

The principle of optocoupler in voltage regulation of switching power supplies

Article Overview

Optocouplers in SMPS provide isolated feedback by converting output voltage deviations into optical signals that control the primary-side switching, ensuring stable voltage regulation.

Role of Optocouplers in SMPS

In a switching power supply, the output voltage must be regulated despite variations in input voltage or load. Optocouplers serve as isolated bridges between the secondary (output) side and the primary (input) side, transmitting feedback signals without direct electrical connection, thus maintaining galvanic isolation and protecting low-voltage circuits from high-voltage hazards .

Operational Principle

An optocoupler consists of a light-emitting diode (LED) on the secondary side and a phototransistor on the primary side. The LED is driven by a shunt regulator or error amplifier that monitors the output voltage. When the output voltage deviates from the setpoint, the shunt regulator adjusts the LED current (I_F), modulating the light intensity . The phototransistor detects this light and converts it into a corresponding electrical signal on the primary side. This signal is fed to the PWM controller's compensation input, which adjusts the duty cycle of the switching transistor, forming a closed-loop feedback system that stabilizes the output voltage .

Key Parameters

- o Current Transfer Ratio (CTR): Defines the ratio of phototransistor output current to LED input current. Proper CTR selection ensures linear and accurate feedback .
- o Biasing: Correct forward current through the LED and collector-emitter voltage of the phototransistor is critical. Improper biasing can cause nonlinearity, saturation, or sluggish response, leading to poor regulation or instability .
- o Compensation Network: The feedback loop often includes a compensator to stabilize the system and shape transient response. Optocoupler parameters, such as CTR and parasitic capacitance, influence the compensator design .

Advantages

- o Provides high-voltage isolation (up to several kV) in a compact package.
- o Reduces noise coupling between primary and secondary circuits.
- o Enables precise voltage regulation in isolated SMPS architectures.

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Summary

In essence, the optocoupler acts as a linear, isolated transducer that converts output voltage variations into optical signals, which are then converted back into electrical signals to control the primary-side switching. This mechanism ensures stable, isolated, and accurate voltage regulation in switching power supplies while maintaining safety and compliance with insulation standards .

Primary side regulation is often chosen when poor / little output regulation is required, as it saves the expense of the

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In devices such as switching power supplies, microprocessor I/O interfaces, and battery management systems,

The main purpose of an optocoupler interface is to completely isolate the input circuit from the output circuit, which normally means

For example, in switching power supplies, optocouplers (e.g., PC817) are often paired with voltage references (e.g., TL431) to

The main function of optocouplers in switching power supplies is to isolate, provide feedback signals, and act as

Abstract This article explains the basic concepts of linear regulators and switching mode power supplies (SMPS). It is aimed at

Power Supply Feedback: In switch-mode power supplies (SMPS), optocouplers like the PC817 provide feedback

Normally they are use on switching power supply to send back to the main switching transistor the turn on and turn off

In an isolated SMPS (Switched-Mode Power Supply), the optocoupler acts as a bridge between the secondary-side

In a switch-mode power supply (SMPS), an optocoupler provides a feedback path from the high-voltage secondary

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Designing Optocoupler Interfaces The main purpose of an optocoupler interface is to completely isolate the input circuit from the

The major cause of the inefficiency of a linear regulator is that its pass transistor operates in the linear region. This

Photo-SCR Optocoupler These optocouplers are designed for high-power applications. In these devices, the light

Have you ever heard the word isolation, especially in electronics? As you might guess, isolation is a key factor when

Optocouplers provide a mechanically-robust isolation barrier with very high voltage ratings (e.g. 5 kV) in a small package size,

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