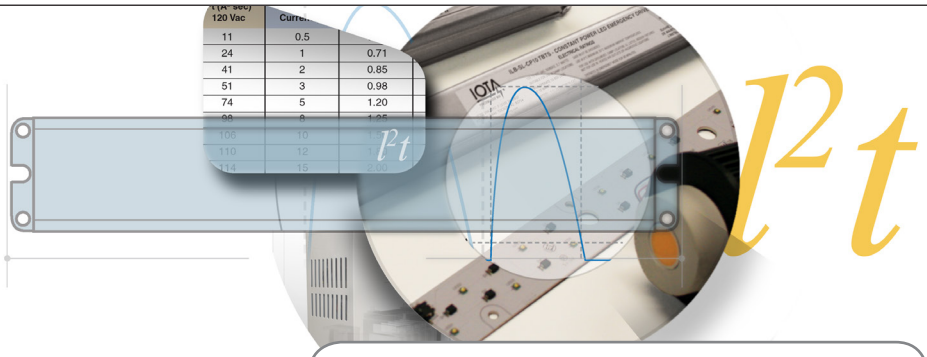

Qualifying Emergency Lighting to NEMA 410 Standards

Inrush

Inrush is an electrical condition that primarily occurs due to **capacitance**. As power is supplied to a device, internal capacitors within the device momentarily draw an *increased* amount of power to charge up the capacitor which is more than the device normally uses during operation. With the adoption of LED technology, capacitance is a much more prominent factor in today's lighting designs. Capacitance occurs in LED drivers as the power supply begins the conversion of AC voltage into the required DC voltage needed to 'bias' (turn on) the LEDs. Additionally, capacitance is added as a filter device to control EMC (electromagnetic compatibility) to reduce the risk of electrical interference to other equipment. The initial draw of increased power for these functions, measured in milleseconds, may seem brief but is incredibly significant in electrical terms. The impact of this inrush current is that when power is supplied to a circuit, **the cummulative inrush surge of multiple devices can exceed the specified ratings of other peripheral devices, such as a switch, sensor or control, on the circuit** and render it inoperable. Some of the more disruptive inrush profiles of LED drivers have been witnessed at 50 times their normal rated power, making it difficult to find peripheral devices that can accommodate these anomalies. The stated electrical ratings of an LED driver may indicate a nominal operating value (continuous duty cycle) but not account for the inrush demands generated at start-up, which can put other connected devices at risk.

To reduce the risk of inrush issues within your lighting system, the **National Electrical Manufacturers Association (NEMA)** has worked to establish standards and best practices to ensure devices within lighting systems function together for proper performance. NEMA has effectively updated language in NEMA 410 to provide guidance specifically for LED drivers in hopes that peripheral devices will be designed to the same electrical boundaries and thwart the incompatibility issues caused by inrush. By voluntarily adopting NEMA standards and recommendations, manufacturers bring an added value of understanding and confidence to specifiers and electricians utilizing NEMA-rated equipment in their system designs.

NEMA Standards

NEMA presents **two practical methods to address this inrush issue**: by establishing a **maximum allowable input capacitance** of the electronic device (see **Table 1**), or by **simultaneously limiting both its Peak Current and Pulse Width** (duration). NEMA combines these two values using the expression I^2t to represent the maximum allowable inrush of the electronic device.

The I^2t formula is used as a measurement of the inrush by multiplying the square of the maximum Peak Current (amps) with the Pulse Width duration (ms) (See Illustration A.) As a "best practice," NEMA recommends that electronic devices not exceed the values shown in **Table 2**. The intent of limiting maximum allowable inrush associated with the LED driver is to enable manufacturers of connected devices to design products that can tolerate this established inrush behavior. Note that impedance is also a factor that limits inrush and should be taken into account when determining inrush values. A device qualified to NEMA 410 standards should perform within the parameters of the data shown in Table 2.

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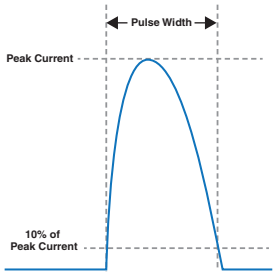

Illustration A: Sample Waveform Waveform illustrating the two factors in determining the I^2t value. The square of the Peak Current is multiplied by the duration (Pulse Width), measured in milleseconds, at 10% of its peak value.

Calculating Inrush to NEMA 410 Qualifications

Table 1: NEMA 410 Bulk Energy Capacitances Showing the recommended maximum capacitance per Vac for limiting electronic device inrush current.

System (Vac)	120	277	347
Bulk energy capacitance: µF per ampere of steady state current	175	125	125

Table 2: Peak Current Requirements with Pulse Widths ≤ 2 ms - NEMA 410 test characteristics for Peak Current and inrush values.

120 Vac

Steady State Current (A)	Peak Current (A) 120 Vac	Pulse Width 120 Vac (ms)	I²t (A² sec) 120 Vac
0.5	75	0.34	11
1	107	0.48	24
2	144	0.70	41
3	166	0.89	51
5	192	1.20	74
8	221	1.25	98
10	230	1.50	106
12	235	1.80	110
15	239	2.00	114
16	242	2.10	117

277 Vac

Steady State Current (A)	Peak Current (A) 277 Vac	Pulse Width 277 Vac (ms)	I²t (A² sec) 277 Vac
0.5	77	0.50	11
1	131	0.71	27
2	205	0.85	76
3	258	0.98	111
5	320	1.20	205
8	370	1.25	274
10	430	1.50	370
12	440	1.80	387
15	458	2.00	420
16	480	2.10	461

When a load is comprised of devices known to generate inrush (ie. LED lighting), attention must be given to the technical specifications of any control or switching device that is present on the circuit. If the operable LED load rating of the device states "20A," the value may not necessarily take into account the type of load or the inrush potential of the load. **A common practice is to de-rate the load** on the circuit by 20% to avoid exceeding the capabilities of the control device. The de-rating is simply a guideline and allows for an engineering margin but does not necessarily guarantee compatibility. If the device explicitly states "per NEMA 410" then the control device should perform as stated when used in conjunction with other equipment qualified to NEMA 410 standards. Since inrush characteristics can vary greatly between electronic devices, the adoption of NEMA standards is a valuable tool for aiding system designers in minimizing failures of equipment in the lighting circuit.

Emergency Lighting Solutions for Accommodating Inrush

Emergency lighting equipment can take many forms, ranging from integral battery packs, inverter supplies, to on-site standby generators. Inrush is accounted for in different ways depending on the design of the emergency solution.

Integral emergency LED drivers, such as the IOTA ILB-CP, electrically exist between the output of the normal driver but before the LED lighting load. This electrical position removes this technology from the input side of the normal driver and thus the **ILB-CP does not expose itself to the potentially unfavorable inrush characteristic** associated with the input side of the LED driver.

When **emergency lighting inverters** are the selected solution for emergency power, and there are no given specifications on inrush capabilities, you would likely defer to the 'de-rating' rule-of-thumb and reduce your total connected load by 20% of the maximum allowable load rating of the inverter. To simplify matters when using an inverter, **IOTA offers a 375W inverter (IIS-375-LED) specifically designed for LED loads.** The IIS-375-LED will operate LED loads up 375W without the need to account for inrush. Unless specifically stated, other inverters will require the 20% de-rating to avoid overload from electronic inrush.

For applications where a generator is being utilized as the emergency power source, an Auxiliary Lighting Control Relay (ALCR), like the IOTA ETS, ETS-DR, or ETS-20 may be introduced into your design to either route power around wall switches in the OFF position or to defeat a dimming system to operate the LED fixture at full output during an emergency power condition. In these applications, **IOTA ETS and ETS-20 units are designed in accordance with NEMA 410 specifications** to account for the inrush of the LED drivers on the circuit.

Regardless of the nature of emergency solutions, inrush should still be a considered when designing your lighting system. The updated LED language introduced into NEMA 410 has provided our solid state lighting industry the tools necessary to harmonize performance ratings of the various components to ensure the best possible compatibility results. IOTA recognizes the value and importance of the NEMA 410 standard and is committed to providing solutions that meet or exceed these practices. For more information regarding IOTA's emergency lighting solutions that achieve NEMA 410 qualifications, contact the IOTA Customer Service team at 1-800-866-4682 or visit www.iotaengineering.com.

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