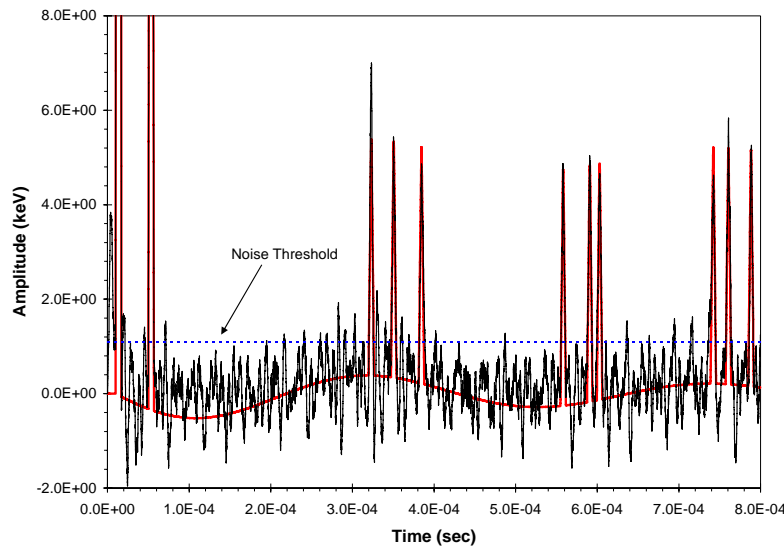


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bias is set correctly for your detector. There are nominal values in the default configurations, but there is some variation in the optimum value from one production lot to the next. You may need to tune the bias for your detector.

### 2. *Is external noise coupling into the system?*

Noise from any number of sources can couple into the system and broaden the peak and/or exceed the thresholds. The figure below illustrates an oscilloscope output when a low frequency (3 kHz) periodic signal couples into the system. Since the noise and signal ride on the baseline, one observes bursts of noise counts (when the baseline ripple approaches the threshold) and the peak is broadened by the amplitude of the noise. When this occurs, the system can trigger nearly constantly or occasionally on noise, mistaking random noise peaks as valid counts. Note that the peak value rides on the noise baseline, so the peak in the spectrum is broadened.

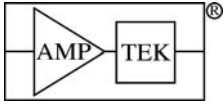


External noise (or interference) arises because energy outside the system is coupling into a sensitive node in the system. To resolve interference noise, one must first establish that the problem is indeed due to interference. One must then identify the source of interference and how it couples into the system. Finally, to solve the problem one can either (a) reduce the intensity of the source of the interference, (b) reduce the coupling, or (c) reduce the sensitivity of the system to the interference.

There are several ways to distinguish interference from intrinsic noise. First (and most unambiguous) is that, when you turn off the source of interference or change the coupling, the spectrum improves. Second, interference usually results in non-Gaussian peak broadening. If the interference level exceeds the intrinsic noise, the result is a set of “double peaks”. Third, low frequency interference often causes occasional “bursts” of noise counts near the “zero” of the energy spectrum. Fourth, an oscilloscope or spectrum analyzer can often distinguish the periodic interference from random noise.

If you get a grossly distorted spectrum and have tried the configuration changes above, then interference should be suspected. If you see the spectral characteristics above (non-Gaussian peaks, bursts of low level noise), then it is likely. We recommend the following approach:

- *Remove ground loops.* We STRONGLY recommend using a single point ground in your system. Make certain there is a ground connection, then break all other connections. We have found many laptop computers in which the charger injects significant current pulses into ground, so try floating any laptops (a 3 to 2 prong adapter is useful). Refer to the grounding diagram for your system to optimize the location of ground connections.
- *Use an oscilloscope or spectrum analyzer.* If you have an oscilloscope, and a system with the analog output available, this is an important tool. A properly operating system will exhibit intrinsic noise, which is broadband, with a characteristic frequency/shape similar to that of the shaped pulses. Set the trigger just above the broadband noise, change the time axis setting, and look for periodic signals.



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The period of the noise is a very good indicator of its source. Always look for 60 Hz (16 millisecc) noise from AC power mains, usually coupled via ground connections.

- *Turn off likely sources of interference.* The system may be susceptible to radiated magnetic fields near the preamplifier. Turn off CRTs, oscilloscope displays, and switching power supplies near the preamplifier. We have seen several X-ray tubes and supplies cause interference. Use an isotopic source to stimulate the detector, block the X-ray tube, and run the power up. Ballasts in some fluorescent lamps have a strong signal in the 20-30 kHz range, so turn off fluorescent lights. Some detectors are microphonic, so acoustic sources in the tens of kHz can cause interference. Turn off anything you don't need, anywhere near the system.
- *Reduce cable lengths.* Cables are antennas, so use the shortest cables possible. This is particularly important for the connection between detector and preamp and between preamp and signal processor.
- *Isolate the system.* Interference may couple in via the power or communications connections. Use batteries to separate the system from power ripple. To test for coupling via the communication lines, use a long preset time (say 2 minutes). With the system connected to the computer, begin the data acquisition, then remove the connector. After acquisition has stopped, reconnect and see if the spectrum is better.