



ADB Airfield Solutions Answers Questions about the Latest Generation of Applications for High Intensity Airfield Lighting

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In the fall of 2002, LED airfield lighting products began appearing on taxiways around the world. These products emerged because a new class of a Light Emitting Diode (LED) light source had been developed. Initially, products were only available for elevated taxiway edge lighting applications. Next, products appeared for in-pavement taxiway centerline and obstruction lighting applications. Not long after, arctic kits were added to LED products for those airports where snow and ice are a concern. Research has now resulted in the certification of a number of airfield lighting products using the latest generation of high-brightness LEDs (HBLED). These ETL-certified LED products include: In-pavement Runway Centerline lights, Touchdown Zone lights, In-pavement Runway Guard Lights, and FAA L-858 signs.

Many questions have come up about various performance aspects of these HBLED products. This article aims to answer many of those questions.

I understand that Runway Centerline and Touchdown Zone fixtures are now ETL certified. Are they available in Style 3 for all applications? What are the electrical load requirements?

A key advantage of LED runway fixtures is that they eliminate the need to shut down the runway for lamp maintenance. The ADB Airfield Solutions FAA L-850A LED runway centerline fixture is available in white or red for uni- or bi-directional applications (see Figure A). The FAA L-850B LED Touchdown Zone fixture is available in white for uni-directional applications (see Figure B). Both fixtures are manufactured in a 12", Style 3 (<1/4" high) aluminum housing.

According to FAA Advisory Circular 150/5340-30, the light output of Touchdown Zone fixtures must be toed 4° toward the runway centerline. The Advisory Circular also states that toeing can be achieved by either using an optical assembly toed 4°, or by angling the base can 4°. The ADB Airfield Solutions LED L-850B can be ordered toed right, toed left or straight. If necessary, the inner optical assembly may be field adjusted for any of the three positions. An advantage of installing base cans that are already toed is that all fixtures are ordered as straight. Otherwise, when ordering touchdown zone fixtures, it must be remembered to order half of the fixtures as toed left and half as toed right. Toeing the base cans also eliminates the need to open a fixture during maintenance if a certain toed option is not immediately available.



Figure A. ADB Airfield Solutions "IRCL" LED L-850A



Figure B. ADB Airfield Solutions "TDZL" LED L-850B

The latest generation of higher wattage HBLEDs used in both the LED L-850A and L-850B fixtures are effectively heatsinked via the aluminum top cover, allowing operation from -40°C to +55°C (-40°F to +131°F). FAA Engineering Brief No.67B, dated March 12, 2007, has specific requirements for airfield LED fixtures. Paragraph 2.12 of the Engineering Brief states: "All fixtures, with the exception of obstruction lights ... must have an optional arctic kit or/and appropriate addressing of potential icing conditions to no less extent than present fixtures. This feature must be an optional feature and may be specified by the consumer at the time of purchase. The arctic kit must be self-activating." We have determined that a separate arctic kit is not required for either the LED L-850A or L-850B, because lab tests have verified that a separate heater is not needed.

An electronic board inside the fixture monitors the CCR input current and outputs a regulated DC current to the fixture's HBLEDs. The combined load of the electronic board and the HBLEDs is known as the "Fixture Load" and is as follows:

| L-850A | Fixture Load | Isolation Transformer | Isolation XF Load | CCR Load |
|----------------------------|-------------------------------|-----------------------|-------------------|----------|
| Unidirectional | 42VA | 30/45W | 9VA | 51VA |
| Bidirectional ¹ | 84VA | 100W | 15VA | 99VA |
| Bidirectional ² | 42VA per side (84VA total) | 30/45W per side | 18VA | 102VA |

¹ One cord set

² One cord set per side (2 total)

| L-850B | Fixture Load | Isolation Transformer | Isolation XF Load | CCR Load |
|----------------|--------------|-----------------------|-------------------|----------|
| Unidirectional | 42VA | 30/45W | 9VA | 51VA |

The LED L-850A lights have been designed to work with any FAA-compliant transformer up to 200W, and the LED L-850B lights work with any transformer up to 100W, without affecting the performance or lifetime of the light fixture or transformer. Although matching the fixture load to the isolation transformer size optimizes the isolation transformer's efficiency, the fixture's design allows either fixture to be installed on older existing series circuits with no other modifications.

Will there be vibration issues when LED fixtures are installed on a runway?

Because an in-pavement LED fixture uses all solid-state or passive components, they are inherently more vibration resistant than incandescent-tungsten halogen fixtures. Incandescent lamps use a wire filament, which is at a higher risk of filament breakage, usually occurring more frequently at the lamp's end-of-life.

This issue has already been put to the test. In January 2007, ADB Airfield Solutions LED L-852N fixtures were installed at the Naval Air Facility in El Centro, CA. L-852N fixtures (often called tail-hook fixtures) are used in Simulated Carrier Deck applications by the US Navy. A total of 216 fixtures on 3 Simulated Carrier Decks were installed (see Figure C). These fixtures have now seen many landings and tail-hook strikes, have been proven to be reliable and effective, and have had no vibration failures.



Figure C. LED L-852N Simulated Carrier Deck at the Naval Air Facility in El Centro, CA

Will the LED Runway Centerline and Touchdown Zone fixtures operate on 5-step CCRs?

I hear that other types of LED fixtures may only operate on 3-step CCRs.

This question often comes up at airports that have standardized on 5-step (2.8A to 6.6A) CCRs for all applications to minimize spare parts needs, even on taxiway circuits. It also has been a concern for airports that may need to use a spare 5-step CCR on a circuit that is normally powered by a 3-step (4.8A to 6.6A) CCR.

For FAA L-850A and L-850B fixtures, however, it is critical that the fixtures operate on all 5-steps. FAA Order JO 7110.65, Section 4, Airport Lighting, states:

3-4-11. HIGH INTENSITY RUNWAY, RUNWAY CENTERLINE, AND TOUCHDOWN ZONE LIGHTS Operate high intensity runway and associated runway centerline and touchdown zone lights in accordance with TBL 3-4-8, except:

- a. Where a facility directive specifies other settings to meet local conditions.
- b. As requested by the pilot.
- c. As you deem necessary, if not contrary to pilot request.

| Step | Visibility | |
|------|---------------------------------|---------------------------------|
| | Day | Night |
| 5 | Less than 1 mile* | When requested |
| 4 | 1 to but not including 2 miles* | Less than 1 mile* |
| 3 | 2 to but not including 3 miles | 1 to but not including 3 miles* |
| 2 | When requested | 3 to 5 miles inclusive |
| 1 | When requested | More than 5 miles |

*and/or appropriate RVR/RW equivalent.

This table shows that it is important to be able to operate L-850A and L-850B fixtures at step B1 (2.8A) and B2 (3.4A). In fact, a recent study showed that airports operate their runway lighting about 46% of the time in step B1 and 4% of the time in step B2. All ADB Airfield Solutions LEDs are designed to operate on both 3- and 5-step CCRs.

To operate LEDs over a 5-step input current range, it is important to Pulse Width Modulate (PWM) the current to the LEDs. Pulse Width Modulation is accomplished by rapidly switching the nominal input current to the LED On and Off a variable amount of time. The length of the On time defines the brightness seen by the human eye. We know that on some other manufacturers' LED products that pure DC current to the LED(s) is simply reduced in lower CCR steps. The problem with this type of design is that the LEDs may not come on at all, because the current to the LEDs will be very low in the lower CCR steps. This can also cause LEDs to flicker On and Off and can cause different intensity levels to be emitted by the fixture (if multiple LEDs are used within the fixture) or varying intensities to be seen by the pilot when a row of LED fixtures is observed.

Given the variety of CCR current wave shapes, the greatly extended range of 2.8A – 6.6A (which requires the use of PWM), and also the need to operate on either 50 or 60Hz, requires a much more sophisticated power supply design. This results in slightly higher fixture loads, but provides the end user with the comfort that the fixture will operate reliably on the wide variety of operational situations encountered on airfield lighting circuits. Operation from 2.8A to 6.6A, 50/60Hz may not be possible with for other manufacturers' LED fixtures—inquire with other manufacturers regarding any operating limitations.

Will the LED Runway Centerline and Touchdown Zone fixtures operate with any CCR architecture?

I have heard that LED fixtures will not operate correctly with SCR-type CCRs – they need to be powered using only ferroresonant CCRs.

Is this true?

ADB Airfield Solutions LED fixtures are designed to operate on either type of CCR architecture. Our fixtures' electrical design takes into consideration the higher harmonic wave shapes that often occur with SCR-type (also known as Thyristor) CCRs.

SCR-type CCRs typically operate by inserting a pair of SCRs on the input power line. These SCRs electronically “chop out” a portion of the input current to regulate the output current at the various step settings. To limit the amount of harmonic distortion in the output current, FAA AC 150/5345-10F, Specification for Constant Current Regulators and Regulator Monitors, addresses this issue by imposing a limit on the Crest Factor. In an AC circuit, Crest Factor is the mathematical ratio of the peak to RMS value of a waveform.

For a pure sine wave the Crest Factor is 1.414. Paragraph 3.3.6, Crest Factor, of the AC states: “The crest factor for L-828 and L-829 CCRs must be less than 3.2 with regulator output loading per paragraph 3.3.1.” In essence paragraph 3.3.1 defines CCR regulation requirements for resistive loading from short circuit to 100% load and reactive loading when the CCR is connected to series isolation transformers with between 0 and 30 percent of the secondary windings open circuited. Paragraph 4.2.6 of the AC further defines the test parameters as:

“a. The maximum crest factor must not exceed 3.2 at nominal input voltage for all current step settings.

b. Crest Factor = $I_{OutPeak} / I_{OutRMS}$ “

ADB Airfield Solutions LED fixtures use a powerful microprocessor to accurately analyze the input wave shape and an innovative DC Pulse Width Modulation design to ensure proper operation over the full range of Crest Factors defined in FAA AC 150/5345-10F. If you'd heard that LEDs won't operate properly on SCR-type CCRs, it may be that other manufacturers have simplified their fixture DC power supply design (to reduce cost) to the point where a lower harmonic current wave shape, something approaching a pure sine wave, is needed for proper operation.

The variety of CCR current wave shapes and the greatly extended range of 2.8A – 6.6A, as well as the need to operate on either 50 or 60Hz, requires a much more sophisticated power supply design. This results in slightly higher fixture loads, but provides the end user with the comfort that the fixture will operate reliably on the wide variety of operational situations encountered on airfield lighting circuits. We have seen that other manufacturers simply don't mention CCR operation limitations in their marketing literature. Operation on higher crest factor CCR current wave shapes may not be possible with these other manufacturers—again, it pays to investigate this issue with all potential suppliers. It is also important for the design engineer to specify the desired performance requirements because, in a low bid market, it is possible to have a situation where new LED fixtures are not compatible with the existing infrastructure.

How do the new LED L-858 signs operate?

ADB Airfield Solutions LED L-858 sign sizes 1 through 4 are now ETL certified according to FAA AC 150/5345-44H. A key advantage of LED signs is that they eliminate the need to shut down the runway or taxiway for lamp maintenance.

The HBLEDs in the new signs use a simple, yet innovative optical and electrical design to meet rigorous FAA photometric performance requirements.

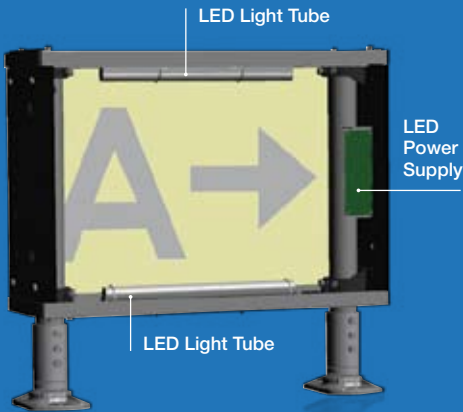


Figure D. L-858 LED Sign

The optical design is based on the use of an HBLED light tube called ZELION™, manufactured by OSRAM® (see Figure D). The OSRAM ZELION HBLED remote phosphor tube light module provides an LED solution for traditional light sources, and is designed for durability and easy installation. This tubular lamp uses a unique plastic co-extrusion construction and incorporates blue to white conversion that naturally eliminates diffusers used in traditional white LED package solutions. This type of construction greatly improves heat dissipation. The ZELION HBLED light tube inherits the flexibility and durability of plastics typically used in outdoor applications. This eliminates the exposure to impact mechanical failure that glass or acrylic tubular lamps are subject to. The light tube has been designed to be powered one lamp at a time or a set of lamps connected in series can be powered to satisfy requirements for longer sign module lengths. The ZELION LED light tube is a green product, because it eliminates the environmental issues associated with discarding incandescent or fluorescent lamps (Fluorescent lamps need to be discarded more carefully due to their mercury content).

The ZELION light tube uses an innovative heat dissipation circuit that closely thermally couples a string of HBLEDs to a heat sink plate mounted on the bottom of the tube. The LED power supply accepts 2.8A to 6.6A from either ferroresonant or SCR-type CCRs and outputs a regulated DC current to each light tube. In accordance with FAA requirements, the DC current to the light tubes remains constant regardless of the CCR step setting.

Use of LEDs also results in significant energy savings. Following are a few examples of energy savings for LED signs vs. signs using tungsten-halogen lamps:

| Size | Style | No. of Modules | Isolation Transformer Size Required | LED Max. CCR VA Load* | Tungsten-Halogen Max. CCR VA Load* | Energy Savings |
|------|------------------|----------------|-------------------------------------|-----------------------|------------------------------------|----------------|
| 2, 3 | Style 2 (3-step) | 3 | 500 W for T-H, 300W for LED | 189 | 340 | 45% |
| 1 | Style 3 (5-step) | 4 | 500W for T-H, 300W for LED | 146 | 233 | 37% |

* CCR Load includes both sign and isolation transformer load.

The LED sign light output is conservatively estimated to be above 70% of the initial value (known as L70) for 10 years. This estimate assumes average sign operation of 12 hours per day. It should also be noted that the use of this new innovative LED sign design competes very effectively with fluorescent lamp sign designs without the inherent low temperature limitations associated with fluorescent lamps.

You can see a list of electrical loads for the various signs on our web site at www.adbairfieldsolutions.com

Are Runway Guard Lights available with LEDs?

ADB Airfield Solutions introduced an LED L-804 Elevated Runway Guard light in 2007, followed by In-pavement L-852G RGL fixtures in the summer of 2008 (see Figure E to below). A key advantage of LED RGL fixtures is that, because they are often operated 24 hours per day, they eliminate the need for frequent lamp replacements. This is also important for airports operating under a SMGCS program where failure of an RGL could impact low visibility operations.

Another key advantage is that “pulsing” incandescent lamp loads on a series circuit are forced to use ferroresonant CCR technology, as SCR (or Thyristor) regulators often have difficulty regulating the output current under rapidly changing loads. As LED devices present a reduced load on the series circuit, the pulsing presents no problems for either ferroresonant or SCR regulators.



Figure E. Installed L-852G LED Fixtures.

Can I substitute LED L-852G in-pavement runway guard lights for my incandescent L-852G fixtures?

FAA L-852G fixtures can be used in either monitored or unmonitored applications. In unmonitored applications, the fixture can be synchronized using our BRITE Remote. However, operation has also been tested with other manufacturers' synchronization devices. An autonomous version is also available that contains additional synchronization electrical circuitry that is the same as inside a BRITE Remote, eliminating the need for any additional external synchronizing devices. For unmonitored applications, failed fixtures are monitored visually. The autonomous version of the L-852G fixture eliminates the need for a local control device (such as the BRITE Remote) to synchronize the fixtures (see Figure F). A separate wireless device is used to configure the autonomous fixture to alternately flash either on or off, reducing the amount of spare fixtures required. Synchronization of the entire bar can also be adjusted to level out the pulsing load on the entire circuit.

In electrically monitored applications, the fixtures can be easily retrofit as shown in Figure G. A Y-connector is used to ensure that power is continuously available to the fixture electronics.

The LED L-852G Runway Guard Light incorporates an electronic monitoring circuit to determine if there has been an LED failure. Once a failure has been detected, an alarm contact is activated, sending the status back to the BRITE Remote, and on to the control system. A Y-connector is used to ensure that power is always available to the fixture electronics to monitor the status, while still monitoring for alarms. Replacing a bar of incandescent guard lights with LED fixtures is as simple as adding the Y-connector and changing out the fixtures.

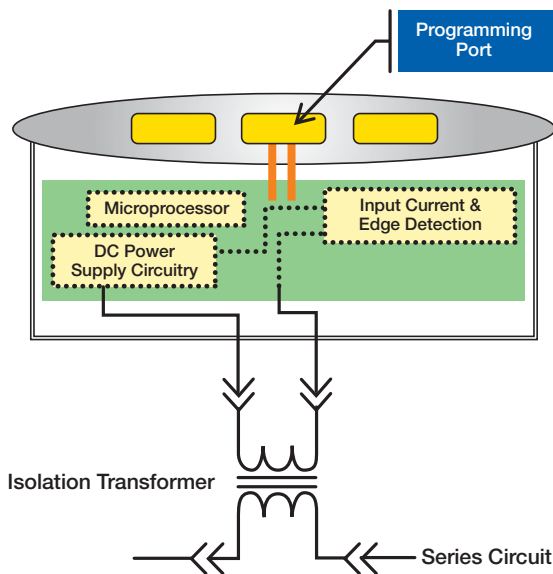


Figure F. Autonomous LED L-852G Fixture Connections

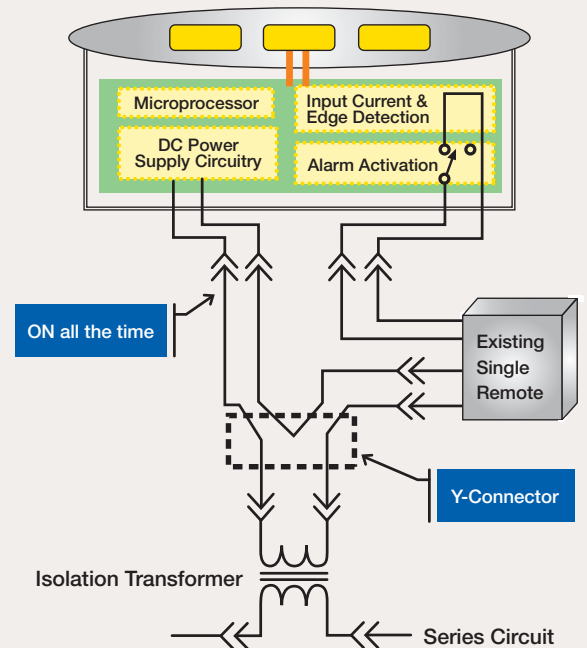


Figure G. LED L-852G Fixture Retrofit Connections

What other airfield lighting applications are now available with LED technology?

Introduction of the latest generation of High Brightness LEDs (HBLed) has allowed development of new airfield lighting applications where higher levels of photometrics are required. Some other products that have recently been available are:

- L-849 REILs--LED Runway Edge Identifier Lights in all Styles (Style A- High Intensity/Single step; Style C- Low-Intensity/Single-Step; Style E- High-,Medium-, and Low-Intensity/Three-Step) have recently been available and ETL certified for both series circuit powered and voltage powered applications. Key advantages of LED REILs are that they eliminate expensive xenon flash lamp replacements and, for series circuit applications, they eliminate the need for Power Adapters which place a high load on the CCR.
- Wind Cones--Internally lit L-807 winds cones are now available and ETL certified for series circuit powered applications. L-806 internally lit LED wind cones are available for series circuit powered applications. A key advantage of LED wind cones for series circuit applications is that they also eliminate the need for Power Adapters. Incandescent Retrofit kits, options for pole center hinges and external LED lighting will be available soon.

You can find out more information on these products on our web site at www.adb-airfieldsolutions.com.

If you want to read a longer version of this article, please visit our website at www.adb-airfieldsolutions.com.

Do you have any additional questions about application issues with LED airfield lighting products? Send an e-mail to Ed Runyon at ed.runyon@adb-airfieldsolutions.com.

Author Profiles

Ed Runyon has worked in airfield lighting since 1981 and has served on various FAA committees, including the ones that developed the Runway Guard Light, the L-890 ALCMS specification and also LED Engineering Brief 67. John Chapman is Product Manager for Control and Power Solutions. Although he has only worked in airfield lighting for several years, he has over 25 years of automation and control experience in various process industries.