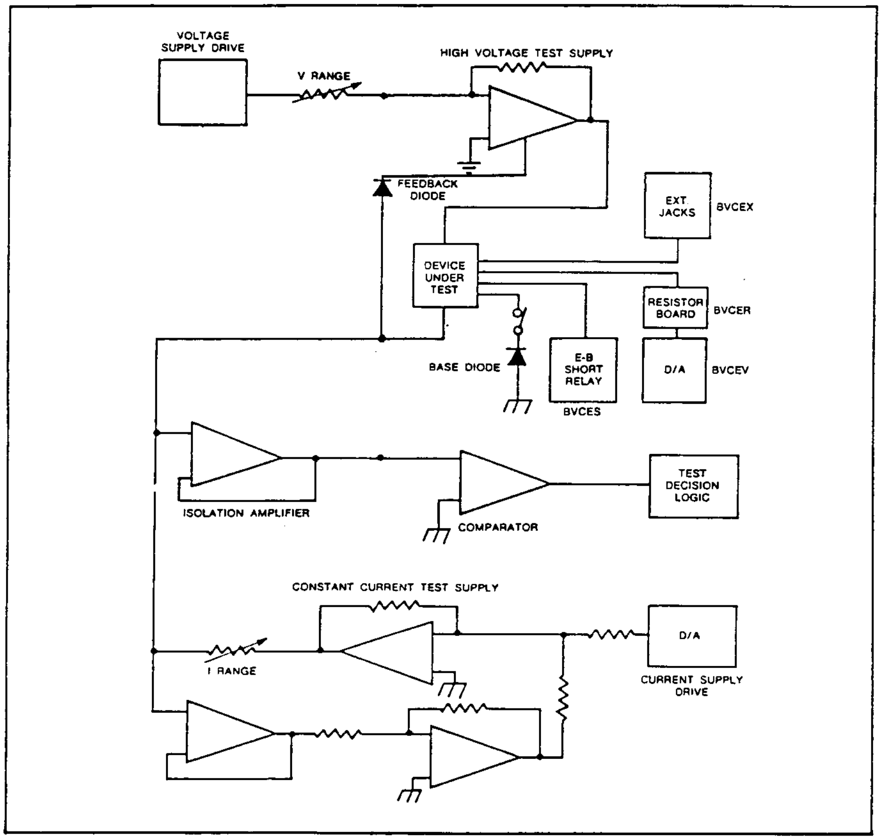
HOW TO MEASURE BREAKDOWN VOLTAGES ON SEMICONDUCTORS



To the left is a simplified diagram illustrating the methods used to perform **Breakdown Voltage measurements.**

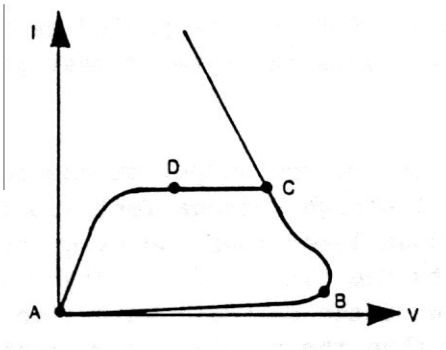
A digital-to-analog converter supplies a precision drive voltage to the High Voltage Test Supply. The Test Supply consists of an operational amplifier and high voltage booster circuit within the control loop. The programmed output voltage can be applied to any lead of the device under test. The two voltage ranges are selected by logic circuits, which change the input resistor.

Another, identical, digital-to-analog converter supplies the drive for a Constant Current Test Supply. The output is also connected to any device lead. This point is at zero potential when the circuit is at it's go/no-go decision, and the presence of a voltage will indicate either a pass or fail, depending upon polarity. An isolation amplifier with unity gain senses the voltage and feeds it to the comparator, which is referenced to ground. The output swing of the comparator is interpreted as a pass or fail by the Test Decision Logic, which evaluates the type of test performed and the type of device.

Feedback diodes connect the output of the constant current supply to a control point in the High Voltage Test Supply. In the event the device under test has a breakdown lower than the programmed voltage, negative feedback is produced which limits the output of the High Voltage Supply to slightly more than the true breakdown of the device. This also limits the circuit current to essentially no greater than the programmed current.

The BVCEO measurement on transistors requires special consideration. Most devices exhibit a snap back characteristic during breakdown which produces a negative resistance region through which the operating point must normally pass. The figure below shows a typical collector characteristic plot. When power is applied, the path of the operating point is indicated by points A, B and C, where point C is the desired point of measurement. Since the negative resistance region is prone to oscillation difficulties, it is highly desirable to avoid this area and to follow path A, 0 and C. Then, as an additional benefit, the voltage capability of the High Voltage Supply has to accommodate only the operating point and not the peak breakdown voltage of the device.

Diodes connect the base of the device to ground for the BVCEO measurement. First, the current supply is turned on, and then the voltage supply is activated. If the breakdown voltage of the device is greater than the programmed value of the high voltage supply, the emitter of the device under test remains opposite in polarity of the collector. This maintains the forward bias of the base diode, and the device is biased in a common-base mode. Path A to D is followed, and the operating point occurs at D. The negative resistance path is avoided, and a good device as described will not enter a breakdown mode. If the breakdown voltage is less than the programmed limit, the device breaks down, the emitter is the same polarity as the collector, the base diode is reversed biased and the operating point progresses from D to C. Although the device may oscillate, the test will have been determined a failure because of the polarity sensed at the emitter by the isolation amplifier.



For BVCER measurements, a resistor is selected from the resistor board and connected between the base and emitter of the device under test. For BVCEV measurements, a D/A converter is connected to the base of the DUT which is programmed for the desired value and polarity of the base voltage. A relay shorts the base to emitter for BVCES measurements and the external jacks at each test station are connected to all three leads of the device.

For additional information, please contact Lorlin Test Systems, Inc.

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