

HOW TO REDUCE ELECTRICAL FAILURE IN MINI-SPLIT UNITS



KEY TAKEAWAYS

- Mini-splits' inverter-controlled, variable-speed compressors optimize energy use by adjusting to heating or cooling needs, providing consistent comfort with greater efficiency than traditional systems.
- Electrical failures are common causes of mini-split system malfunction because of these sensitive components.
- The location of the Transient Voltage Surge Suppressor (TVSS) impacts the system's protection against transient overvoltage.

INTRODUCTION

Mini-split systems, also known as ductless systems, have rapidly increased in popularity as a flexible, energy-efficient solution for both heating and cooling. Unlike traditional forced-air HVAC systems, a mini-split system places units in each room to pull in warm air and send it back out as cold air (reversing this process to heat each room). Individual room zoning capabilities and ductless design result in energy savings of up to 60% compared to standard electric radiators. Despite these benefits, users must be aware of the electrical challenges that come with mini-splits to ensure they perform optimally over time.



HOW MINI-SPLIT SYSTEMS OPERATE: **THE BASICS**

Mini-splits are ideal for homes without existing ducts or areas that traditional systems cannot reach. Instead of a central unit connected by long lengths of ductwork, a mini-split system places small units directly in each room. The system consists of two main parts: an outdoor compressor/condenser and an indoor air-handling unit. As warm air from the room blows over the indoor unit's evaporator coils, the coils absorb and transfer that heat to the outdoor unit. The compressor circulates refrigerant to facilitate heat exchange between the indoor and outdoor units.

HOW TRANSIENT OVERVOLTAGE AFFECTS **MINI-SPLIT SYSTEMS**

Modern mini-splits rely on advanced electronics to produce energy-efficient results. An inverter compressor operates in conjunction with a variable frequency drive (VFD) that continuously adjusts the compressor motor speed to match cooling demands. By dynamically adjusting speed, the inverter compressor modulates refrigerant flow and cooling output. The drive communicates cooling requirements to the motor, which adapts accordingly, ensuring precise and efficient cooling performance.

While these components make the system more energy-efficient, they also increase the system's vulnerability to transient overvoltage, as identified by the Department of Energy (DOE). Transient overvoltage—short, high-voltage increases in voltage that can occur due to common, everyday switching operations or other electrical fluctuations—can easily damage or degrade the delicate electronic components inside mini-splits, leading to component failure or complete system breakdown.

Furthermore, mini-splits are often designed for European markets, where systems are built to handle 230VAC with a tolerance up to 253VAC. American systems use 240VAC, putting mini-splits into more harms way when used stateside. This means transient overvoltage doesn't have to rise very high to negatively impact mini-splits. Even minor voltage increases can disrupt their performance, causing malfunctions or permanent damage.

SIGNS OF TRANSIENT OVERVOLTAGE IN MINI-SPLIT SYSTEMS

While mini-split systems are known for their efficiency, they are prone to electrical misoperations and failures caused by transient overvoltage. Electrical issues commonly caused by transient overvoltage may include:

- Compressor Failure
- Capacitor Failure
- Phantom PCB Faults
- PCB Failure
- Communication Errors

Maintaining a stable electrical supply, utilizing TVSS, and performing regular inspections are essential to minimize these risks.



TVSS LOCATION **OPTIONS**

Placing a TVSS in the right location is crucial for mitigating transient overvoltage's impacts on your mini-split system. Many technicians install TVSS at the disconnect located outside the unit. While this placement is more convenient to install and offers protection from external transient overvoltage sources, it does not address internally generated transient events.

VFDs themselves can cause transient overvoltages. When switching any component (like VFDs), a transient response is created, traveling both up and downstream from the source. Installing the TVSS device as close as possible to the condenser unit (where sensitive PCBs reside) addresses these occurrences.

CONCLUSION

Mini-split systems offer a flexible, efficient way to heat and cool your home, but they are susceptible to electrical issues. Due to their sensitive electronics, such as VFDs and inverter-controlled compressors, mini-splits are vulnerable to transient overvoltage. Those who fail to appropriately harden their electrical systems from the damaging effects of transient overvoltage increase the risks of mini-split failures and misoperations.

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