whitepaper

BACKFEED PROTECTION IN UPS SYSTEMS

INTRODUCTION

Backfeed protection is an essential safety mechanism against dangerous electric shocks and arc flashes.

As a cost-cutting measure, however, some uninterruptible power supply manufacturers no longer incorporate complete internal backfeed protection devices as standard on some of their models. They pass the ultimate responsibility onto the electrical installer or contractor.

This whitepaper explores the safety standards that UPS installations must comply with and outlines the different ways of ensuring adequate backfeed protection is in place.

WHAT IS ELECTRICAL BACKFEED?

Backfeeding refers to the flow of electricity in the reverse direction to its usual flow of power.

In relation to uninterruptible power supplies (UPS), protection against backfeeding is a vital safety consideration. It safeguards users and service engineers from potentially lethal electric shocks due to current feedback from the UPS's output.

Whenever there's a mains supply failure or fault within the UPS system, current can start feeding back from the UPS to isolated circuits. For example, if a bypass supply thyristor short-circuits, the output from the inverter could pass through to the input terminals via the faulty component.

Without the necessary backfeed protection, this would be extremely dangerous to anyone handling that circuit.

However, with robust backfeed protection in place, a service engineer can safely work on the incoming supply side of the UPS without the risk of experiencing an electric shock from any current backfeed from the output.

BACKFEED PROTECTION SAFETY STANDARDS

Backfeed protection is a requirement as outlined in the quality standard ***EN 62040-1:2008 Uninterruptible Power Systems (UPS): General and Safety Requirements for UPS***.

It states that when the input supply fails, the backfeed protection device must be capable of preventing hazardous voltage or energy from being present on the UPS input AC terminals.

No shock hazard should be present at the input terminals when measured one second after de-energisation for pluggable UPS or 15 seconds for permanent, hardwired installations.

The EN standard outlines two locations where backfeed protection devices can be installed on a UPS:

- Installing an internal backfeed isolation device inside the UPS itself
- Installing an external input line isolation device, for example, a magnetic contactor or circuit breaker with UVR (undervoltage release) functionality – note that this option is only applicable for hardwired UPS, not pluggable solutions.

INTERNAL BACKFEED PROTECTION DEVICES

The type of backfeed device depends on the size and type of the UPS system:

- **Plug And Play UPS Systems**

For single-phase UPS systems with an input rating of up to 16A, the internal backfeed protection device needs to ensure a complete disconnection of the live and neutral input conductors using a specified air gap. Typically, this air gap comes in the form of a relay which opens in the event of a mains supply failure.

If a fault occurs inside the UPS when the user disconnects from the mains power (i.e. pulling the plug out from the wall socket), the backfeed relays prevent the exposed pins from becoming “live” and eliminate the possibility of the user receiving an electric shock.

- **Hardwired UPS Systems**

Larger UPS systems (i.e. input above 16A) tend to fall under one of two approaches:

1. Mechanical Backfeed Protection Device

This is similar to the relay or contactor-based solution as described above for plug-in UPS. Once again, there’s a safety air gap that opens when the mains supply fails or disconnects. The phase conductors disconnect, although the neutral continues to remain connected. Note that such a device can also be installed externally with a hardwired UPS too.

2. Electronic Backfeed Protection Device

Many hardwired UPS systems incorporate a backfeed current detection system, which continually monitors the current flowing through the bypass supply. The UPS automatically detects any faults that occur in the bypass thyristors and immediately shuts down the inverter.

How do the different approaches impact on operation and business continuity?

Mechanical Backfeed Protection Device only: if the UPS is operating in online mode and the mains supply is available, if the UPS detects any energy backfeed it can simply open the backfeed device, thus ensuring the inverter continues to protect the connected load.

In addition, if the UPS is operating from battery when any energy backfeed is detected, the backfeed protection device opens and there's nowhere for that energy to flow, enabling the UPS to continue operating as normal.

Electronic Backfeed Protection Device only: if the UPS is operating in online mode and the mains supply is available, the UPS must transfer to bypass if it detects any energy backfeed, which means that the load is no longer protected.

If the UPS is operating from battery when energy backfeed is detected, the UPS inverter must shut down, so the supply to the protected load is switched off.

Regardless of which of the two methods are used, all hardwired UPS should be supplied with a **"Risk of Voltage Backfeed"** warning label that must be fitted to all isolators installed within the electrical system upstream of the UPS.

EXTERNAL BACKFEED ISOLATION DEVICES

If using an external backfeed protection device on the input line such as a motor-operated circuit breaker or magnetic connector, clear warning labels stating **"Hazard Of Electric Shock, Explosion, Or Arc Flash"** – or similar – must be displayed on all switchgear access points and every switching device between the UPS and the external isolator.

Relying on external backfeed protection can also impact the UPS's supply configuration. For example, it could make it necessary to have a dual input with separate supplies for the rectifier and bypass, rather than a single feed.

The isolation device would also need either the same or similar components to the UPS within the switchgear to control the switching according to the mains power status. This could add hidden costs to the overall UPS system.

WHAT IS EN 62040-1?

BS EN IEC 62040-1:2019 Uninterruptible Power Systems (UPS): General and Safety Requirements for UPS is an internationally-recognised quality standard developed by the International Electrotechnical Commission (IEC).

It relates to UPS systems with an electrical energy storage device in the DC link and applies to UPS that are used in low-voltage distribution systems, whether they be moveable, stationary, fixed or for building-in.

The standard specifies the requirements to ensure the safety of any operator or other person who may come into contact with the equipment.

It covers a broad range of topics, including design considerations, wiring, connections and supply, general test conditions, physical and electrical requirements, and battery location.

IMPACT ON FAULT TOLERANCE

While the ultimate purpose of backfeed protection is to prevent hazardous voltages upstream, it also often has a secondary role in enhancing system resilience.

In practice, the backfeed protection device isolates the UPS's output from the incoming supplies. This means it can also safeguard against any faults within the static switch.

Usually, when a static switch develops a fault that puts it into an unwanted conductive state, power is fed between the UPS output and its supply. Such an unexpected current flow could cause an overload.

However, the UPS can detect this current and then open the internal backfeed device to isolate the fault. This eliminates a single point of failure from the system and enables the UPS system to remain online protecting the critical load.

SUMMARY

Some UPS models, including all Riello UPS solutions, incorporate internal backfeed protection as standard.

However, in an effort to reduce costs, many manufacturers now don't include such protection. Instead, electrical installers and contractors are left to ensure the UPS complies with EN 62040 by fitting the necessary backfeed protection themselves.

Before purchasing and commissioning any new UPS system, it is important to clarify whether any specific backfeed protection devices will need installing.

Opting for a UPS with ready-installed and fully-tested internal backfeed protection is the only way to guarantee that all safety considerations are met.

Ultimately, this approach is far safer than having to rely on the installer or electrical contractor, who may not have the necessary in-depth and product-specific knowledge.

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