

VIDEO#31: Electronic Basics #31:Schottky Diode & Zener Diode

Understanding Schottky and Zener Diodes

Introduction to Diodes

A common diode is a crucial electrical component used in circuits. When a positive voltage is applied to its anode and a negative voltage to its cathode, it allows current to flow, creating a characteristic forward voltage drop. This property is always listed in the datasheet. However, if the voltage polarity is reversed, no current flows through the diode, making it ideal for reverse voltage protection and AC-to-DC rectification.

Apart from regular diodes, two other popular types are Schottky diodes and Zener diodes. These diodes serve unique purposes and have different characteristics. This lecture explores their differences and their practical applications in circuits.

Schottky Diode

Characteristics and Symbol

The Schottky diode has a unique symbol and is known for its small conduction losses. A common example is the 1N5819 Schottky diode.



Low Forward Voltage Drop

A key advantage of the Schottky diode is its low forward voltage drop. For instance, a standard 1N4007 diode with a 1A current creates a voltage drop of 0.87V, leading to a power loss of 0.87W, generating noticeable heat. In contrast, the Schottky diode under the same conditions shows only a 0.45V drop, leading to a power loss of just 0.45W and a temperature of around 50°C.

Fast Switching Speed

Schottky diodes also exhibit extremely fast switching speeds, making them ideal for high-frequency operations. This characteristic is crucial for circuits that require rapid transitions between states.

Schottky Diodes in Boost Converters

Working Principle

A boost converter is a circuit that steps up a low DC voltage to a higher DC voltage. It consists of an inductor, a MOSFET, a diode, and a capacitor. The inductor stores energy when the MOSFET is closed and releases it when the MOSFET is open, generating a higher voltage at the output.

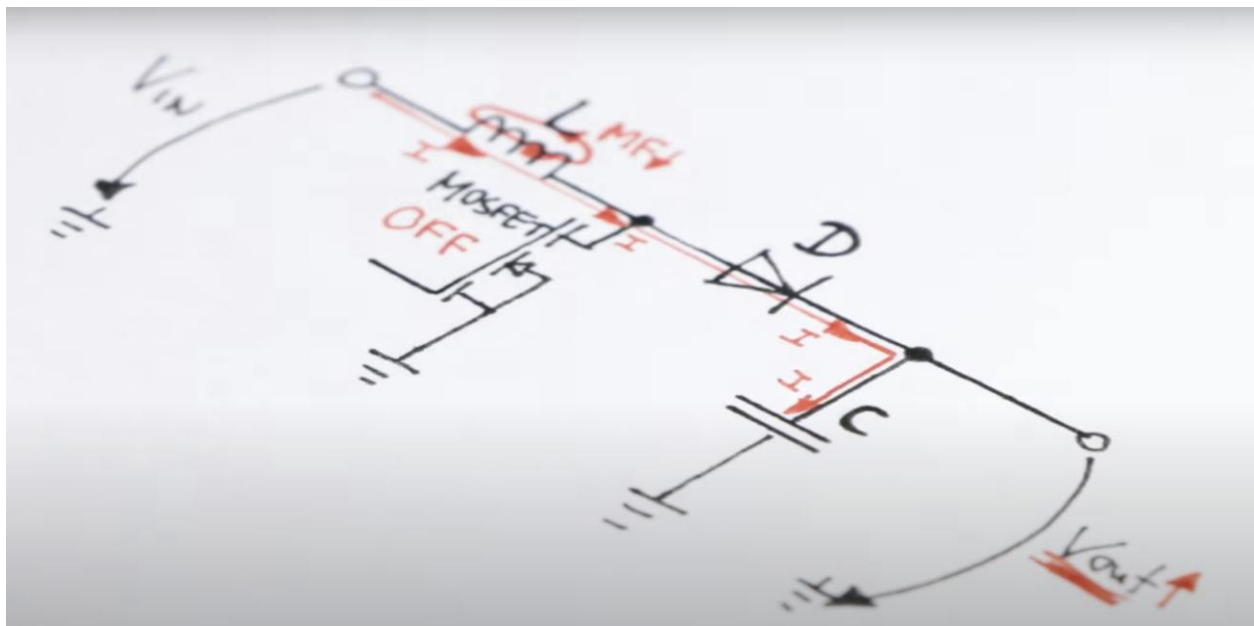


Fig: Schottky Diodes in Boost Converters

High-Frequency Performance

A regular diode works well for rectification at low frequencies but begins conducting during the negative half-cycle at around 5 kHz, which is undesirable in switch-mode power supplies. Schottky diodes, however, can rectify efficiently up to 100 kHz and beyond, making them essential for circuits operating at high frequencies (e.g., a boost converter running at 1.2 MHz).

Limitations

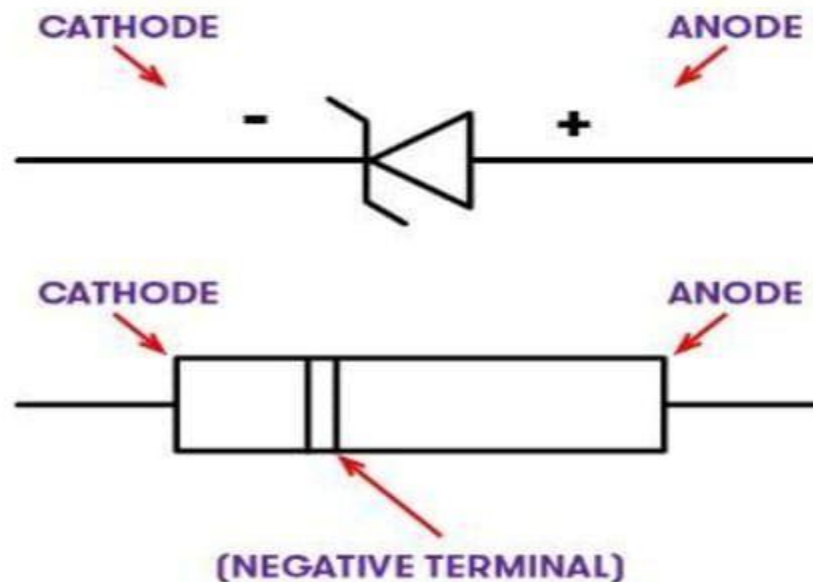
Despite their advantages, Schottky diodes have two notable drawbacks:

1. Their blocking voltage is relatively low compared to standard diodes.
2. Their reverse leakage current can be significantly higher, which may affect circuit performance.

Zener Diode

Characteristics and Symbol

The Zener diode, also known as the 'Z' diode, has a distinctive circuit symbol. It functions like a standard diode when forward-biased but is primarily used in reverse-bias mode.



Reverse Bias Operation

When connected in reverse bias (with a positive voltage on the cathode and a negative voltage on the anode) through a series resistor, the Zener diode starts conducting once the applied voltage exceeds its Zener voltage. This results in a nearly constant voltage drop equal to the Zener voltage.

Voltage Regulation and Reference

Zener diodes are widely used for voltage regulation and voltage reference applications. For instance, a 5.1V Zener diode with a 1kΩ series resistor regulates voltage effectively when the applied voltage is above 5.1V.

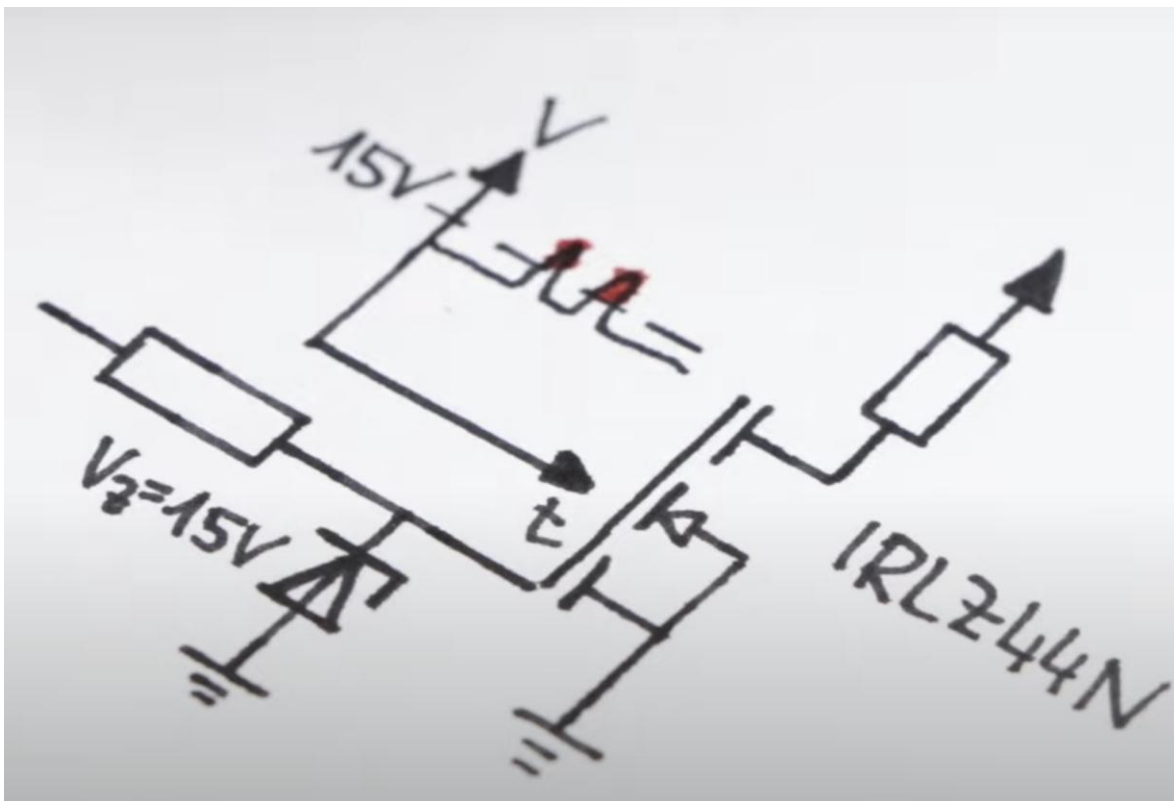
Example Calculation

- The Zener diode has a voltage drop of 5.1V and can handle 500mW.
- Maximum current = $500\text{mW} / 5.1\text{V} = 98\text{mA}$.
- Series resistor = $(\text{Input voltage} - \text{Zener voltage}) / \text{Maximum current}$.
- Choosing a 100Ω resistor allows the circuit to supply up to 69mA to the load.
- If the load demands more current, the voltage regulation will fail.

Clipping and Protection

Zener diodes are also used for voltage clipping and protection circuits. For instance:

1. **MOSFET Gate Protection:** A 15V Zener diode connected to a MOSFET gate protects it from exceeding its maximum gate-to-drain voltage (16V), preventing damage.



2. **AC Signal Clipping:** Two Zener diodes in series can clip both positive and negative peaks of an AC signal to predefined voltage levels.

Regular diodes are fundamental components in electronics, but Schottky and Zener diodes have specific advantages that make them essential in many applications.

- **Schottky diodes** offer low forward voltage drop and high-speed switching, making them ideal for power efficiency and high-frequency circuits like boost converters.
- **Zener diodes** are used primarily for voltage regulation, reference, and protection against overvoltage.

Understanding these diodes and their appropriate applications enhances circuit design and efficiency in modern electronics.