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Safe energy supply in electrified vehicles

Electrification in flux: challenges faced by commercial vehicle energy supplies

The rapid increase in the popularity of electrified commercial vehicles must not come at the cost of electrical safety and, most importantly, personal safety. Learn more about how Bucher Hydraulics is meeting these challenges with innovative solutions and helping to facilitate an energy supply for commercial vehicles that is safer than the one we use in our own bathrooms.

With electrification of commercial vehicles increasing in popularity and the introduction of permanent ePTOs (electric power take-offs) and even electrical outlets, the way in which we use mobile work equipment is undergoing a fundamental change. These developments demand innovative solutions from vehicle manufacturers – solutions that can guarantee a reliable and safe energy supply. This kind of energy supply needs to not only prevent electrical accidents from occurring, but must also ensure that there is no negative impact on vehicle handling as a result of additional electrical systems.

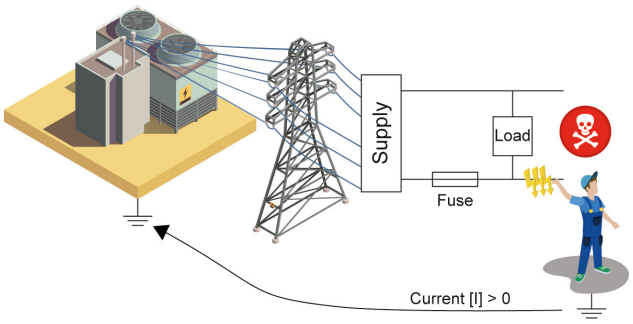
This professional article looks at why traditional safety solutions from stationary applications cannot, in many cases, be simply transferred to mobile environments, and presents new approaches that offer improved protection, often going beyond what common standards in other areas, such as our bathrooms, provide.

Hazards in stationary and insulated power grids

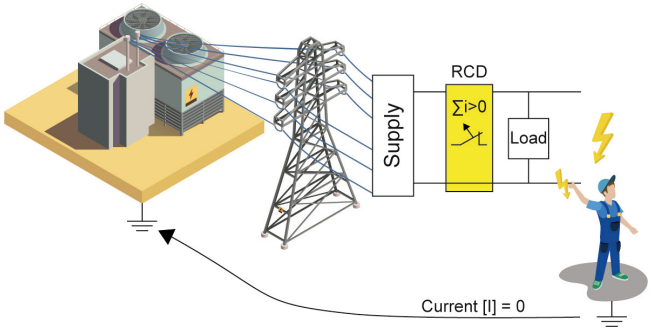
A core element of electrical safety is equipotential bonding, which prevents hazardous differences in voltage and minimizes the risk of electric shock. In conventional buildings, the neutral conductor (N) and all conductive parts with a risk of contact are connected to ground. In the event of a malfunction, the leakage current is conveyed to ground and, in the event of an overload, the fuse is tripped.

In some cases though, the ground connection of the supply grid can lead to unintentional current flow if someone comes into contact with a live conductor – perhaps one that is exposed by a defective cover. This passage of current through the body can cause serious injury, even fatal injury.

To minimize these kinds of risks, fault-current circuit breakers are used in grounded stationary systems to permanently monitor the flow of current through individual conductors. They interrupt the supply immediately if they detect an imbalance indicating a discharge as a result of contact with the human body, thereby offering effective protection against injury.

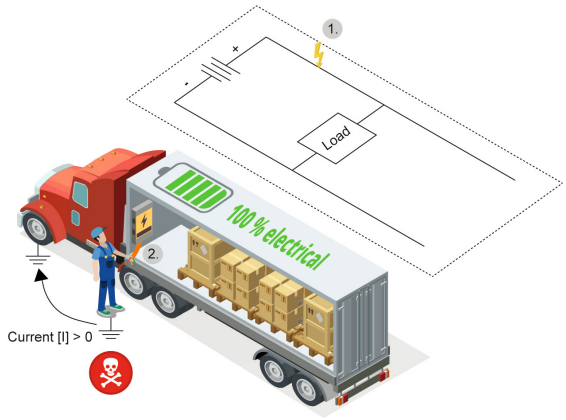


Stationary grids have high risk potential, even with fuses installed.

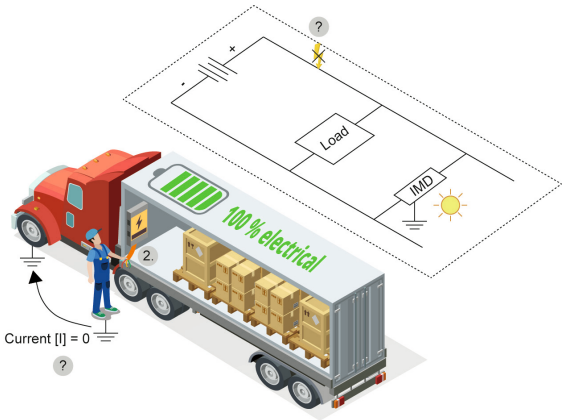


Fault-current circuit breakers minimize the risk in stationary grids.

In contrast, energy grids in vehicles have all-pole insulation and are not grounded. This means that contact with live parts will not cause power to be transferred to the vehicle chassis or to the ground. This method of insulation reduces the risk of electric shock considerably, although faults in the insulation will not be reliably detected by the current limiting fuse and fault-current circuit breaker safety mechanisms. These kinds of insulation faults are not immediately hazardous, but when combined with a secondary fault (such as contact) could lead to critical situations. This elevates the need for advanced monitoring to ensure that insulation problems are detected promptly, and rectified, so that user safety is ensured.



Contact with an open line (secondary fault) has high risk potential in the event of an insulation fault (primary fault) in insulated grids.



Insulation faults in commercial vehicles are reliably detected by “Insulation Monitoring Devices” (IMDs). This component ensures improved safety in electric vehicles.

Insulation Monitoring Devices

Insulation Monitoring Devices (IMD) can handle this monitoring task and are an important component in ensuring electrical safety in electric vehicles. These devices continuously monitor the insulation resistance of the electrical system and ensure that it remains above the minimum values laid down in international standards, such as ISO 6469-3. This helps to prevent hazardous flows through the body in the event of contact with live parts.

Insulation Monitoring Devices are traditionally used in emergency grids with high availability, where shutdown is unwanted and maintenance work can be completed quickly. In electric vehicles, they are classed as “warning devices”, which means that they only emit warnings and do not shut down the high-voltage network automatically, as doing so could cause hazardous fault states. A warning from the IMD can, however, prevent the vehicle from starting in order to ensure prompt rectification of the insulation fault.

It is important to note that additional covers are used over electrical systems in electric vehicles to ensure that live parts cannot be touched while the vehicle is being used, thus minimizing the risk of electric shock. In the event of an accident, e.g., when an airbag is triggered, the high-voltage system is shut down immediately, irrespective of whether an insulation fault was detected. A shutdown of the high-voltage system is the only definitive way to prevent electrical hazards.

With this form of continuous monitoring and preventive measures, IMDs can make an important contribution to electric vehicle safety. They offer protection against electrical malfunctions to both passengers and maintenance personnel and help to ensure reliable operation.

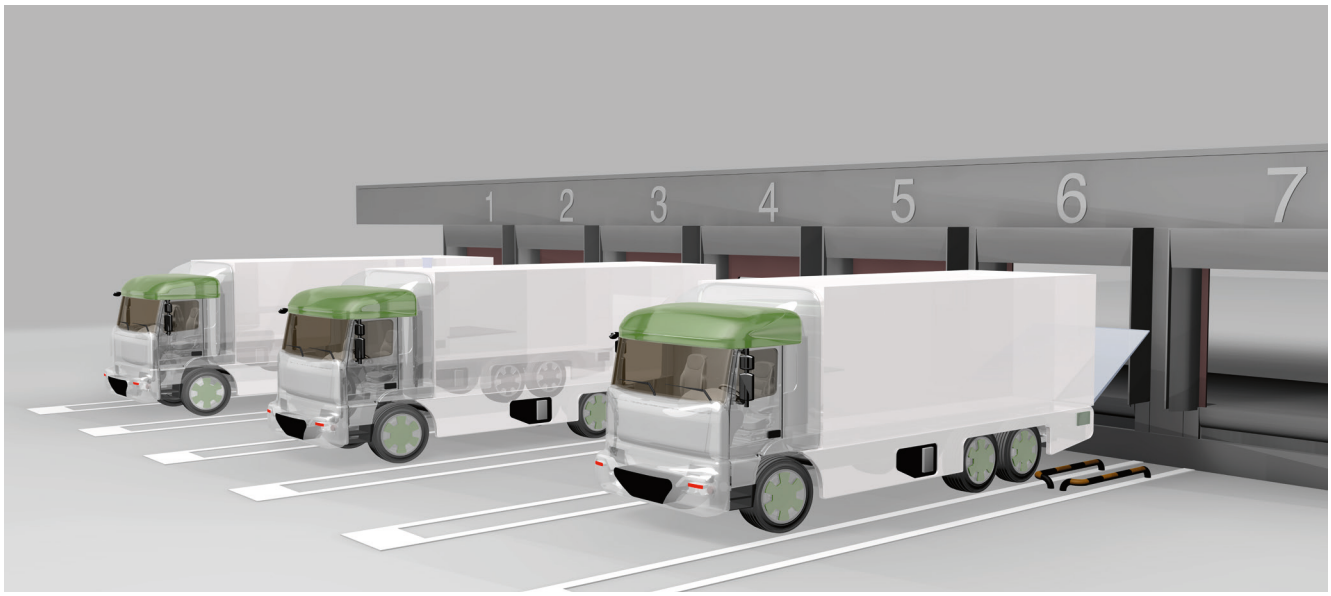
Short-circuit protection in electric vehicles

Modern power electronics in electric vehicles always have highly effective short-circuit protection to protect sensitive semiconductor elements from damage. In contrast to stationary systems where conventional fuses are used to interrupt the flow of power in the event of overload, they are not needed in vehicles. In vehicle electronics, the flow of power is automatically interrupted in milliseconds when a short-circuit is detected, which is a quicker response than that produced by a conventional fuse. This rapid response thus protects the wiring and connected loads, contributing to the reliability and longevity of the vehicle.

Installation of electrical outlets in commercial vehicles

Electrical outlets in commercial vehicles expand their functional capabilities considerably and enable operation of devices such as tools, battery chargers, coolers, heaters, and lighting equipment. In addition, they also allow for use of high-performance compressors, helping to expand vehicle deployability. The installation of electrical outlets in commercial vehicles is subject to certain safety requirements, and in order to minimize risks, especially in the event of access by untrained personnel, sophisticated protective measures are required.

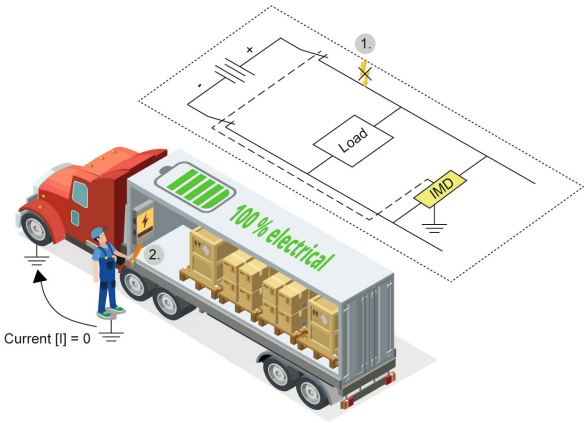
Use of electrical outlets is not determinative when it comes to safe vehicle operation. This means that it is a good idea and essential to shut outlets down whenever a harmless initial fault occurs. This is made possible through the combination of insulation monitoring and automatic shutdown. The IMD thus becomes a “safety device”. The direct load (with the insulation fault) is disconnected from the traction system, thus preventing it from having an impact on vehicle handling. It is essential to prevent a faulty load from leading to unsafe vehicle handling. This kind of situation could, of course, render perishable goods in a refrigerated vehicle unusable if the driver is unable to find a solution to the fault quickly enough.



Safe electrical outlets thanks to Bucher components

Bucher Hydraulics has been working on development of an innovative solution that meets the new requirements. These safe outlets are fitted with high-impedance IMDs that quickly detect insulation faults and interrupt the circuit before hazards can arise.

These advanced safety features mean that the vehicle's traction system remains unaffected by the effects of an insulation or short-circuit fault. At the same time, user safety is also ensured even when multi-outlets without their own fault-current circuit breakers are used. The Bucher Hydraulics approach will help to ensure that outlet solutions are not just functional but extremely safe and will become an essential component of modern-day commercial vehicles.



Electrical outlets from Bucher Hydraulics are fitted with high-impedance Insulation Monitoring Devices and thus ensure a fully safe energy supply in commercial vehicles.

Conclusion / brief summary

The electrification of commercial vehicles is an innovation that not only opens up new opportunities for mobile work equipment but that also comes with new electrical safety requirements. The solutions developed by Bucher Hydraulics, which are equipped with high-impedance Insulation Monitoring Devices for electrical outlets, set new standards in safety technology. These technologies effectively minimize risks and maximize operational safety by providing reliable protection against electrical accidents and preventing impacts on vehicle handling.

With continuous innovation and the pursuit of higher safety standards, Bucher Hydraulics is able to demonstrate that efficiency and safety can be aligned. With this, the company is making a decisive contribution to the efficient and, most importantly, safe electrification of commercial vehicles.

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