

# Radiation Detector High Voltage Shock Potential

## By Richard Smola - Design Engineer

**INITIAL QUESTION:** Knowing that most common radiation detectors (Geiger-Mueller, scintillation, and proportional detectors) require a high voltage (HV) supply to operate correctly, is this HV dangerous for the operator?

**BACKGROUND:** Most common radiation electronics have a coaxial cable connection that allows detectors to be interchanged easily. The center pin of this connector usually has a high voltage of approximately 500 to 2000 Vdc, with 900 Vdc being the most common voltage. Touching this center pin, or the center pin of a connecting cable, can result in an unpleasant shock-though not much different from the static electricity shock one might receive after walking across a carpet. The coaxial connector has been in use for over 50 years, so there is much industry support for keeping the same connector-but at what liability?

**SAFETY STANDARDS:** A safety standard IEC 61010-1 (very similar to UL 1010-1) is used worldwide as “safety requirements for electrical equipment for measurement, control, and laboratory use”. In section 6.3.1, it defines values above 70 Vdc hazardous live IF the current exceeds 2 mAdc when measured with a particular circuit chosen to represent the impedance of the human body. This circuit is shown in Annex A of this standard. It also references a limit of 45  $\mu\text{C}$  (micro-coulombs) of capacitive charge for voltages up to 15 kV.

**DATA TAKEN:** We measured the current, using the circuit specified above, of some common Ludlum instruments. We also calculated the stored capacitive charge in the last capacitor of the HV circuit:

<i>CURRENT LIMIT (2mA or 2000 <math>\mu\text{A}</math>)</i>	<i>CHARGE LIMIT (45 <math>\mu\text{Coulombs}</math>)</i>
Model 3 (old unit, before 1998 redesign) at 900 Vdc—78 $\mu\text{A}$	2.43 $\mu\text{C}$ charge
Model 3 (new unit) at 900 Vdc—442 $\mu\text{A}$	0.90 $\mu\text{C}$ charge
Model 12-6 at 1500 Vdc—112 $\mu\text{A}$	7.05 $\mu\text{C}$ charge
Model 2200 at 1500 Vdc—390 $\mu\text{A}$	30 $\mu\text{C}$ charge
Model 2221 at 1500 Vdc—200 $\mu\text{A}$	8.40 $\mu\text{C}$ charge

**SIDE NOTE:** If one figures the capacitance of the connected coax cable, it might be possible to exceed the charge limit of 45  $\mu\text{C}$ . Given the capacitance of a typical cable at 29 pF/foot, the Model 2200 at 1500 Vdc (the worst case above) would exceed the limit with a 345 foot cable, summing the instrument and cable capacitive charge.

**SUMMARY:** The data taken and the analysis of the stored energy available at the coax connector of some common instruments suggest that the shock received by touching the center pin of the connector is not one that is deemed hazardous live by international safety standards.

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