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The Emergency Lighting Experts

WHITEPAPER

E3MINI: SMART MINI INVERTER

Dimming & Control Integration

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INTRODUCTION

Designing an emergency lighting system into a building is an essential, life safety code-mandated piece of the overall lighting system. Unfortunately, traditional solutions for emergency lighting have left a lot to be desired—providing inflexible options that poorly fit the needs of the lighting system and often require extra components and complex wiring exercises to deliver more power to a space than is necessary.

A lighting inverter provides the backup power for a lighting system by converting DC battery power into the standard AC voltages that lights need to operate during an emergency. These components are often distinguished by the battery capacity they offer. The smallest size, often referred to as a micro inverter, converts 25-35W of battery power. Mini inverters feature a battery capacity in the range of 100-350W, while large inverters are often described as having a battery capacity of 350W+.

While there is an appropriate use case for each type of inverter, this whitepaper will focus on the mid-range mini inverters. Recent advancements in the E3MINI smart mini inverter now enables this solution to tailor the outputs and voltages that are delivered to the lighting system in normal and emergency conditions. This enhanced flexibility better satisfies the intent of the life safety code for emergency lighting, while improving the utilization of the battery life and providing more even illumination so that people may exit the building safely during an emergency.

Let's begin with emergency lighting code requirements.

EMERGENCY LIGHTING CODE REQUIREMENTS

The egress lighting design and performance in a building is governed by the National Fire Protection Agency (NFPA) through their NFPA 101: Life Safety Code. While the life safety codebook covers a broad array of topics, the section on egress path lighting can be summarized by the following criteria:

- The average level of illumination must be greater than 1.0 foot-candle (fc) along the entire egress path.
- The minimum level of illumination at any point on the egress path may not be less than 0.1 fc.
- The ratio of the brightest point along the egress path as compared to the darkest point must be less than 40:1.

The performance of the egress system can be summarized by the following requirements:

- The emergency light levels must be active within 10 seconds of an emergency.
- The emergency lighting must stay illuminated for at least 90 minutes.

Keep in mind that NFPA 101 sets a minimum standard; specific jurisdictions may have requirements above and beyond this minimum design and performance level.

It is also important to remember that NFPA 101 mandates that emergency lighting systems must respond to "local" failures of the electrical system, if any of the lights in a space are interrupted via an emergency or circuit breaker tripping, the emergency lighting for that area must illuminate. This has important ramifications for the design of systems, especially when deploying systems based on advanced lighting control architectures like the digital addressable lighting interface (DALI).

Inverters represent a cost effective, modern way to achieve a code-compliant emergency lighting system, but it's important to note that not all inverters are created equal.

NEW ENHANCEMENTS IN MINI INVERTERS

Traditional inverter solutions had some functional limitations that constrained the design of the emergency lighting system and compromised its performance. For example, many traditional inverters only support one zone, or circuit, of light and can only bring the attached lights to full on during an emergency. This single zone, full-on default delivers more light into a space than is required by the code and it minimizes the total number of lighting fixtures that can be powered by each inverter, which meant that more pieces of equipment were necessary to complete the job.

Ideally, an emergency lighting inverter would have more flexibility in the lights it controls and be able to bring more lights on to lower levels, allowing each inverter to use its battery capacity to provide more even illumination over a larger area. New enhancements in the E3MINI smart mini inverter now enable them to do just that.

The E3MINI inverter is now available with multi-purpose outputs and dimming integration. These new features address the shortcomings of the traditional inverters and result in a better emergency lighting solution.

SEVERAL MULTI-PURPOSE OUTPUTS

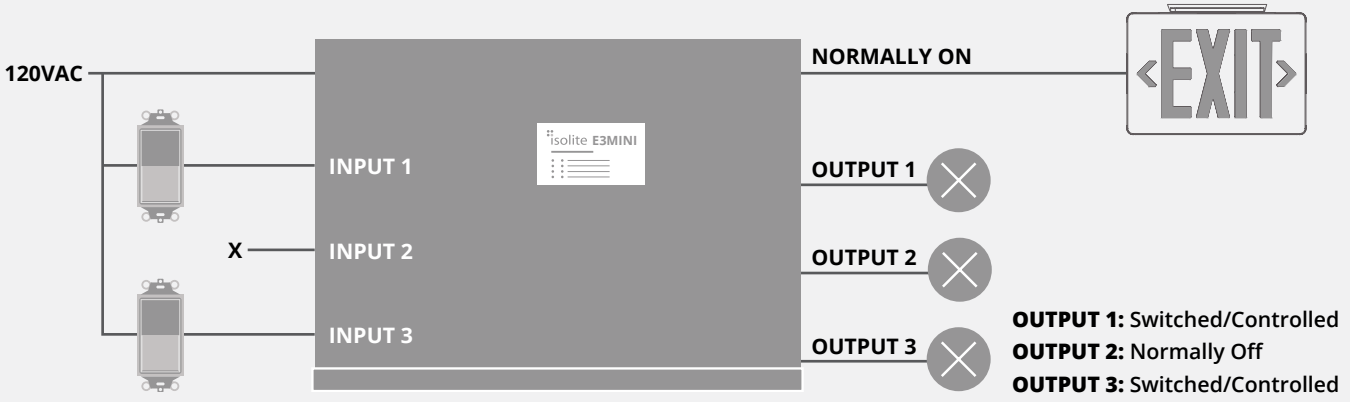
Instead of controlling a single zone of light, the E3MINI inverter can control several and allows designers flexibility in the types of circuits that can be connected.

There are three types of circuits commonly found in a lighting system—normally on, normally off, and a switched/controlled circuit. The normally on circuit powers items like exit signs, night lights that are always on, parking garage lights, and circuits with downstream UL 924 automatic load control relays (ALCRs), which are transfer devices that transition normal lighting fixtures into emergency fixtures when an emergency occurs. Normally off circuits are used for things like dedicated emergency-only fixtures, but they aren't commonly deployed in buildings. Then there are switched/controlled circuits which are zones of light that do not include UL 924 ALCR devices.

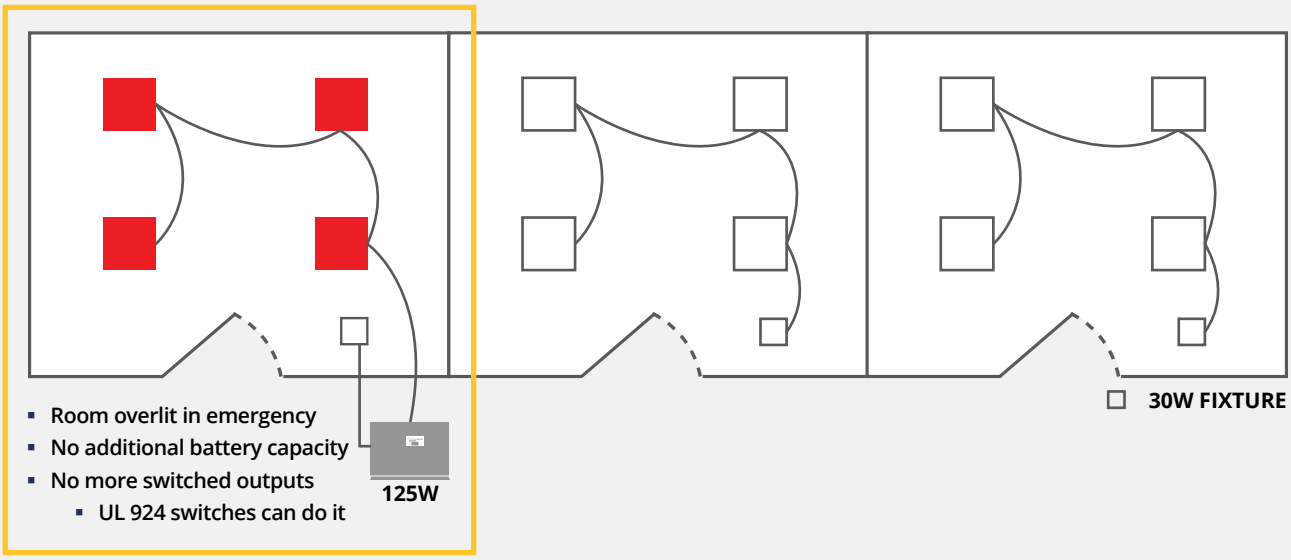
OUTPUT TYPE	EXAMPLE USES
Normally On	Exit Signs Always-On Night Lights Parking Garage Lights Circuits with Downstream UL 924 / ALCR Devices
Normally Off	Dedicated Emergency-Only Fixtures Generator Replacement
Switched / Controlled	Controlled Zones without UL 924 / ALCR Devices

The E3MINI series inverter allows for one normally on output and three configurable outputs which can be mixed and matched between normally off and switched/controlled circuits. This capability provides designers with a lot more flexibility in their emergency lighting layouts and results in better use of the inverter's battery capacity, without requiring additional hardware.

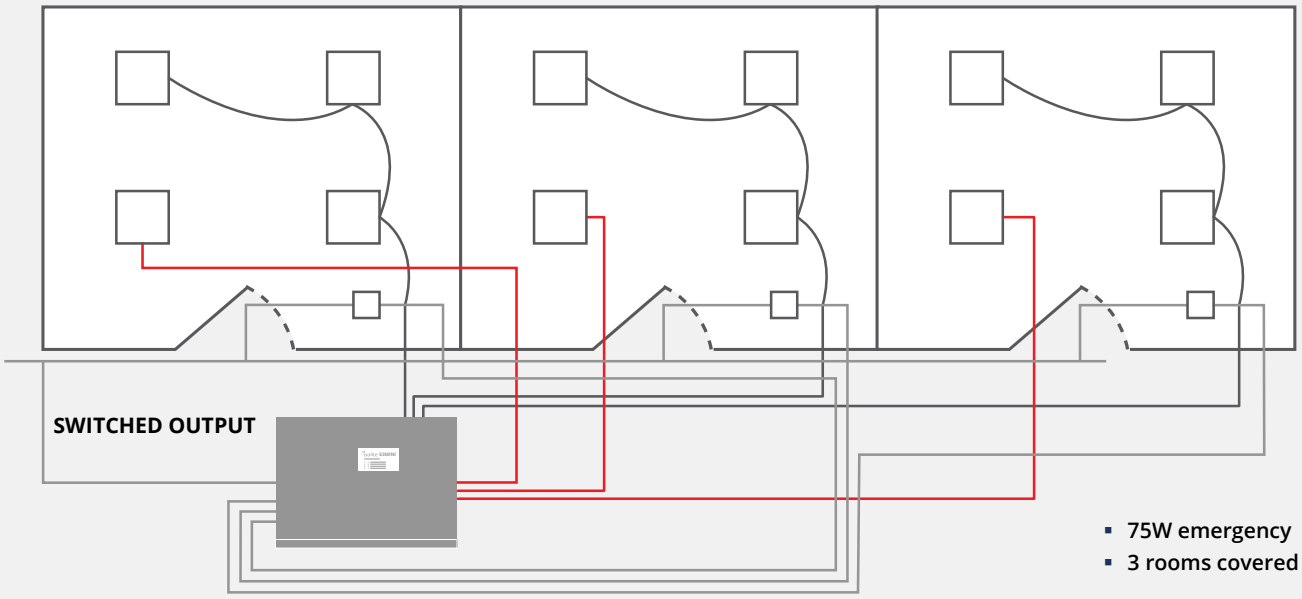
MULTIPURPOSE OUTPUTS



Let's explore a practical application of this technology. Consider a row of offices which have emergency lighting requirements and an inverter with a 125W capacity. An individual office does not require 125W of emergency lighting, that would over-light the space. Using traditional solutions, designers have two options. Option 1 is to deploy all the inverter's capacity in the single room and add more inverters to accommodate additional rooms. This is expensive and provides too much light in the space. Option 2 is to use several UL 924 ALCR transfer devices to share the inverter's power with the additional rooms. This would require additional hardware and more sophisticated wiring.



With its multipurpose outputs, the E3MINI smart inverter can divide its power output into three separate zones of emergency lighting, which all operate independently under normal conditions. The rooms are directly connected to and controlled from the inverter, without additional hardware.



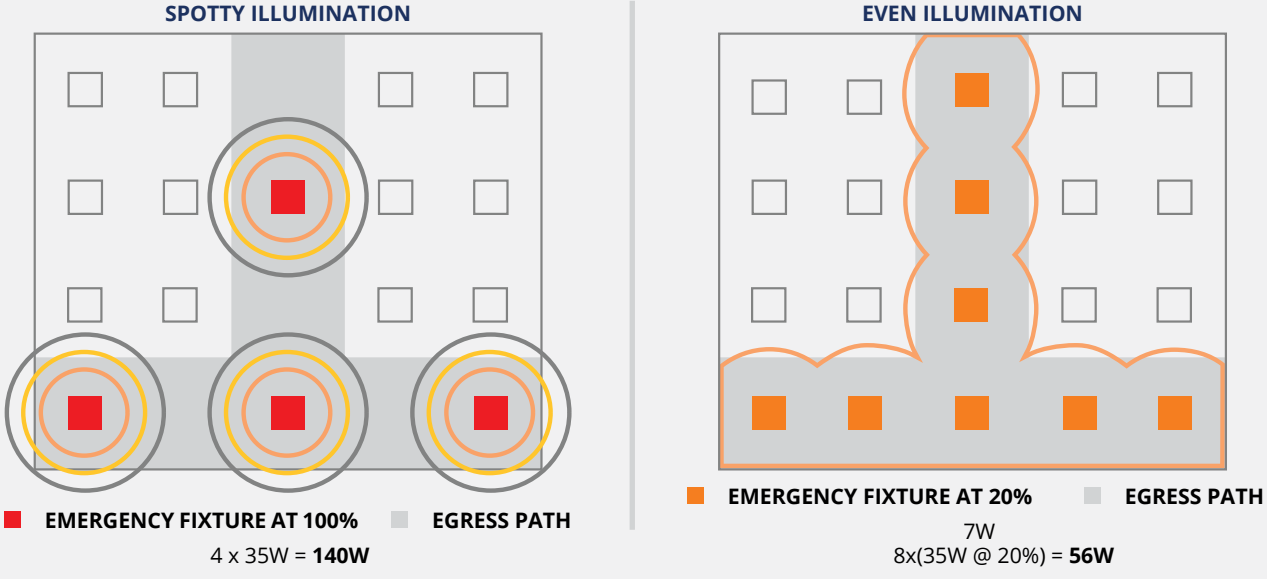
DIMMING INTEGRATION

Another important new feature of the E3MINI inverter is its integration of dimming. As previously mentioned, traditional mini inverters were only able to bring the lights to full on during an emergency. This minimized the number of fixtures that could be controlled on one inverter and potentially caused a code-compliance issue, where the combination of full on and full off fixtures in a space could create spotty illumination with illumination ratios that exceed the 40:1 allowed by the NFPA 101.

The dimming functionality offered by the E3MINI inverter allows the lights to be brought to a lower level than full on during an emergency. This means that the attached load can exceed the inverter's rating during normal operation. When the system is in emergency mode, the architectural controls are overridden and the lights are driven to a lower light level, reducing the emergency load to within the inverter's operational capacity. The ability to dim emergency lights during a response allows one inverter to control more lighting fixtures and delivers more even illumination into a space.

This solution also simplifies wiring and reduces the overall power consumed by the emergency system (allowing this system to be furnished with a 125W inverter instead of a 250W inverter).

MORE ZONES, LESS POWER, MORE COMPLIANT



SYSTEM EXAMPLES: 0-10V & DALI

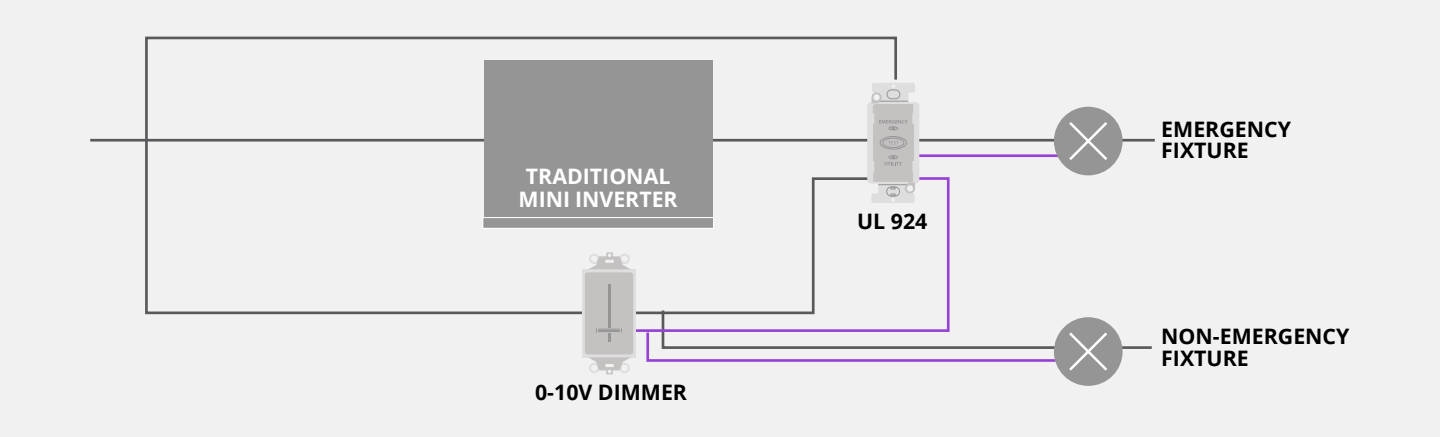
Selecting a mini inverter that offers multiple zones of control as well as dimming integration can solve many of the issues that exist in the market today while reducing the cost and complexity of systems. Let's explore how the E3MINI inverter would actually be used in a few different types of lighting systems.

0-10V DIMMING

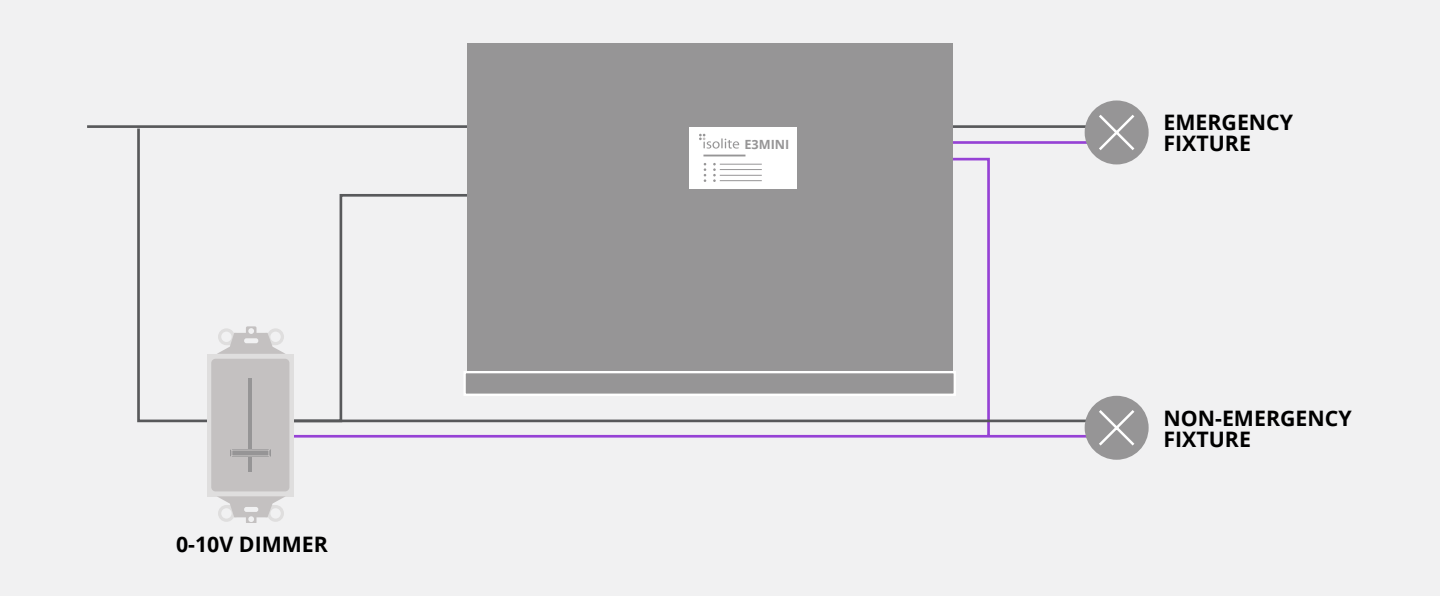
0-10V dimming is a low voltage DC dimming technology that utilizes an additional set of low voltage control wires to communicate the dim level to the lighting fixtures. With this technology, there are four different wires that are run to the fixture. They are:

- Switched 120/277V Hot (Typically Black)
- Neutral (Typically White)
- Low Voltage 0-10V Signal (Typically Purple)
- Low Voltage Common (Typically Grey)

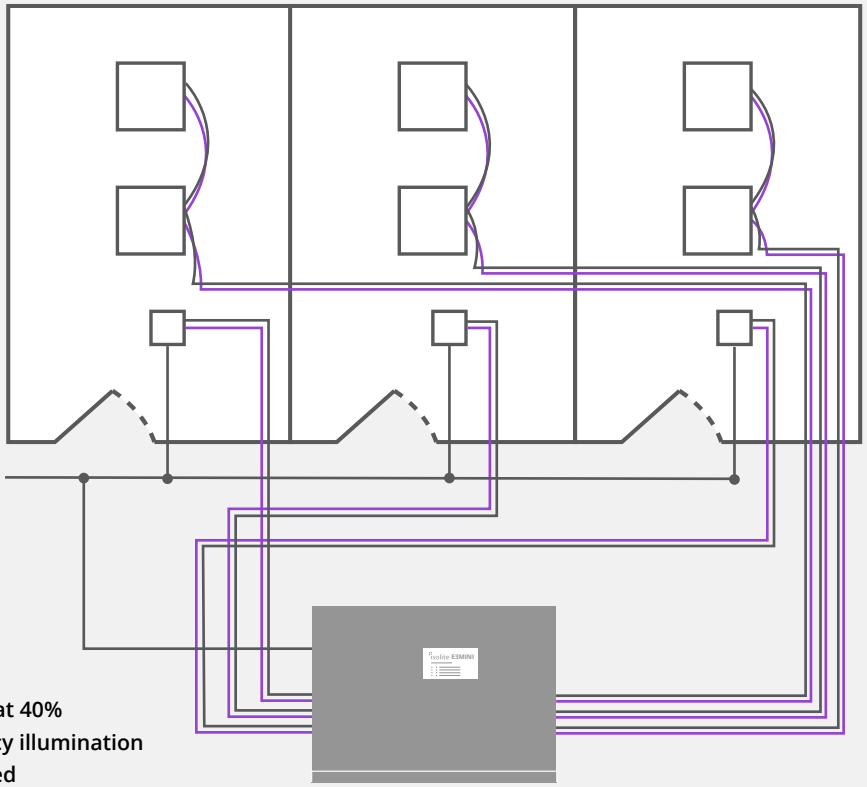
The E3MINI inverter allows for the direct integration of 0-10V (and DALI) lighting controls which are common when the systems include daylight harvesting, occupancy control, advanced scenes and timeclock events. Traditional inverter systems would require the use of a UL 924 ALCR device in these applications to drive the loads to a known light level in an emergency.



Notice that both the high voltage switched connections and the low voltage dimming connections must be integrated into the system to ensure the light fixtures aren't being controlled by the architectural lighting controls in emergency mode. The requirement for the UL 924 ALCR drives the cost and complexity of the system up and the UL 924 ALCR devices that are on the market today do not allow for dimming of the fixtures when in emergency mode, they merely override the connected light fixtures to full on.



With the switched multipurpose outputs, the E3MINI allows for the integration of 3 zones of 0-10V dimming, each with **independent** control of the output dim level when in emergency mode.



- **All fixtures on at 40%**
- **Even emergency illumination**
- **3 rooms covered**

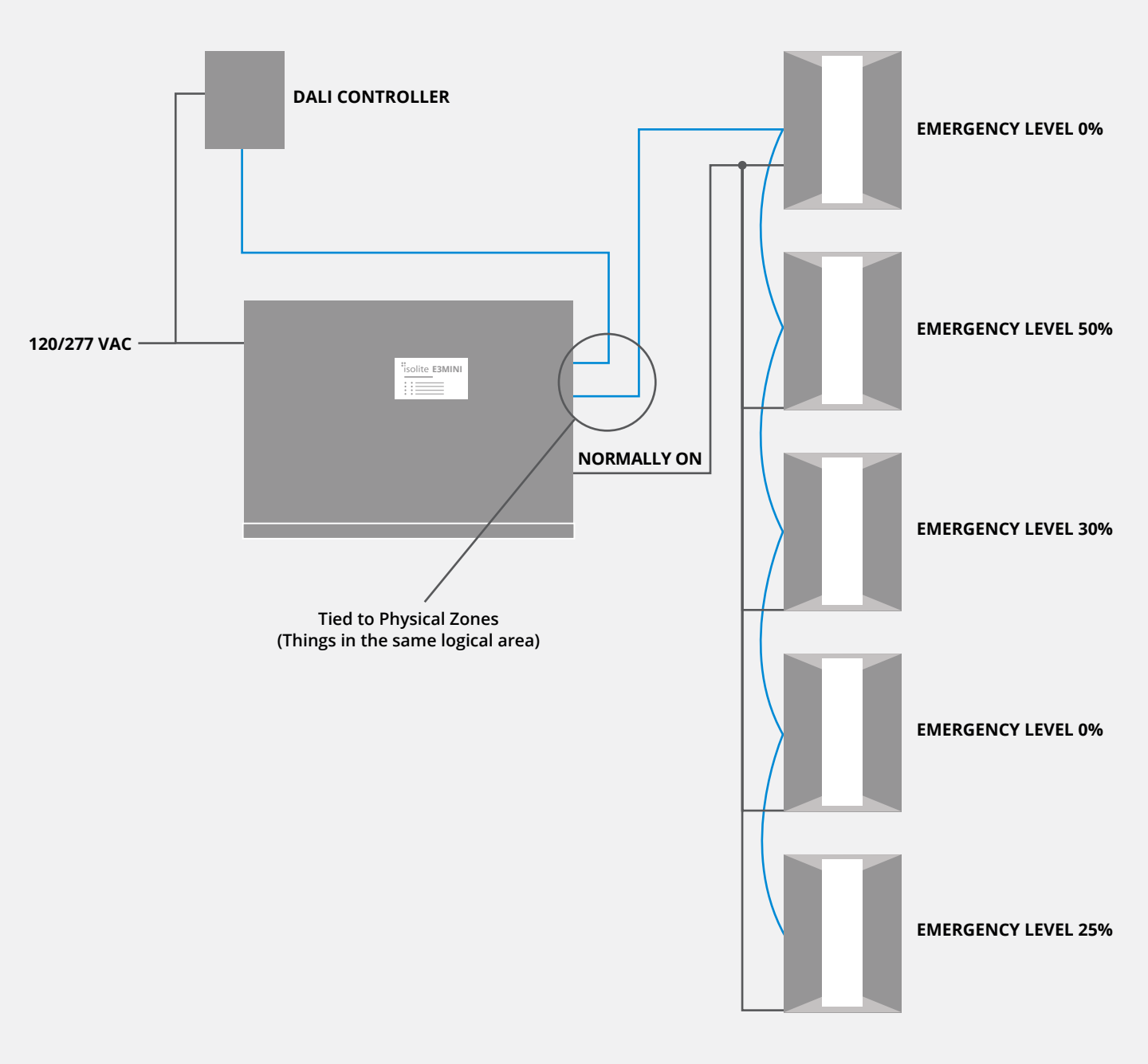
EXAMPLES OF DALI SYSTEMS

DALI a control technology that allows for every light fixture in an installation to be independently addressed and controlled via a digital bus that links the fixtures together. It's common in applications that require advanced controls such as daylighting or a high level of independent occupancy zones.

The principle of operation for an inverter-backed lighting system that uses DALI for dimming is similar to the 0-10V implementation, but there are a few factors to keep in mind:

DALI Systems Have More Dimming Flexibility

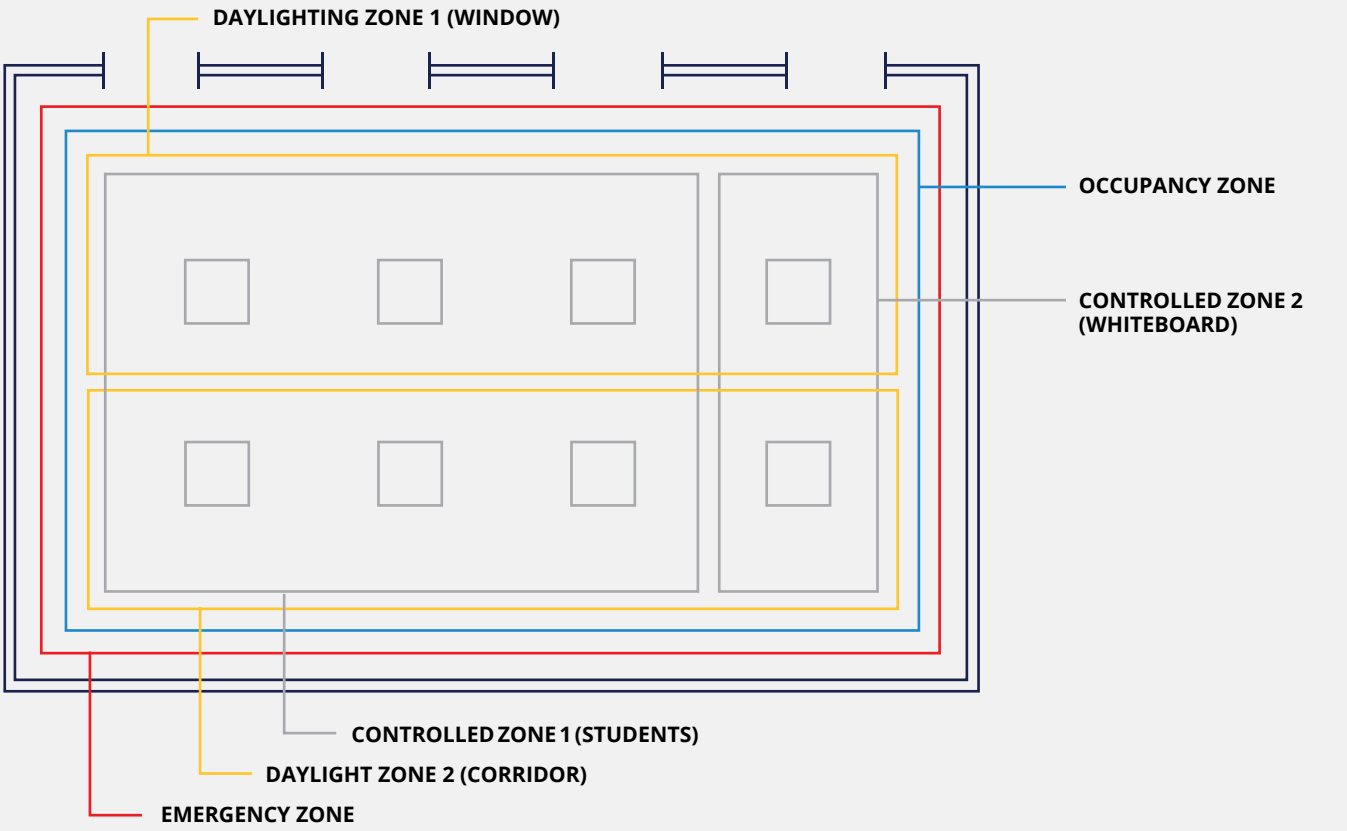
DALI LED drivers store their own emergency light level on a per driver basis. As such, instead of having an entire zone of lighting dimmed to the same light level, all fixtures in the zone can have a different emergency light level, i.e., two fixtures could illuminate at 100%, while four others illuminate at 10%.



ZONING FLEXIBILITY

In traditional dimming systems, the relationship between emergency outputs and emergency lighting zones is one-to-one. One architectural zone is one emergency lighting zone. This limitation exists because traditional dimming systems are hardwired into their zone configurations. DALI-based systems, however, utilize a digital communication bus, allowing for multiple architectural control zones to be considered as one emergency lighting zone. This is particularly helpful in open office situations where a single E3MINI has enough battery capacity to drive many lighting loads in emergency mode, but the architectural control system has several independent zones for daylighting and occupancy control.

MULTI-ZONE DALI



PHASE CONTROL DIMMING

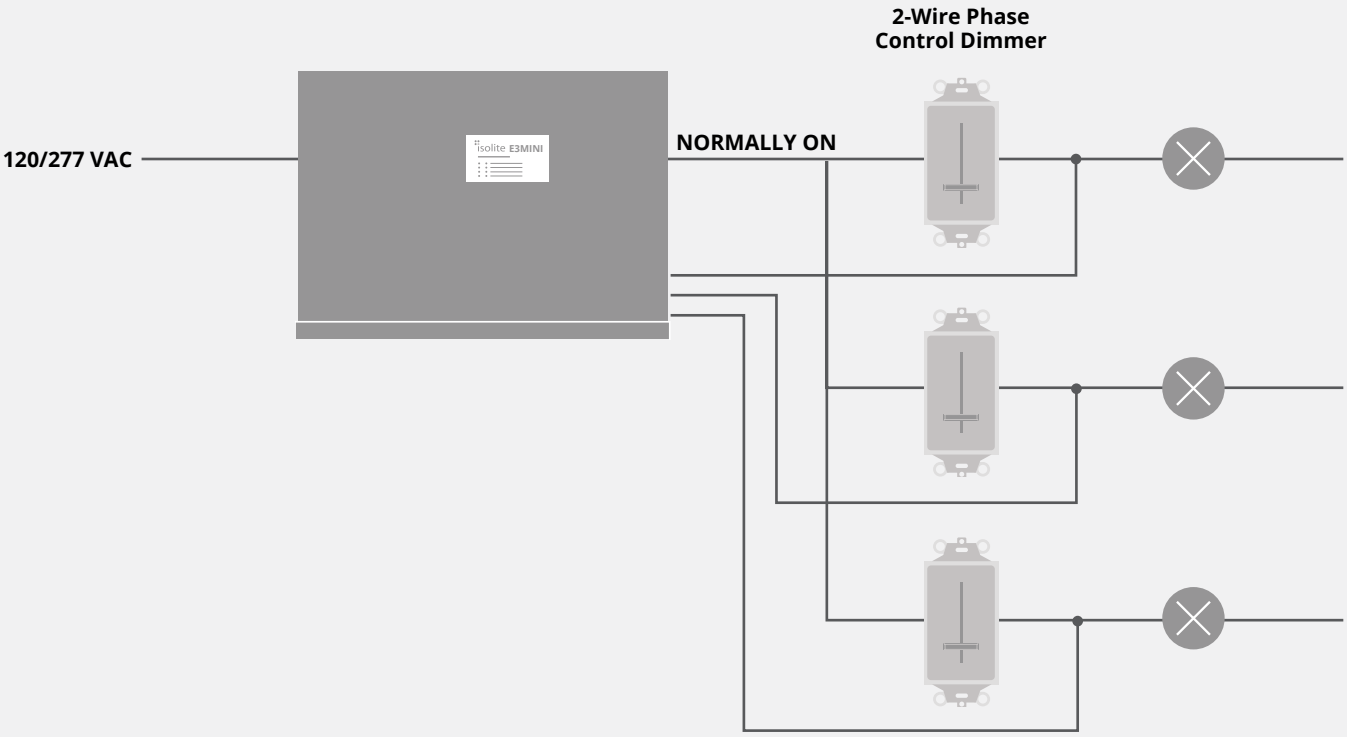
Phase control (sometimes called 2-wire) dimming systems manipulate the 120/277V AC waveform to dim the lights. This style of dimming is more prevalent in residential applications, but it's also used in commercial spaces for retrofit projects or to accommodate standard Edison-base LED bulbs.

PHASE CONTROL DIMMING

When using a traditional 2-wire dimmer, the dimmed control signal is not sent through the inverter. Instead, the inverter shunts around the phase control dimmer to short circuit the controls in an emergency. Note that while it is possible to operate the lights at a dimmed level in normal operation, when the system goes into emergency mode, the fixtures will be at 100%.

The multipurpose outputs on the E3MINI series inverters allow for 3 phase control dimmed zones to be backed up as a part of the emergency system.

THREE ZONES OF PHASE CONTROL DIMMING



A NOTE ABOUT SMART POWER PACK INTEGRATION

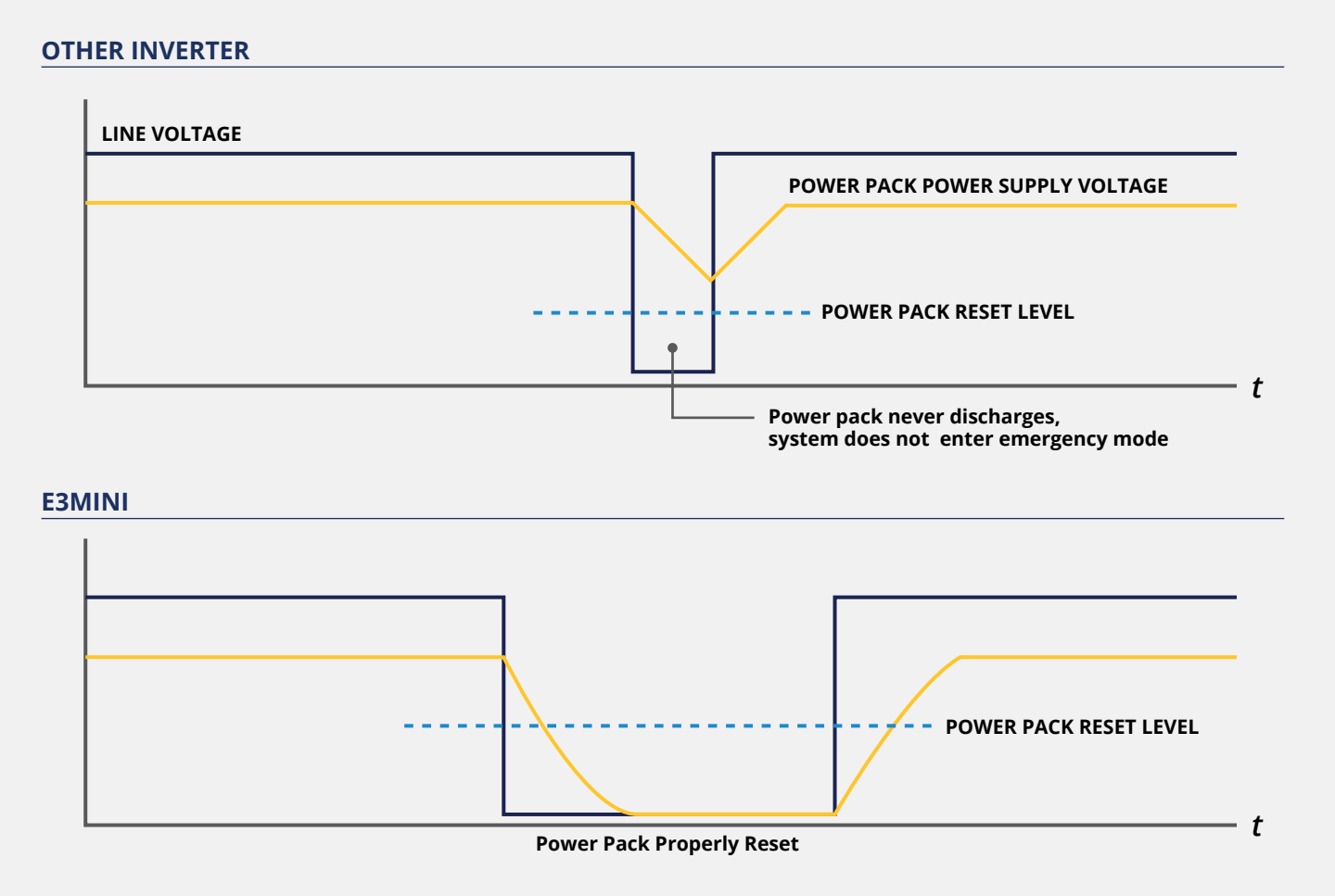
One of the most recent trends in the controls industry is to use wireless smart power packs for individual zone controls. Manufacturers of these smart lighting power packs realized that embedding a lighting control in the fixture would not leave the installer with a way to integrate UL 924 ALCR devices in the system. To address this issue, manufacturers have created versions of their smart power packs that carry a UL 924 listing and have a unique way of operating.

1. During normal operation, the power pack listens to the control devices as expected. Scene keypads, occupancy sensors, daylight sensors, etc. are all able to control the lights.
2. When the power goes out, the UL 924-listed power pack resets into emergency mode
3. Upon return of power, the power pack drives the light to a known level, ignoring all command signals for 90 minutes

This behavior means that when emergency power kicks on after power failure, the lights will be overridden to a known state.

THE ISSUE WITH SMART POWER PACKS

The transition from steps 2 to 3 above, requires the smart power pack to observe a power failure. The potential issue with that requirement is that when the emergency power is applied quickly, the power pack never actually loses power due to front end capacitance inside the device.



The E3MINI has a field-configurable transfer time, which defaults to a time appropriate for use with smart power packs. Faster (and slower) transfer times are selectable in the field during installation.

Smart power packs should ALL be connected to the normally on output of the E3MINI inverter.

SUMMARY

The enhancements offered by the E3MINI inverter provide a simple and elegant solution that addresses many of the traditional issues faced when designing an emergency lighting system. This mini inverter provides a better fit for the needs of the space, maximizes the number of fixtures that it can manage, simplifies wiring, eliminates the need for extra pieces of equipment, works with both traditional and modern lighting control systems and easily satisfies the life safety code designed to keep people safe when an emergency occurs.

To learn more about the E3MINI inverter or any of Isolite's products, please reach out to your local sales representative or contact us directly at quotes@isolite.com.

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