X-ray Detectors

Proper Grounding Techniques for Optimum Detector Performance

Technical Note

Proper grounding is essential in low noise electronic design, including circuits for energy dispersive x-ray detectors such as PINs and SDDs. Improper grounding in a system with multiple devices will lead to cross-talk between devices, negatively affecting low-noise performance, and in the case of energy dispersive x-ray detectors, degrading energy resolution and adding low energy noise. The electronic signals from Si-PIN and SDD x-ray detectors are very small and very sensitive to noise coming from other devices.

Guidelines and Figures

1. Figure 2 demonstrates the recommended layout for low noise design, which is a single point ground in a star configuration. All device grounds return to a single point, not by alternate routes.
2. In circuit board design, the best practice is to place a ground plane on the PCB to serve as the single grounding point. This simplifies implementation of a star topology as it avoids the need for additional ground layout.
3. Ground loops should be avoided by design (see Figure 3 for example). A ground loop occurs when there is an electrical path between the grounds of two devices that is not through the single grounding point, as shown in Figure 3. A star configuration avoids ground loops by design.
4. Device cases should be electrically isolated from one another to avoid ground loops that occur outside of layout. Often the cases of individual devices are grounded, so allowing electrical contact between the cases of devices will cause a ground loop, such as the x-ray source case touching the detector case, illustrated in Figure 3.
5. Communication between devices should be through differential signaling as shown in Figure 2. The signal cables are not referenced to ground, thereby avoiding ground loops. USB signaling meets this requirement.

Ground loops usually cause energy dispersive detectors to have increased low energy counts and impaired energy resolution. Failing to follow proper grounding procedures will likely reduce the capability of the system.

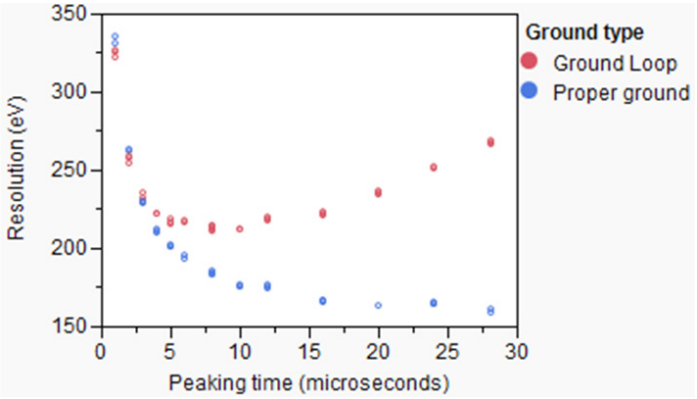

Figure 1: Energy resolution for Fe-55 spectrum. Blue points are for properly grounded detector, red points are for a detector with a ground loop.

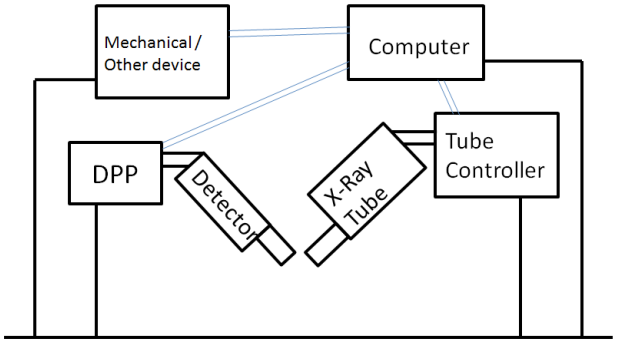

Figure 2: Single point grounding in a star configuration over a ground plane. Communication between devices is done with differential signaling (blue wire pairs, USB is acceptable), and all device grounds trace directly to a single point independent of other devices.

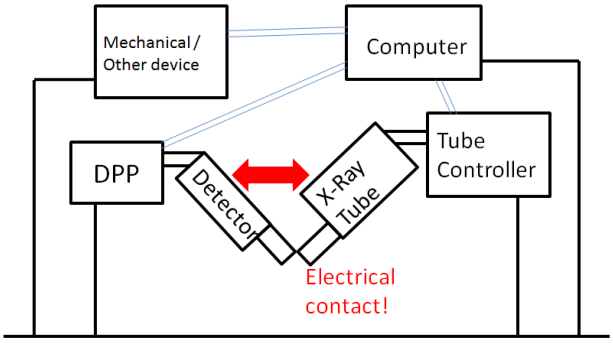

Figure 3: The detector having an electrical path to the x-ray tube casing or any other separate component causes a ground loop and will deteriorate the detector's performance. For best results, the detector should be electrically isolated from the x-ray source and all other devices.

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