

TRANSFER SWITCHES

The Complete Guide to UL 924 vs. UL 1008

ABSTRACT

The purpose of this paper is to discuss the technical aspects between the two types of emergency lighting transfer switches, UL 1008 and UL 924, and to detail precisely when and how to use them.

INTRODUCTION

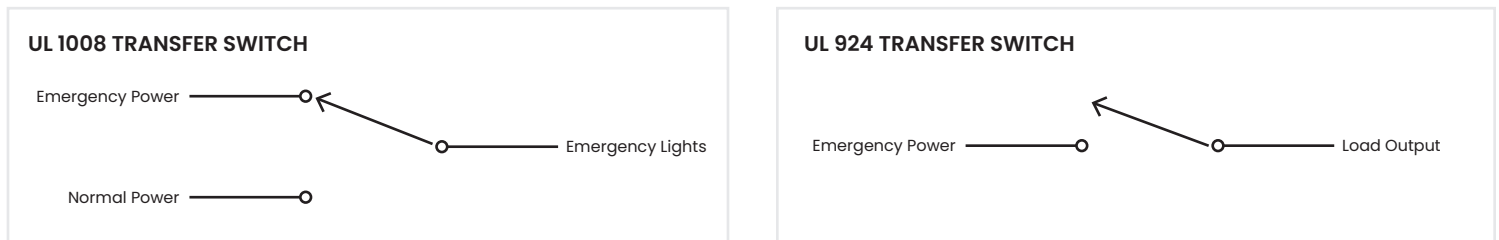
Emergency lighting transfer switches enable general illumination lighting fixtures to act as emergency lighting fixtures when an emergency power source is available. These devices sense normal power and automatically connect the emergency power source to its lighting loads during a power outage.

There are two classes of emergency lighting transfer devices: UL 1008 and UL 924, with some uncertainty in the industry as to how and when to implement each type. Recent changes to the National Electrical Code (NEC) concerning emergency lighting transfer devices have further complicated matters. Perhaps the biggest confusion is that, although they are both referred to interchangeably as basic “transfer devices,” their transfer capabilities serve very different functions.

It is very important to understand the differences between the two as it will affect costs, complexity and compliance to the NEC Article 700 code. Article 700.2 of the latest NEC categorizes the UL 1008 as a Branch Circuit Emergency Lighting Transfer Switch (BCELTs) and the UL 924 transfer device as an Automatic Load Control Relay (ALCR). Both types can be used to achieve a fully compliant NEC Article 700 emergency lighting design. However, by examining the inner workings of each “transfer device” it soon becomes apparent how the UL 1008 transfers between two power sources while the UL 924 transfers from input to output.

THE INNER WORKINGS

The fundamental difference between UL 1008 and UL 924 transfer devices are illustrated in these two, simplified diagrams:



The UL 1008 transfer device has two power sources connected to its contacts and switches between these sources (normal power and emergency power) which connects to the emergency lights. The UL 924 transfer device simply acts as a switch and connects the constant “on” emergency power to the emergency lights. Engineers would classify the UL 1008 as a FORM-C type relay and the UL 924 as a FORM-A type relay. Both transfer devices sense normal power, and upon its loss, cause the relay to connect the emergency power to the lights.

Because there are two different power sources for a UL 1008 device, it has to undergo a completely different test program than the UL 924. Two big safety concerns are short circuit protection and synchronicity between the two different power sources. Non-synchronous means that the emergency power source can be completely out of phase from the normal power source. This phase shift can lead to up to a 2X voltage potential difference if they are out of phase by 180°. When this 180° phase shift occurs on a 277V circuit, the potential difference between the emergency power and the normal power can be as high as 554VAC (277VAC x 2). This situation can never happen with a UL 924 device since there is only ONE power source being turned on or off.

UL 1008 devices are typically more expensive than UL 924 devices due to the inclusion of overcurrent protection devices (normally fuses) as additional safety measures to satisfy the fault current requirements. The overcurrent protection may need to be reset or replaced, which means that these devices need to be easily accessed. Because of these and other factors, it may be more desirable to use the UL 924 devices when possible. The easiest way to accomplish this is to use an up-stream “normally on” emergency power source which can feed UL 924 devices. Two possible solutions are a generator coupled with a UL 1008 transfer switch (Example 1) or a central inverter (Example 2) which has a “normally on” power output.

Emergency lighting applications that require a UL 1008-style are line-voltage dimming, also known as 2-wire dimming. These applications are illustrated below (Examples 3A and 3B).

Stacking UL 1008 transfer switches (a process in which one UL 1008 device feeds another UL 1008 device in a series arrangement) is not necessary to meet code and may incur a severe cost penalty to do so due to the increased cost of the UL 1008 device mentioned earlier. Stacked UL 1008 designs are shown in Example 3A which should be avoided unless line voltage dimming is used to control the emergency lights. Although stacking UL 1008 transfer devices still meets the NEC, it is often not required to do so.

NEC CHANGES/CLARIFICATIONS

The governing code which we shall reference is the NEC, part of the National Fire Protection Agency Article 70. The NEC covering emergency lighting is Article 700, sections 4 and 5. These codes are revised every three years and, as of this writing, the latest is 2017. Changes made to the 2017 code specific to transfer devices was the further definition of the Branch Circuit Emergency Lighting Transfer Switch (BCELTs). Earlier revisions of the NEC had already contained definition and use of the automatic load control relay (ALCR) for emergency lighting. The latest 2017 revisions further clarify the difference between the two and set requirements for the use of each type.

The following excerpts are taken from the 2017 NEC code and include clarification between BCELTs and ALCR and commentary text:

NEC SECTION 700.25: BRANCH CIRCUIT

Emergency Lighting Transfer Switch Emergency lighting loads supplied by branch circuits rated at not greater than 20 amperes shall be permitted to be transferred from the normal branch circuit to an emergency branch circuit using a listed branch circuit emergency lighting transfer switch. The mechanically held requirement of 700.5(C) shall not apply to listed branch circuit emergency lighting transfer switches (new for 2017).

NEC SECTION 700.26 AUTOMATIC LOAD CONTROL RELAY

If an emergency lighting load is automatically energized upon loss of the normal supply, a listed automatic load control relay shall be permitted to energize the load. The load control relay shall not be used as transfer equipment.(existing prior to and included in 2017).

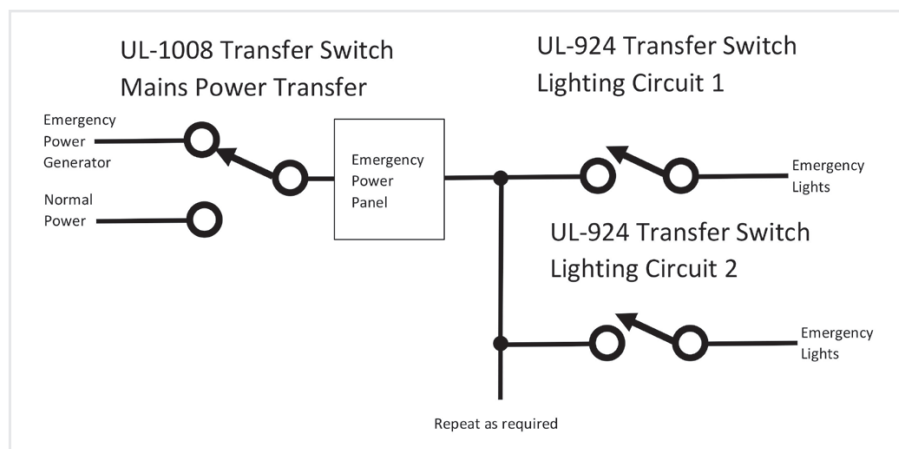
NEC COMMENTARY TEXT

Automatic load control relays were traditionally part of emergency unit equipment, but stand-alone devices are now listed under ANSI/UL 924, Standards for Emergency Lighting and Power Equipment. Proper application of these devices depends upon their function in an emergency circuit.

Load control relays listed to UL 924 are not to be used to transfer a load between two non-synchronous power sources: only transfer equipment listed to UL 1008 is suitable for this application. These power sources might be out of phase with one another. Load control relays do not have the mechanisms required by UL 1008 to prevent inadvertent connection of the normal and emergency sources, and they do not undergo the fault-current evaluation that is required of UL 1008 for transfer switches.

EXAMPLES TO ILLUSTRATE DIFFERENT EMERGENCY LIGHTING DESIGNS:

EXAMPLE 1: UL 1008 Transfer Switch w/ Building Generator and Down-Stream UL 924 Transfer Switches

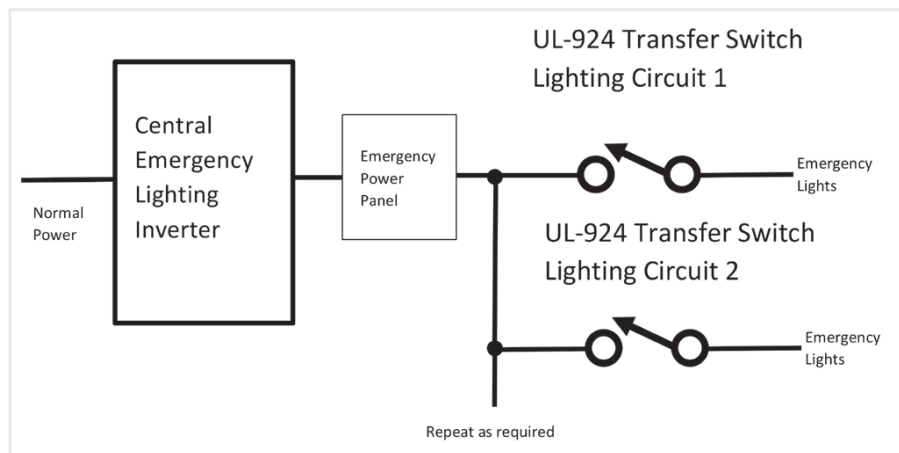


In this example, the UL 1008 transfer switch would be very large (200A or greater) and would probably reside in the main electrical room of a building or next to the generator. When normal power is lost, the generator spins up to speed and the UL 1008 switch is then transferred from normal power to emergency power. It is noteworthy to add that this process may take too long in many cases due to the generator size as the building code requires emergency lights to come on within 10 seconds (NEC Article 700.12). Generator solutions are generally reserved for large installations which use whole building generators capable of providing power for extended power outages. Typical examples would include hospitals, schools or other large facilities.

Example 1 is fully code-compliant to the latest NEC 2017 standard and series arranging the UL 1008 and a UL 924 in this manner is very cost effective. This example does not show dimming for the lights but can be accomplished with a UL 924 style that incorporates a 0-10V/DALI type interface. If line voltage (2-wire) dimming is required, please see Example 3A or 3B. The safety requirements of the UL 1008 switch are most critical when both power sources are present.

When normal power returns and the transfer device switches from emergency power back to normal power, or when there is a system test, there can be a large potential difference between the two power sources due to the phase shift difference. Many modern UL 1008 transfer devices wait for the two power sources to synchronize before the transfer occurs. This is the best-case scenario since there is no potential difference between the sources at that time.

EXAMPLE 2: Emergency Lighting Central Inverter w/ Down-Stream UL 924 Transfer Switches



For many applications, a central inverter may be preferred due to the cost, maintenance and convenience of the installation. The central inverter contains all of the necessary provisions to charge its internal batteries, sense incoming power and energize (discharge the batteries) when normal power is lost. There are many types of central inverter topologies including double conversion, on-line and standby. Each type has its purpose and specifiers should choose accordingly based on the required application. This example may be the most cost-effective solution for small- to mid-sized sites where there are several zones that must be controlled.

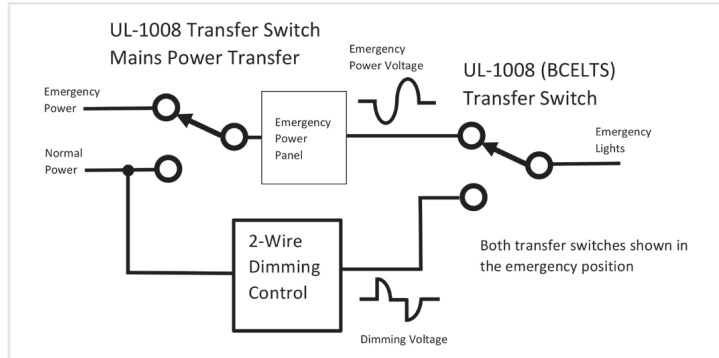
OPERATION

In Example 2, the inverter's output would be on 24/7, considered "normally on." The output then feeds the input to the UL 924 relay so that the emergency lighting load current is always provided by the inverter. The normal power for the UL 924 device is simply a sense line which causes the UL 924-style relay to close.

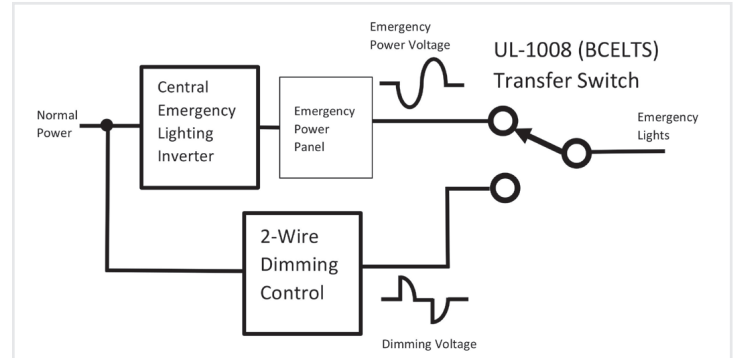
The UL 924-style relay can include additional features such as fire alarm interface and also dimming interface that is compatible with 0-10V controls or DALI. The 0-10V/DALI lighting controls are typically fed through another signal relay within the UL 924 device and upon power loss are opened up to bring the lighting fixtures up to full brightness. Line voltage dimming is not possible with a UL 924-style relay as will be discussed in further examples.

Example 2 is fully code compliant to the latest NEC 2017 standard since the UL 924 switch does not transfer between two non-synchronous sources. All of the elements of the transference of power between normal power and emergency power are handled internal to the central inverter. The inverters' output carries all the load current of the emergency lights in normal mode and emergency mode. The UL 924 device simply turns the lights on and off by sensing loss of normal power.

EXAMPLE 3A: UL 1008 Transfer Switch with Line Voltage Dimming and Down-Stream UL 1008 Transfer BCELTS



EXAMPLE 3B: Central Inverter with Line Voltage Dimming and Down-Stream UL 1008 Transfer BCELTS



When working with line-voltage dimming, the transfer between the dimming voltage and emergency power voltage must be a UL 1008 transfer switch. Upstream from this can be a UL 1008-style or central inverter as shown in Example 3A and 3B respectively. Both examples are fully NEC compliant.

OPERATION

In both Example 3A and 3B, normal power is fed into a line-voltage (2-wire) dimming controller. The output of this dimming controller is a line voltage dimming signal as depicted. As long as normal power is present, the emergency lights will be fed from the dimming controller through the UL 1008 (BCELTs) transfer switch.

When normal power is lost (Example 3A) it causes both the mains power UL 1008 transfer switch and the downstream UL 1008 (BCELTs) to change to the “Emergency” state; this brings the emergency lights to full brightness. The UL 1008 (BCELTs) operation in both 3A and 3B are identical in operation. However, the upstream feed power to the UL 1008 (BCELTs) in Example 3B is fed with a central emergency lighting inverter. The central inverter contains its own internal transfer circuits which provides a continuous power source to feed the downstream UL 1008 (BCELTs).

SUMMARY

In this white paper, we have shown that a full compliance for NEC Article 700 for emergency lighting can be achieved with either UL 1008 or UL 924 transfer switches. How the emergency lighting load is controlled (line voltage dimming vs- 0-10/DALI) will determine which device is used. The UL 1008 is going to be required for line voltage dimming. However, the more cost-effective

UL 924 device can generally be used for everything else. UL 1008 transfer devices are required when transferring power from two non-synchronous power sources. UL 924 devices do not transfer two non-synchronous power sources and simply turn lights on and off from a constant emergency power source. Both devices can be used congruently.