Semiconductor HV Test & Reliability

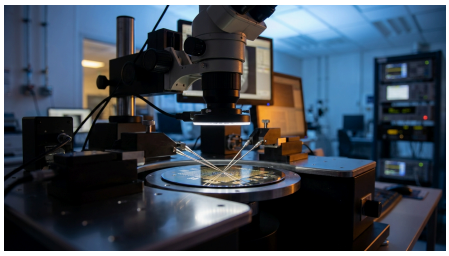


Illustration: a wafer on a probe station under a microscope, with probe needles landed on a die. Leakage at the needle is read by an electrometer; the supply holds the stress voltage.

Apply controlled high-voltage stress to power devices, isolation structures and dielectrics from 1.5 kV to 30 kV, with the repeatability, ramp control and polarity switching that breakdown and reliability work demand.

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

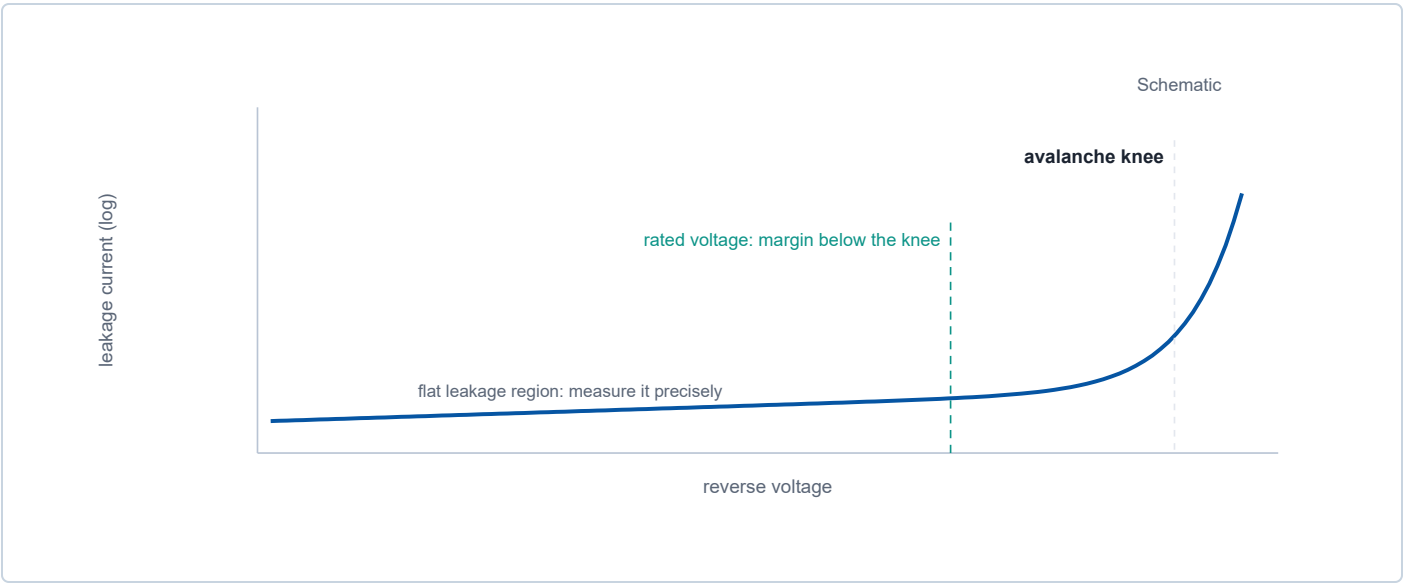
Semiconductor HV Test & Reliability



Every power device, diode, and isolation structure on a wafer carries a voltage rating. The job of high-voltage test is to prove that rating is real. That means applying controlled stress, watching for the onset of breakdown, and measuring, with an electrometer or source-measure unit in the return path, the small leakage currents that flow well below the point of failure. The numbers that come out of this work feed directly into datasheets, qualification reports, and the reliability models that customers depend on.

Breakdown voltage on a junction, a termination or an isolation barrier has to be located within a fraction of a percent, because a device binned at the wrong grade either fails in service or gives away margin. Leakage currents at operating voltage are often in the nanoamp range, and that measurement belongs to the electrometer; what the supply contributes is a rail steady enough that the reading is not chasing a moving voltage, and ripple low enough that the displacement current it drives through the fixture capacitance can be filtered or guarded out. Reliability campaigns add another demand: the same stress condition has to be reproduced across thousands of parts, day after day, with results that line up.

Then there is polarity. Test plans for complementary devices, dielectric studies, and bias-temperature work frequently call for both positive and negative stress on the same fixture. Swapping cables and supplies between runs wastes time and introduces error. The cleaner answer is a supply that reverses electrically, under software command, between sequences.



SCHEMATIC **Figure 1.** Reverse-stress I-V of a power device. The flat leakage region and the avalanche knee are the two measurements that prove a voltage rating; both demand a stress source steady enough that the current being read reflects the device, not the rail.

How the BNC HVX-Series line solves it

The BNC HVX-Series is a fully digitally regulated DC high-voltage supply, built around a microcontroller and FPGA rather than analog control loops. That architecture is what gives reliability test the stability it needs. Voltage is set across roughly 0.01 to 100 percent of nominal with 16-bit resolution, line regulation holds tighter than plus or minus 0.01 percent of nominal across a 10 percent mains swing, and stability stays within 0.01 percent of nominal over an eight-hour shift. Ripple is held to 0.01 percent of nominal plus 100 mV peak to peak, which is 1.1 V on a 10 kV unit. That ripple drives a displacement current through the fixture capacitance (for example, about 0.7 µA through 10 pF at a 20 kHz ripple component), which is why DC leakage is read through a low-pass filter or a guarded electrometer input rather than straight off the rail.

Response to a load change matters as much as steady-state accuracy. After a 0 to 100 percent change in load current the rail recovers to within 0.1 percent of nominal in under 1 millisecond, so a device that begins to conduct does not drag the stress voltage down for long. The current limit is set with 16-bit resolution from 0.01 percent to 100 percent of nominal, which is 20 µA to 200 mA on a HVX-10000-200, so the supply caps the current when a device breaks down; a compliance limit in the microamp range or below is set in the source-measure unit or electrometer, not in the supply.

Polarity is handled in the hardware. Reversible models on the 1.5 kV to 10 kV classes switch between positive and negative output, earth-referenced, so a single instrument covers both halves of a complementary test plan. The supply reaches the operator over Ethernet and RS232 using a standard SCPI command set, which is what makes thousands of identical, time-stamped runs practical inside an automated prober or a rack-based reliability oven controller.

Which HVX-Series models and options fit

Discrete power devices are rated from 600 V to 6.5 kV, so most device stress runs on the 1.5 kV and 5 kV classes with margin to the avalanche knee; isolation barriers, passivation and dielectric samples run higher. The choice follows the rating to be cleared, with margin, and the current the part draws at breakdown.

Table 1.

Need	Recommended HVX-Series model	Rating
600 V to 1.2 kV devices, stress with margin	HVX-1500-1400	1.5 kV, 1400 mA, reversible

Need	Recommended HVX-Series model	Rating
1.7 kV to 3.3 kV devices, isolation to 5 kV	HVX-5000-400	5 kV, 400 mA, reversible
6.5 kV devices and isolation barriers to 10 kV	HVX-10000-200	10 kV, 200 mA, reversible
Passivation and dielectric samples to 20 kV	HVX-20000-25	20 kV, 25 mA, positive or negative
Dielectric and standoff samples to 30 kV	HVX-30000-17	30 kV, 17 mA, positive or negative

Two retrofittable options earn their place on a reliability bench. **Ramp Control** sets a defined voltage gradient, from 1 V/s up to ten times nominal per second, so a breakdown sweep rises at a repeatable rate instead of a step. That turns a destructive test into a measurable one and keeps results comparable across operators. **Arc Detection** watches for flashover, reports the event, and can shut the output off when a device fails, which protects the fixture, captures the failure point cleanly, and shortens the path to a root-cause read. For test plans that demand both stress polarities, specify the reversible polarity variant rather than a fixed-polarity unit.

Recommended configuration

For a device reliability cell covering 600 V to 3.3 kV power diodes and transistors, a **HVX-5000-400** in the reversible configuration is the practical center. It clears those ratings with margin to the avalanche knee, sets the stress voltage in 16-bit steps of about 76 mV, and reverses polarity under software for complementary plans; leakage is read by the electrometer or source-measure unit in the return path. Add **Ramp Control** for repeatable breakdown gradients and **Arc Detection** with output shut-off to protect the prober and capture the failure point.

Cells that stress 6.5 kV devices and isolation barriers step up to the **HVX-10000-200**, and passivation and dielectric work to 30 kV uses the **HVX-20000-25** or **HVX-30000-17** in a fixed polarity, with the same two options. Drive everything over Ethernet with SCPI, log the time-tagged event record the supply keeps, and rack-mount the 2U enclosure alongside the prober controller for an automated reliability station.

Talk to an application engineer

Berkeley Nucleonics can help you match a HVX-Series model and option set to your reliability test plan. 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.