

JEDEC STANDARD

Zener and Voltage Regulator Diode Rating Verification and Characterization Testing

JESD211.01

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION



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ZENER AND VOLTAGE REGULATOR DIODE RATING VERIFICATION AND CHARACTERISTIC TESTING

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ZENER AND VOLTAGE REGULATOR DIODE RATING VERIFICATION AND CHARACTERISTIC TESTING

Introduction

The diodes described in this document are used as voltage regulator diodes and voltage references. These devices maintain a near-constant voltage by operating in the breakdown region, where large changes in current result in relatively small fluctuations in voltage. Voltage regulator diodes are similar to Avalanche Breakdown Diode (ABD) Transient Voltage Suppressors, except that they are designed for continuous voltage regulation, rather than for short-duration overvoltage protection. They are also typically unidirectional. They may be in a single p-n junction package with two-terminals or may also have multiple p-n junctions in a single package with two-terminals as well. Other configurations beyond two-terminals may also exist depending on package and overall configuration such as with multiple p-n junctions for diode arrays.

For the purpose of achieving, specific registration formats are available to fit particular types of Zener and voltage regulator/reference diodes. These formats are subject to change as new semiconductor developments or circuit applications become practicable. At present, the following formats are available:

NUMBER	DESCRIPTION
RDF-2	Diode, Voltage Regulator Single Unit or Family
RDF-7	Diode, Voltage Reference, Single Unit

ZENER AND VOLTAGE REGULATOR DIODE RATING VERIFICATION AND CHARACTERISTIC TESTING

(From JEDEC Board Ballot JCB-09-46, formulated under the cognizance of the JC-22.2 Subcommittee on Rectifiers, Zeners and Signal Diodes.)

1 Scope

This standard is applicable to diodes that are used as voltage regulators and voltage references. It describes terms and definitions and explains methods for verifying device ratings and measuring device characteristics.

Voltage regulator diodes are sometimes used as transient voltage suppressors, but are not characterized for their clamping ability or peak pulse power rating. Terms and tests related to transient voltage suppression will not be covered in this document, but are discussed in the JEDEC document JESD210 on Avalanche Breakdown Diode (ABD) Transient Voltage Suppressors.

2 Terms and definitions

These may use terms similar to avalanche breakdown diodes, but have variations unique to Zener and voltage-regulator diodes.

2.1 Basic concepts

2.1.1 voltage-regulator diode: A semiconductor diode with a single p-n junction (or with multiple p-n junctions, none of which interact) that is normally biased in the breakdown region of its voltage-current characteristics and limits variation in voltage across its terminals over a specified current range.

NOTE 1 The breakdown region may be due to either avalanche breakdown or Zener breakdown phenomenon (also often known as tunneling or field-emission breakdown).

NOTE 2 When forward-biased, voltage-regulator diodes have voltage-current characteristics similar to rectifier diodes.

NOTE 3 In general usage, voltage-regulator diodes are often referred to as **Zener diodes**, even if their breakdown characteristics are due to avalanche breakdown. Voltage-regulator diodes are also referred to as **voltage-reference diodes** when their application is to maintain a reference voltage within a specified accuracy over a specified current and temperature range in the breakdown region of its voltage-current characteristics.

NOTE 4 Figure 1 shows the symbol for a regulator or reference diode.

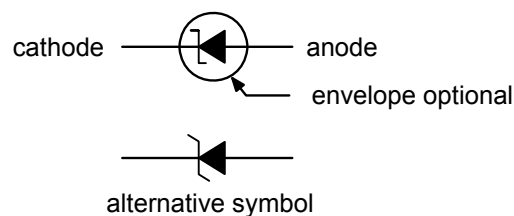


Figure 1 — Zener diode symbol

2.1 Basic concepts (cont'd)

2.1.1 voltage-regulator diode (cont'd)

NOTE 5 Figure 2 shows a typical voltage-current characteristic, which illustrates that Zener diodes operate in the third quadrant with a negative voltage applied to the anode with respect to the cathode.

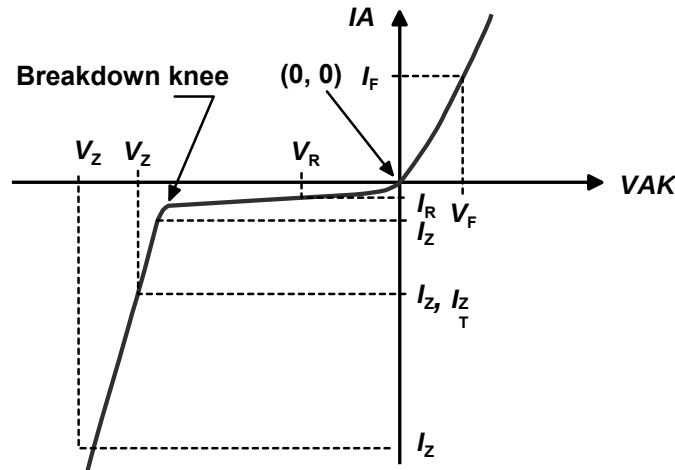


Figure 2 — Zener diode I-V characteristic

2.1.2 Zener diode: A semiconductor diode with a single p-n junction whose breakdown characteristics are due to the Zener effect.

NOTE Although true Zener breakdown occurs below approximately 6 volts, the term “Zener diode” is often used interchangeably with “voltage-regulator diode” and “voltage-reference diode” even for voltages over 6 volts, where breakdown characteristics are due to avalanche breakdown.

2.1.3 temperature-compensated voltage-reference diode: A voltage-regulator diode that is designed to have minimal changes in the regulated voltage over a broad temperature range.

NOTE A temperature-compensated voltage-reference diode is often provided with one or more forward-biased p-n junctions placed in series with a Zener p-n junction to offset or compensate the positive temperature coefficient of the Zener. This series combination may also involve more than one Zener p-n junction within the temperature-compensated voltage-reference diode, particularly for higher voltages.

2.1.4 nonconducting region: The portion of the voltage-current characteristic of a reverse-biased p-n junction that exhibits a high resistance to the passage of current.

2.1.5 breakdown region: The portion of the voltage-current characteristic beyond the initiation of breakdown where the current increases rapidly for any additional increase in reverse voltage.

NOTE In this region the voltage remains essentially constant for increases in reverse current, up to a specified current and power dissipation rating.

2.1.6 forward-conducting region: The portion of the voltage-current characteristic of a forward-biased p-n junction that exhibits a low small-signal resistance to the passage of current.

2.1 Basic concepts (cont'd)

2.1.7 anode terminal (A, a): The terminal connected to the p-type region of the p-n junction or, when two or more p-n junctions are connected in series and have the same polarity, to the extreme p-type region.

NOTE For voltage-reference diodes, any temperature-compensation diodes that may be included shall be ignored in the determination of the anode terminal.

2.1.8 cathode terminal (K, k): The terminal connected to the n-type region of the p-n junction or, when two or more p-n junctions are connected in series and have the same polarity, to the extreme n-type region.

NOTE For voltage-reference diodes, any temperature-compensation diodes that may be included shall be ignored in the determination of the anode terminal.

2.2 Voltage-regulator [voltage-reference] [Zener] diode parameters

In the parameter names and definitions below, the word “reference” may be substituted for the word “regulator” consistent with the diode-type name chosen by the manufacturer. “Zener” is often used for parameters with all three diode-type names.

2.2.1 maximum steady-state power dissipation (P_D): The maximum-rated value of continuous dc power dissipation.

NOTE The maximum steady-state power dissipation is calculated by multiplying the rated maximum regulator [Zener] current by the maximum regulator [Zener] voltage.

2.2.2 regulator [Zener] current, dc (I_Z): The dc reverse current through the diode when it is biased to operate in its breakdown region at an operating point between I_{ZK} and I_{ZM} .

2.2.3 regulator [Zener] current near breakdown knee, dc (I_{ZK}): The dc reverse current through the diode when it is biased to operate in its breakdown region at a specified current near the breakdown knee.

2.2.4 maximum regulator [Zener] current (I_{ZM}): The dc reverse current through the diode when it is biased to operate in its breakdown region at a specified current based on the maximum-rated power.

2.2.5 regulator [Zener] current at specified test point, dc (I_{ZT}): The dc reverse current through the diode when it is biased to operate in its breakdown region at a specified current between I_{ZK} and I_{ZM} for the purpose of specifying V_Z and Z_{ZT} .

2.2.6 regulator [Zener] current near breakdown knee, rms component (I_{zk}): A specified rms current for measuring regulator impedance.

NOTE According to JEDEC registration formats, this current should not exceed 10% of the simultaneously applied dc current I_{ZK} .