# Choosing a High-Voltage DC Power Supply

**A selection guide for precision HV work: how to read voltage and current ratings, pick polarity, weigh regulation and ripple, and match a job to the right Berkeley Nucleonics HVX-Series model.**



TECHNICAL NOTE · HVX-SERIES

## 1 Start with the Load

The fastest way to overspecify or underspecify a high-voltage supply is to start with a catalog number instead of the load. Before comparing models, describe what the supply has to drive. Is it a resistive divider, a capacitor bank, a gas tube, a photomultiplier, a deflection plate, a magnet coil, or a device under test that arcs by design? Each of these behaves differently, and the differences decide which ratings matter.

A clean resistive load asks mostly for steady voltage. A capacitive load asks for current during charging and tolerance of stored energy during discharge. An ionizing or breakdown load asks for current limiting and fault behavior that protects both the supply and the experiment. Write down the worst case for each: the highest voltage you will ever set, the highest current you will ever draw, and the fastest change you will ever command. Those three numbers, plus your accuracy target, drive almost every later decision.

## 2 Voltage, Current, and Power

A DC supply is bounded by three numbers, and they are not independent. The HVX-Series spans **1.5 kV to 30 kV** of output voltage across three power classes: **500 W, 2 kW, and 3 kW**. Each model carries a fixed voltage rating and a fixed current rating, and their product is its power class. A 1.5 kV, 3 kW unit delivers up to 2000 mA at any voltage up to 1.5 kV, while a 30 kV, 500 W unit delivers up to 17 mA at any voltage up to 30 kV. The supply holds whichever of the two limits the load reaches first.

The two ratings are independent of each other. A HVX-10000-200 delivers up to 200 mA whether it is set to 1 kV or 10 kV; what changes with the setting is the power available, which is the product of the two: 200 W at 1 kV and 2 kW at 10 kV. Check the working point against both ratings, since a load that needs 300 mA at 2 kV is outside this unit's envelope even though 600 W is well inside its power class.

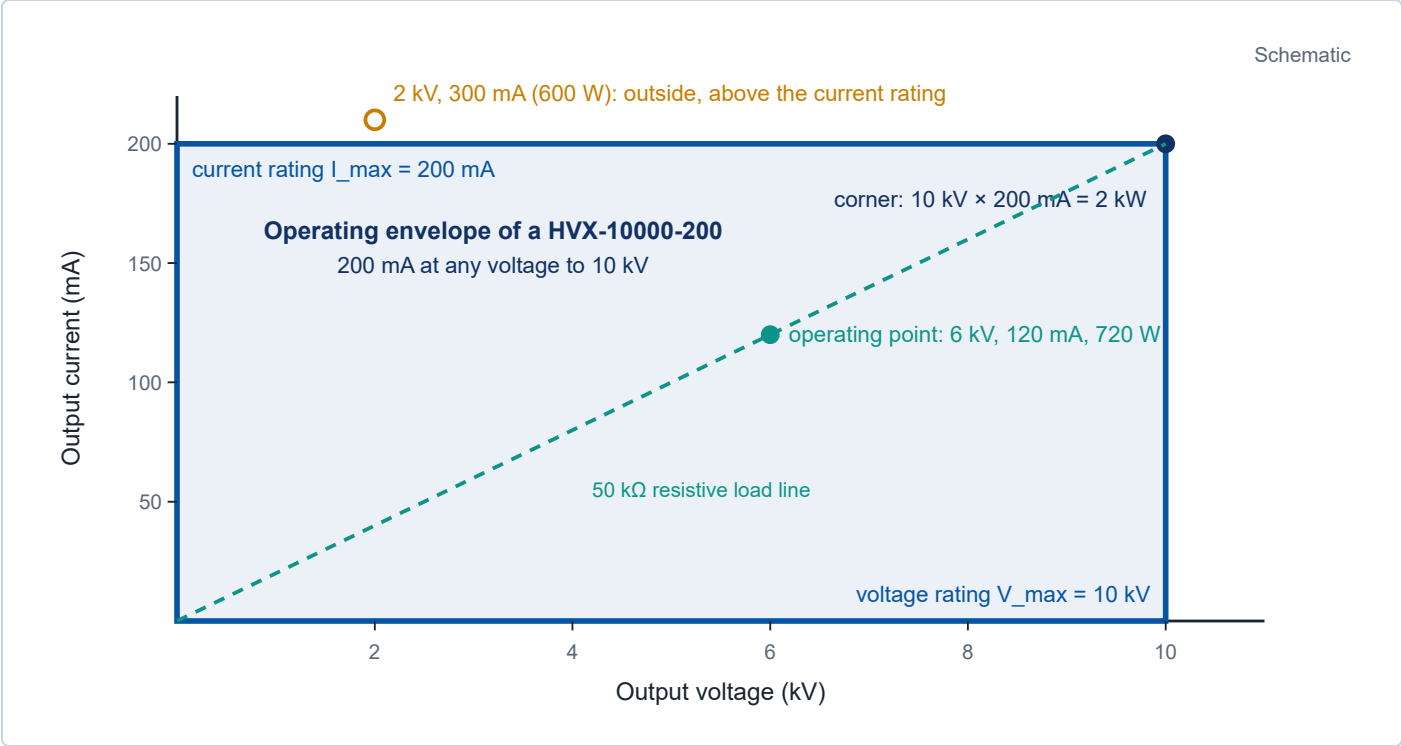
**Table 1.**

| Power class | Example HVX-Series models | Voltage | Max current |
|---|---|---|---|
| **500 W** | HVX-20000-25, HVX-30000-17 | 20 to 30 kV | 17 to 25 mA |
| **2 kW** | HVX-1500-1400, HVX-5000-400, HVX-10000-200 | 1.5 to 10 kV | 200 to 1400 mA |
| **3 kW** | HVX-1500-2000, HVX-5000-600, HVX-10000-300 | 1.5 to 10 kV | 300 to 2000 mA |

Model names encode the rating directly. `HVX-5000-400` is a 5 kV, 400 mA unit. The 1.5 kV, 5 kV and 10 kV models are available in positive, negative or reversible-polarity versions, and the two 1.5 kV ratings also come as fixed floating-output (FLO) variants. The 20 kV and 30 kV models are positive or negative. Specify the polarity and any options when ordering.

## 3 The Operating Envelope

The clearest way to see voltage and current together is to plot them. An HVX-Series model is bounded by its voltage rating on one axis and its current rating on the other, so its operating envelope is a rectangle, and the power class is the product at the corner. The load draws a line or a curve through that space (a straight line through the origin for a resistor, a horizontal line for a constant-current charge), and the operating point is where the load line meets the setting. If that point falls outside the rectangle, the supply cannot serve the load, whatever either rating is on its own.




**SCHEMATIC** **Figure 1.** The operating envelope of one HVX-Series model is the rectangle bounded by its voltage rating and its current rating; the supply holds at whichever limit the load reaches first. Drawn for a HVX-10000-200: 200 mA at any voltage to 10 kV, 2 kW at the corner. A 50 kilohm load line and an operating point at 6 kV, 120 mA are inside; a point at 2 kV, 300 mA is outside because it exceeds the current rating even though its power is 600 W.

## 4 Polarity

Polarity is a real decision, not a footnote. HVX-Series units come in three polarity styles. **Positive** and **negative** models reference one output terminal to earth and drive the other terminal above or below ground. **Reversible** models let you switch between positive and negative electrically, without rewiring, which suits a bench that serves several experiments or a test sequence that needs both polarities.

Separately, **floating** output models keep both terminals isolated from earth, so you can reference the output to a point in your own circuit. Floating outputs matter when the supply sits in series with another source, when you need to bias a stage that is not at ground, or when grounding the output would create a fault loop. The trade is that a floating output carries its own safety obligations, since neither terminal is automatically at a safe potential. We cover earth-referenced and floating outputs in depth in a companion note.

> **Rule of thumb**
>
> If every experiment uses the same polarity and one terminal can sit at ground, a fixed positive or negative unit is the simplest and safest choice. Choose reversible only when you genuinely switch polarity, and floating only when the load cannot share earth.

## 5 Regulation and Ripple

Regulation describes how well the output holds its setpoint when something changes. **Line regulation** covers changes in the AC mains, and the HVX-Series holds tighter than **+/-0.01% of nominal voltage** across a +/-10% mains swing. **Load regulation** covers changes in the load current, and the HVX-Series holds within **0.05% of nominal voltage** for a 10% to 90% load step. After a 0 to 100% change in load current the output recovers to within 0.1% of nominal in **under 1 ms**.

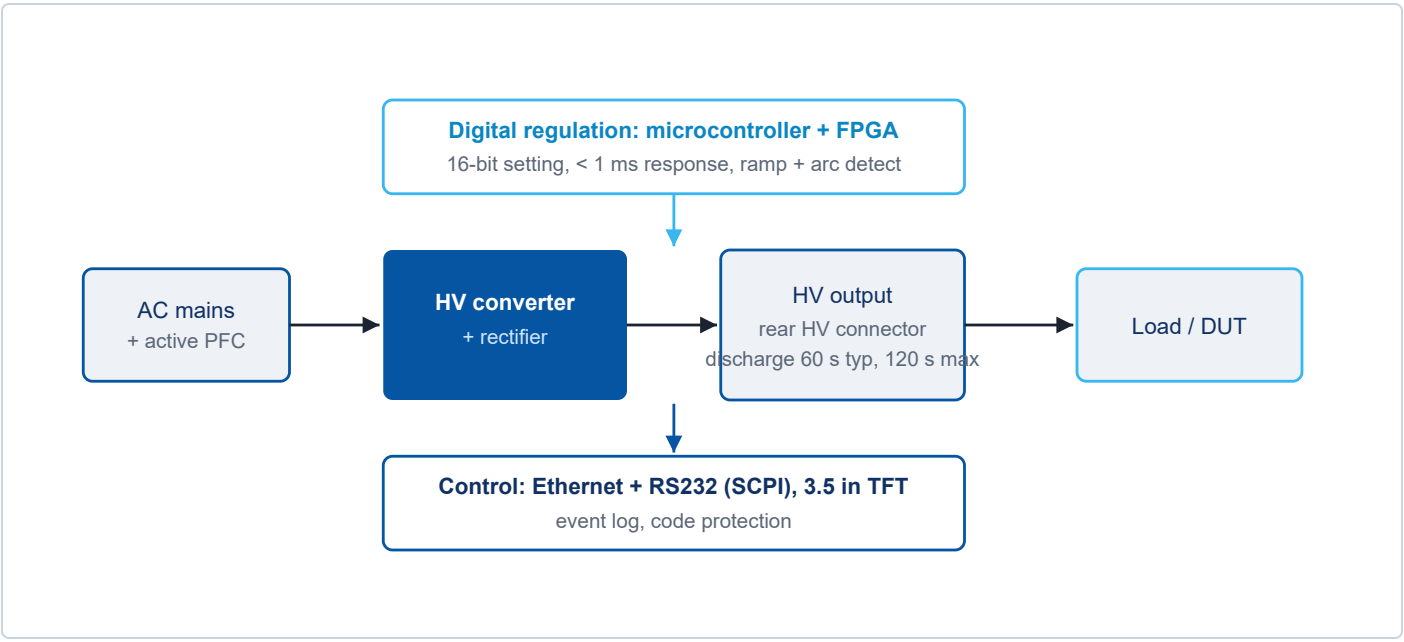
Ripple is the small residual AC riding on the DC output. The HVX-Series keeps voltage ripple at or below **0.01% of nominal voltage plus 100 mV**. For a photomultiplier, an electron optic, or a precision deflection plate, that residual matters as much as the absolute setpoint, because it shows up directly as noise in the measurement. A supply that is accurate but noisy can still ruin a sensitive experiment. The numbers and what they mean for your result get a full treatment in the ripple and regulation note.

## 6 Stability Over Time

A supply can hit its setpoint and still drift over a long run. The HVX-Series holds stability within **0.01% of nominal per 8 hours** and a temperature coefficient at or below **0.01% of nominal per kelvin**. For calibration work, where the supply holds a point while a reference divider is read, these are the numbers to read first. Full 16-bit setting resolution across 0.01% to 100% of the nominal range lets you place the operating point precisely, and reproducibility, the agreement between repeated settings of the same point, is **0.1% of nominal**.

## 7 Interfaces and Automation

If the supply lives in an automated test rack, the control path is as important as the output. Every HVX-Series carries **Ethernet and RS232 on board** and speaks a **SCPI command set**, so it drops into a LabVIEW, Python, or instrument-control framework without a translation layer. The front panel offers a **3.5-inch color TFT** with two soft keys and a turn-and-press knob, structured menus, configurable code protection, and a time-tagged error and event log for traceability.




SCHEMATIC **Figure 2.** HVX-Series system block diagram. A digitally regulated chain runs from a power-factor-corrected AC input through the HV converter to the rear output connector, with the FPGA-based regulator and SCPI interfaces governing the whole path.

## 8 Form Factor

The HVX-Series ships as a **19-inch rack-mount or benchtop** unit with an integrated adapter, so the same hardware works in a rack or on a bench. Height is **2U, 3.5 inches (89 mm)**; chassis depth behind the rack panel is **19.7 inches (500 mm)** and overall depth is **21.0 inches (534 mm)**. Weight starts near **28.7 lb (13.0 kg)** for the lower-voltage units, around **36.4 lb (16.5 kg)** at 20 kV, and about **38.6 lb (17.5 kg)** at 30 kV. The AC inlet is an IEC 60320 C20 connector at the rear. The 3 kW models take 230 V plus or minus 10% single phase and the 2 kW models 187 V to 253 V, at 47 Hz to 63 Hz, with active power factor correction.

## 9 Safety: Ramp and Arc

High voltage demands controlled behavior at both ends of a run and during faults. Two retrofittable options address this. **Ramp Control** brings the output up and down on a defined gradient, from **1 V/s to 10 times the nominal voltage per second**, so a sensitive load is never hit with a step. **Arc Detection** watches for flashover, reports it, and can shut the output off, which protects both the supply and the device under test in breakdown-prone setups.

Beyond options, the HVX-Series discharges its own output at no load in **60 seconds typical and 120 seconds maximum**, depending on the model. A load with its own capacitance holds charge longer than that. Confirm zero potential with an HV probe before handling, whatever the elapsed time.

> **Handling**
>
> Stored energy in a high-voltage supply and its load can remain dangerous after the output is set to zero. Follow your site lockout procedure and confirm discharge with an appropriate HV probe before contact.

## 10 From Use Case to HVX-Series Model

The matrix below is a starting point, not a substitute for a load analysis. Confirm the operating point, the polarity, and the accuracy target against the full specifications before you order.

**Table 2.**

| Use case | What it needs | Suggested HVX-Series starting point |
|---|---|---|
| **Capacitor charging / pulsed power** | Charging current at the bank voltage, repeatable set point | HVX-10000-300; HVX-1500-2000 for banks under 1.5 kV |
| **SiC / GaN double-pulse test** | Bus to 1.5 kV for 650 V to 1700 V parts, low ripple floor | HVX-1500-2000; HVX-5000-400 above 1.5 kV |
| **EV inverter and powertrain HV test** | Amperes at 800 V, potential-free rig | HVX-1500-2000 FLO; HVX-5000-600 for isolation checks |
| **End-of-line withstand test** | Ramp, dwell, arc trip, SCPI | HVX-5000-600; HVX-1500-2000 below 1.5 kV; HVX-10000-300 above 5 kV |
| **Semiconductor device stress** | Margin to the avalanche knee, reversible polarity | HVX-5000-400 (reversible); HVX-10000-200 for 6.5 kV parts and isolation |
| **Calibration source** | Low ripple, 8 h stability, 16-bit setting, read through a divider | HVX-10000-200; HVX-30000-17 above 10 kV |
| **R&D / university HV lab** | Flexible voltage, reversible polarity, SCPI | HVX-5000-600 (reversible) |
| **Low-energy X-ray tube** | Negative polarity, milliamperes, ramp for conditioning | HVX-30000-17; HVX-10000-200 for tubes to 10 kV |
| **Electron-beam and ion-beam stages at 30 kV or less** | Extraction, focus and low-energy acceleration; source bias off earth | HVX-10000-200; HVX-20000-25 or HVX-30000-17; HVX-1500-2000 FLO for source bias |
| **Electrostatic processes** | Microamperes at 10 to 30 kV, or amperes at 1.5 kV | HVX-30000-17 (electrospinning); HVX-1500-2000 (sputter bias, chucks) |
| **Detector bias (PMT, SiPM, proportional counter)** | Low current, low ripple, high stability | HVX-5000-400 (reversible) |
| **Mass spectrometry ion optics** | Source and lens bias, both ion modes | HVX-1500-2000 (reversible); HVX-10000-200 for time-of-flight stages |

## 11 Talk to an Engineer

The right supply is the one matched to your load, your accuracy target, and your safety plan, not the one with the largest rating on the front. To work through an operating point, a polarity choice, or an automation path, contact Berkeley Nucleonics at **800-234-7858** or info@berkeleynucleonics.com.

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

**Berkeley Nucleonics Corp.**
Test, Measurement and Nuclear Instrumentation since 1963
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**Technical Note**
HVX-Series