



Internal overvoltage protection (OVP) in DIN rail power supplies

What you need to know to protect your critical devices

Learn more about

- The importance of internal overvoltage protection (OVP) in critical applications
- The basics of circuit activation
- How to enhance the reliability in an existing or new application

Introduction

Critical applications demand a high level of reliability to protect field devices and personnel. Regardless of the industry, processes and systems must be designed with secure and dependable devices to avoid costly, unexpected downtime or even a catastrophic event.

Designing a reliable application begins with a high-quality DIN rail power supply delivering a stable DC voltage to the DC-powered field devices.

To help alleviate a detrimental voltage spike, standard DIN rail power supplies are manufactured with an internal overvoltage protection (OVP) circuitry integrated on the device’s output. The OVP is a critical asset in maintaining a reliable output voltage, but the circuit is commonly misunderstood. In reality, the OVP’s activation voltage level may be too high for the devices within an application. It is important to understand an OVP activation, as it can damage devices on the DC bus. While a redundant system will control a voltage loss, this design will not stabilize an unintentional rise in output voltage, which can damage an application. The key to a reliable system is knowing the voltage tolerance of each field device, while also understanding the behavior of the power supply’s output.

Therefore, it is critical to understand:

- The function of the OVP
- Why the circuit activates
- How the circuit affects the output voltage and field devices
- How to determine when the circuit has been activated and
- How to enhance the reliability in an existing or new application

The primary function of the OVP

It is a common misconception that a DIN rail power supply’s OVP protects the power supply from reverse-feed overvoltage or even transients. In fact, the OVP is a feature on the power supply’s output that prevents a detrimental output voltage from instantly destroying the field devices on the DC bus.

The regulation circuitry controls the precision of the 24 V DC output. However, due to safety extra-low voltage (SELV) requirements, if a fault occurs in the regulation circuit, the output voltage can rise to 60 V DC, causing immediate failure of 24 V DC field devices on the DC bus. To lower the risk of damage to connected devices, a traditional DIN rail power supply’s OVP circuitry recognizes the failed regulation circuitry and limits the rising voltage. ■

Contents

OVP activation	3
The effects of OVP on field devices on the DC bus	3
Activation of OVP in a redundant system	3
Identifying an activated OVP	4
Enhancing reliability in an existing application	4
The ideal solution for new applications	4
Conclusion	5

OVP activation

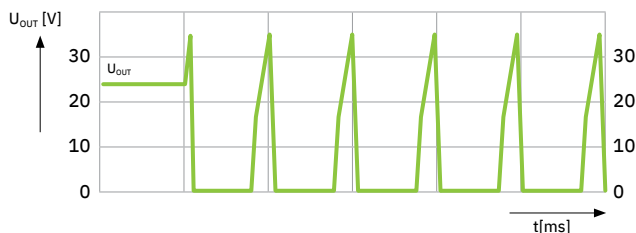
In standard DIN rail power supplies, the OVP activates when a rise in output voltage is detected due to a fault in the regulation circuitry. The OVP typically limits the output voltage to 32 – 35 V DC. However, 32 V DC is still too high of a voltage for most field devices. Sensitive devices such as distributed control systems (DCS), sensors, HMIs, and PLCs are particularly susceptible to damage and can fail when the voltage rises to the OVP level.

Once the OVP has activated, the OVP's control circuit will interrupt the energy transmission and force the output voltage to as low as 0 V to avoid damaging the devices on the DC bus. After a short period of time, depending on the load, the energy interruption is released, and the output voltage ascends to determine if the fault in the regulation circuit is still present. The duration of the energy interruption is contingent on the speed of the DIN rail power supply's internal controller and the percentage of current being drawn from the DC load. The lower the DC load percentage, the shorter the energy interruption.

Typically, when an anomaly occurs in the regulation circuitry, the circuit is permanently damaged. Therefore, the OVP will again limit the output voltage to the OVP level. The voltage will continue to fluctuate between the OVP level and 0VDC indefinitely. This fluctuation creates a sawtooth waveform on the output voltage. See Figure 1. If the DIN rail power supply is generating little to no load on the output, the output voltage will simply remain at the static OVP level.

Common DIN rail power supply

Figure 1



The effects of OVP on field devices on the DC bus

Although the OVP protects the DC bus from a perilous amplification in voltage, the limited OVP output voltage can still damage field devices and cause devices to fail. The high OVP level voltage and relentless rise and fall of voltage cause both the power supply and field devices on the DC bus to operate at a higher temperature. This will significantly shorten the electrical lifetime of both the power supply and field devices.

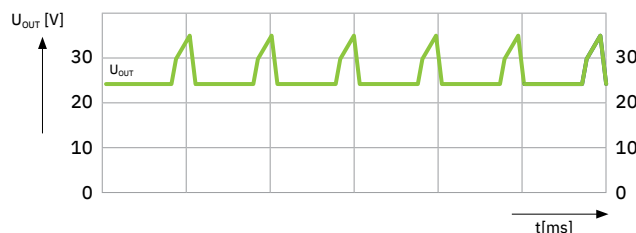
Activation of OVP in a redundant system

A redundant application comprises at least two DIN rail power supplies operating in parallel while decoupled by a diode module. When using a MOSFET-based diode with monitoring and current balancing capabilities, two DIN rail power supplies will equally distribute a stable 24 V DC to field devices.

If a regulation circuit failure occurs in either one of the two standard power supplies in redundancy, the affected power supply's OVP will activate and output 32 – 35 V DC. Similar to a standalone power supply, in a redundant configuration, the affected power supply's OVP control circuit interrupts the energy transmission, subduing the output voltage to 0 V. However, due to the supplementary power supply providing a stable 24 V DC, the field devices will see the output voltage pendulate between the OVP level and 24 V DC. See Figure 2.

Output voltage to the field devices in a redundant application

Figure 2



This voltage oscillation stresses the redundant power supplies and the field devices on the DC bus. Therefore, devices will operate at an elevated temperature. Consequently, the entire application is susceptible to damage and premature failure due to heat. ■

Identifying an activated OVP

When the OVP activates, the standard DIN rail power supply and the field devices on the DC bus begin to increase in temperature. The devices may become hot to touch. The temperature increase is a prime indicator that normal activity has been interrupted.

The proactive approach to maintaining a reliable application is to continuously monitor the output voltage of the DIN rail power supply and field devices. Monitoring equipment such as a voltage transducer, monitoring relay, or energy meter can be implemented to identify voltage anomalies. Advanced DIN rail power supplies are capable of using an analog output to monitor the output in real time. These intelligent DIN rail power supplies can also produce a digital output signal when the OVP has been activated.

Reactively, when an OVP activation is suspected, a digital voltage meter can be used to investigate the output voltage of the power supply. With the load connected, the voltage meter will measure a value between the OVP level and 0 V. This value will vary depending on the amount of load being drawn. If the load is disconnected, the voltage meter will detect the OVP level voltage.

Enhancing reliability in an existing application

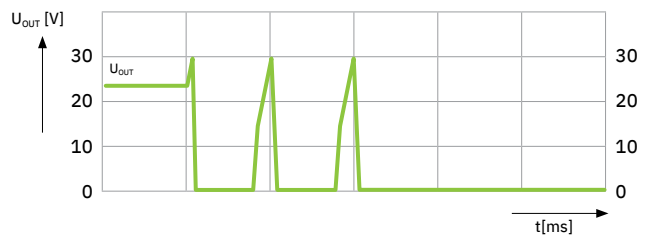
An existing application powered by a DIN rail power supply with a standard OVP can easily be enhanced to prevent a significant fault on the DC bus caused by a rise in voltage. Upgrading your system to include a single-channel, MOSFET-based redundancy module with an integrated voltage-limiting OVP will increase the reliability of an application.

In contrast to a traditional power supply's OVP, the single-channel redundancy module's OVP restricts the output voltage to 30 V DC in the event of a failure in power supply's regulation circuitry. This limits the output to a more tolerable voltage and diminishes the probability of a destructive incident.

The single-channel redundancy module's OVP will crowbar the output voltage down to 0 V before allowing the voltage to rise and recognize the regulation circuitry has failed. Following three attempts to revive the regulation circuitry, the single-channel redundancy module's OVP securely shuts off its output. See Figure 3. Subsequently, the energy transmission of the connected DIN rail power supply will be interrupted, causing a loss of output voltage.

Single channel redundancy module

Figure 3



In a redundant application, when the single-channel redundancy module shuts off the one side, the parallel power supply securely supplies the field devices on the DC bus with a stable 24 V DC.

Securely shutting off the output of the redundancy module and DIN rail power supply eliminates the threat of an overvoltage damaging or potentially causing failure of the devices on the DC bus. Furthermore, the application's reliability increases as the risk of hazards decreases.

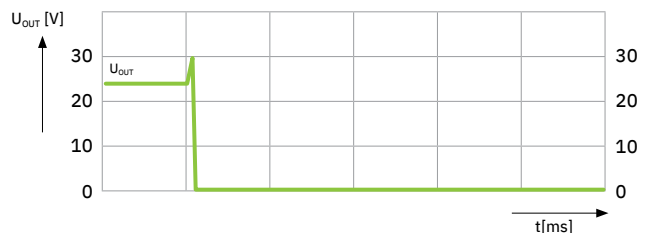
The ideal solution for new applications

When designing a new application, the ideal DIN rail power supply eliminates the potential generation of a repeating high output voltage on the DC bus.

In the event of a failure in the regulation circuitry, this DIN rail power supply's OVP will acknowledge the rise in voltage and limit the voltage to 30 V DC. Unlike any other DIN rail power supply on the market, when the OVP is activated, this power supply securely shuts off the output by interrupting the flow of energy to the output. Furthermore, this alleviates any output voltage fluctuation that could damage the DC bus. See Figure 4.

Ideal DIN rail power supply

Figure 4



The ideal DIN rail power supply features a redundant OVP to enhance the reliability of the application. The supplementary OVP certifies the DIN rail power supply with a Safety Integrity Level (SIL) 3 rating recognized by TÜV. This power supply is also approved for applications requiring ATEX, IECEx, and Class I, Division 2. The

continued →

The ideal solution for new applications **continued** →

conformally coated power supply also has an integrated decoupling MOSFET, eliminating the need for an external redundancy module.

When paralleled in a redundant system, the activation of one ideal DIN rail power supply's OVP will not influence the voltage of the load. The adjacent power supply remains unaffected and will continue to operate the application without interruption.

Conclusion

Regardless of the critical nature of an application, the protection of personnel and field devices must be of the utmost importance. To determine the level of quality and reliability of an application, designers must initially understand the component performance within the DIN

rail power supply. During this evaluation, the primary function of a DIN rail power supply's OVP is frequently misunderstood or neglected.

Although a common DIN rail power supply's OVP does limit an unanticipated rise of output voltage, designers must acknowledge that the impact of a constant voltage instability will lead to the crippling of field devices on the DC bus. This can lead to dangerous and unreliable conditions. A precarious output voltage on the DC bus can prompt unexpected downtimes and a potential hazard for personnel.

Precautions should be taken to alleviate potential risks. Using a DIN rail power supply designed with redundant secure shut-off OVPs will ultimately protect critical applications. This solution can prevent unanticipated voltage fluctuations while the system is in operation. The end result is a safer and more reliable system. ■

About Phoenix Contact

Phoenix Contact is a global market leader based in Germany. Since 1923, Phoenix Contact has created products to connect, distribute, and control power and data flows. Our products are found in nearly all industrial settings, but we have a strong focus on the energy, infrastructure, process, factory automation, and e-mobility markets. Sustainability and responsibility guide every action we take, and we're proud to work with our customers to empower a smart and sustainable world for future generations. Our global network includes 22,000 employees in 100+ countries. Phoenix Contact USA has headquarters near Harrisburg, Pa., and employs more than 1,100 people across the U.S.

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