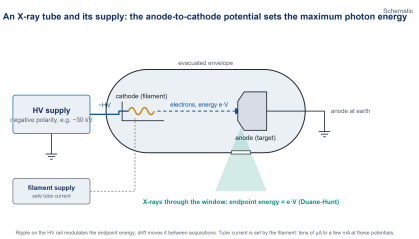
X-Ray Generation Systems

Bias low-energy X-ray tubes for benchtop XRF, soft X-ray sources and tube conditioning with a stable, low-ripple rail up to 30 kV that keeps the emission spectrum repeatable.

APPLICATION BRIEF · HVX-SERIES HIGH VOLTAGE POWER SUPPLIES · dc-62022201



Schematic: an X-ray tube and its supply. A negative high-voltage supply biases the cathode filament with the anode at earth; electrons cross the gap with energy e times V and produce X-rays whose endpoint energy equals the applied potential.

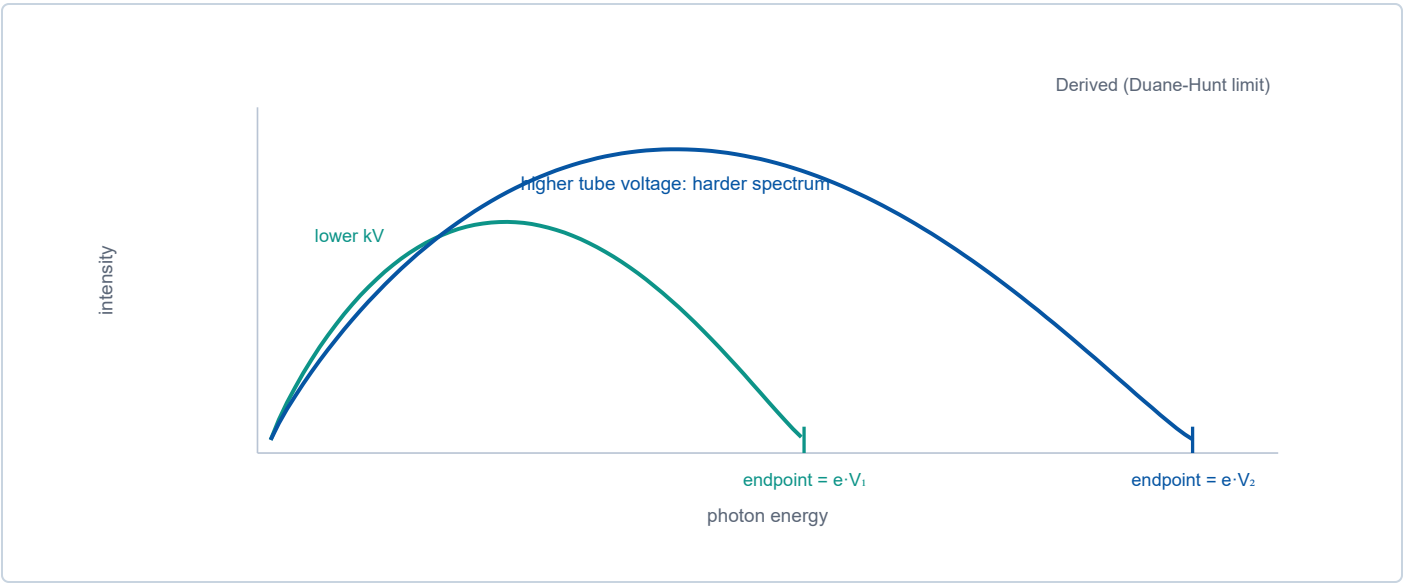
X-Ray Generation Systems

An X-ray tube runs on a high-voltage DC supply. The tube accelerates electrons across the anode-to-cathode potential, and that potential sets the maximum photon energy and the shape of the spectrum the tube emits. Tube potentials span a wide range: benchtop X-ray fluorescence tubes run at 4 kV to 50 kV, diffraction tubes at 40 kV to 60 kV, and industrial radiography and security screening at 80 kV to 450 kV. The HVX-Series covers the low-energy end of that range, up to 30 kV: soft X-ray sources, electron-impact calibration sources, the lower part of benchtop XRF excitation, and tube conditioning. In each of these the measurement is only as good as the voltage behind the tube.



Ripple on the high-voltage rail modulates the endpoint energy of the spectrum the tube emits, and drift over a session moves the excitation conditions between one acquisition and the next. For analytical work the effect is direct: a wandering tube voltage changes the excitation of the sample and undermines the repeatability that quantitative XRF depends on. The supply is part of the measurement chain.

X-ray tubes also misbehave. Spark-downs and flashover events are a normal part of tube life, especially as a tube ages or when a fresh tube has not yet been conditioned. Each event dumps stored energy back toward the supply, and without fast protection that energy can damage the electronics driving the tube. A practical X-ray supply has to set voltage precisely, hold it quietly, bring the tube up gently, and survive the arc when it comes.



DERIVED **Figure 1.** From the Duane-Hunt limit: each bremsstrahlung continuum ends at the photon energy equal to the tube voltage. The rail sets the spectrum's endpoint, so rail stability is spectral stability, and spectral stability is measurement repeatability.

How the HVX-Series solves it

The HVX-Series provides the clean rail a low-energy X-ray tube needs. Each supply is fully digitally regulated with a microcontroller and FPGA, so the set voltage is held rather than trimmed by analog drift. Line regulation is tighter than plus or minus 0.01 percent of nominal across a 10 percent mains swing, ripple is specified at 0.01 percent of nominal plus 100 mV peak to peak, which is 3.1 V on a 30 kV unit, and stability holds within 0.01 percent of nominal over an eight-hour session. A rail that quiet holds the endpoint of the spectrum to about one part in ten thousand, so the analytical line stays where the method expects it.

Setting the tube point is as precise. The HVX-Series offers 16-bit setting resolution across roughly 0.01 to 100 percent of nominal, which lets an operator dial in a specific accelerating voltage and return to it, within the 0.1 percent reproducibility, on the next run. Response to a load change is fast: after a 0 to 100 percent change in tube current the rail recovers to within 0.1 percent of nominal in **under 1 millisecond**, so a change in emission does not pull the anode potential off its set point.

Ramp Control brings the tube up at a defined gradient rather than a step. That matters twice over: it conditions a new or rested tube gently, working the voltage up so the tube seasons rather than shocks, and it protects the tube from the stress of an abrupt inrush. The gradient is adjustable from 1 V/s up to ten times nominal per second, so the conditioning profile fits the tube.

Arc Detection handles the spark-down. The supply watches for a flashover, reports it through the event log, and can shut the output off when it detects one, which limits the energy of the event. Pair that with the time-tagged event log and an operator can see when and how often a tube is arcing, which is a useful early signal that a tube is nearing end of life.

Control is automation-ready. Ethernet and RS232 with a standard SCPI command set let an inspection or analytical routine set the tube voltage, read status, and log every step from the same script that drives the stage, the detector, and the rest of the instrument. Rack the 2U enclosure into the system alongside the tube housing and control electronics.

Which HVX-Series models and options fit

The HVX-Series serves tube potentials up to 30 kV. Tubes in this range draw from tens of microamperes to a few milliamperes, so the 500 W class, at 25 mA and 17 mA, carries ample current and the choice follows the tube's maximum potential. Negative polarity is common, since the high voltage is most often applied as a cathode bias with the anode at earth.

Table 1.

Need	Recommended HVX-Series model	Rating
Soft X-ray and calibration sources to 10 kV	HVX-10000-200	10 kV, 200 mA, positive, negative or reversible
Tubes to 20 kV	HVX-20000-25	20 kV, 25 mA, positive or negative
Tubes to 30 kV, benchtop XRF excitation	HVX-30000-17	30 kV, 17 mA, positive or negative

Two options are recommended for every X-ray tube supply. **Ramp Control** brings a cold or rested tube up at a defined rate, which is the conditioning procedure tube manufacturers specify. **Arc Detection** with output shut-off removes the drive when a tube flashes over, which protects the electronics behind the tube. Specify negative polarity where the tube takes a cathode bias.

Recommended configuration

For a benchtop XRF or soft X-ray source running at tube potentials up to 30 kV, a **HVX-30000-17** is the fit. Its 17 mA rating is many times the beam current of a low-power tube, and the 16-bit setting places the anode potential in steps of about 0.46 V. Specify negative polarity for a cathode-bias tube, and add **Ramp Control** for conditioning and **Arc Detection** with output shut-off for flashover protection.

Sources that run at 10 kV or less, such as soft X-ray and electron-impact calibration sources, use the **HVX-10000-200**, and tubes to 20 kV use the **HVX-20000-25**. Tubes above 30 kV, which includes diffraction, radiography and screening, are outside the HVX-Series range. In every case, drive the supply over Ethernet with SCPI from the same routine that controls the rest of the instrument, log the arc and event history, and rack the 2U unit into the system.

Talk to an application engineer

Berkeley Nucleonics can help you match a HVX-Series model and option set to your X-ray system. Call **800-234-7858** or email info@berkeleynucleonics.com.

For a quick question, chat with an engineer at berkeleynucleonics.com.

Ask now → Chat with our assistant and get an answer in seconds.

Berkeley Nucleonics Corp.
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Application Brief
HVX-Series High Voltage Power Supplies | dc-62022201