

Aluminum Extrusion Design

3 Toughest LED Lighting
Design Challenges Solved
Using Aluminum Extrusions



Momentum™
Manufacturing Group



Engineered Extrusions

Introduction



Today, demand from businesses and consumers for energy-efficient lighting, advanced lighting control, and reduced prices has transformed the global LED lighting market into a highly competitive business predicted to reach \$25 billion in 2023.

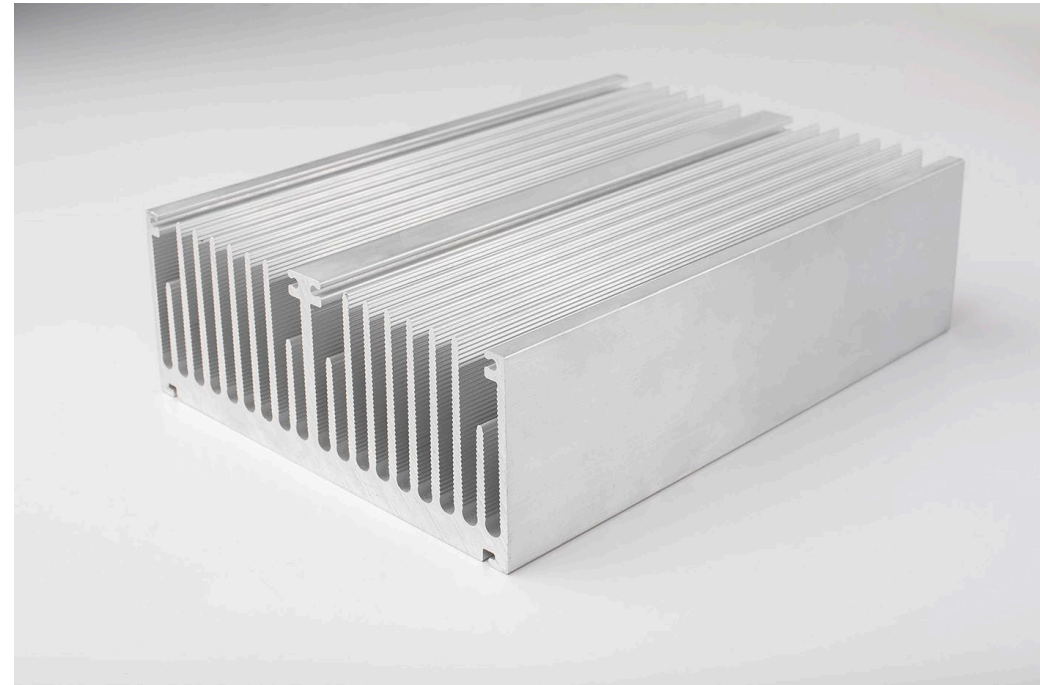
Expanded use of LED-based lighting technologies for both exterior and interior design schemes is driving the creation of new fixture designs. Today, luminaire designers must rethink their designs to carefully integrate and balance the competing requirements of optics, mechanics, electronics, thermal management, and light generation. In addition, lighting manufacturers are seeking new business models to combat the drastic fall in LED prices.

This paper discusses the use of aluminum extrusions to meet these competing requirements and to solve three of the toughest design challenges of working with LED technology.

The Thermal Challenge

Although LEDs are cool to the touch, within the devices there is plenty of unwanted heat. With high-power LEDs, it is crucial this heat be removed through efficient thermal management. Without good heat sinking, the junction (internal) temperature of the LED rises, causing both the forward voltage and the lumen output to decrease. This causes LED brightness and efficiency to decline over time, greatly reducing its lifespan.

The objective for design engineers is to remove the heat from the source and dissipate it as fast as possible. The use of heat sinks is an important part of LED lighting design as they provide a needed path for heat to travel from the LED light source to outside elements.



Heat sinks are able to dissipate power in three ways:

- conduction (heat transfer from a solid to a solid),
- convection (heat transfer from a solid to a moving fluid, air in most cases), or
- radiation (heat transfer from two bodies at different temperatures through thermal radiation)

Historically, aluminum has been the material of choice for thermal management applications in the lighting industry due to its thermal conductivity. The design variable has been whether to design heat sinks from aluminum extrusions or aluminum castings. LEDs, however, have created new thermal challenges and greater diversity in solid-state lighting (SSL) forms that have accelerated the use of custom aluminum extrusions.

Aluminum extrusions can be designed to incorporate cooling fins that act as an integrated heat sink to dissipate heat from the LED light. A variety of extruded aluminum heat sinks can be used in LED lighting, with

great size flexibility up to 21 inches wide and fin ratios of 19:1.

Heat Sink Shape

Finned heat sinks help as they provide more surface area for heat to transfer from. When fins are made too close together, the air in between doesn't cool and stops thermal transfer all together. For optimum performance in LED light fixtures, ensure your fins are well spaced.

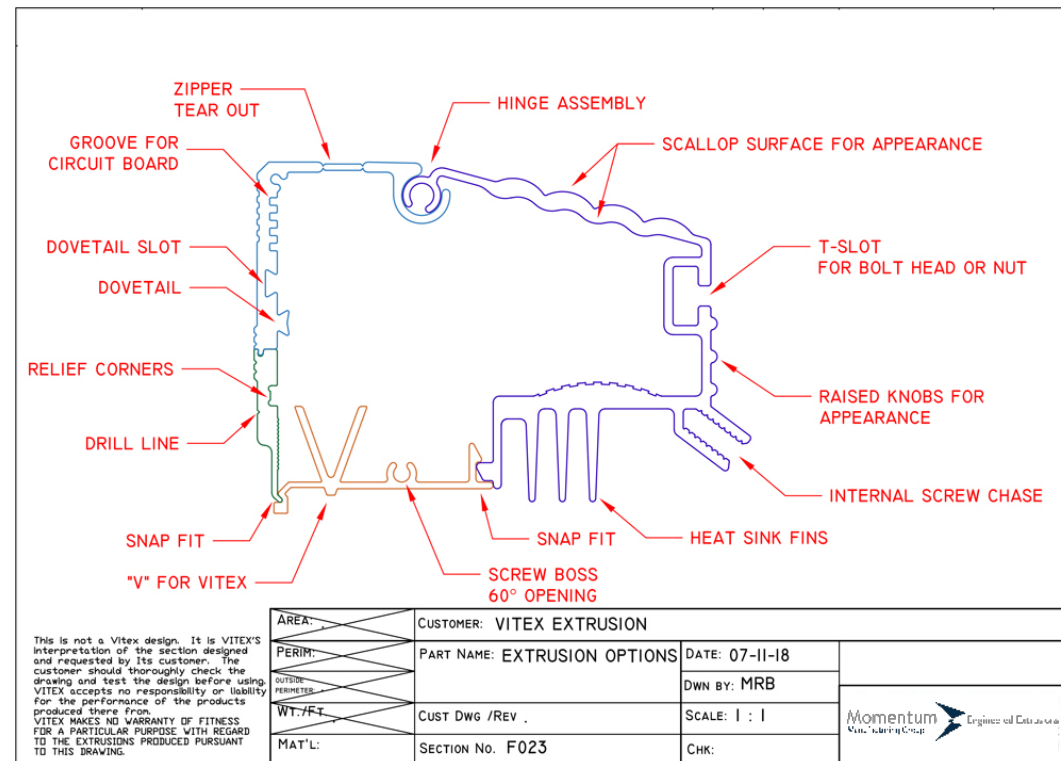
Rethinking Fixture Design

Engineers are also utilizing aluminum's thermal conductivity to design complete extruded LED light fixtures that transfer and dissipate heat for optimal thermal efficiency. The increase in thermal conductivity of extrusions versus castings allows the lighting manufacturer to use less material to obtain the same thermal efficiency. Less material plus a smaller footprint equates to lower total cost for the product manufacturer.

The Design Challenge

Growing demand for LEDs means retrofit lamps are out, making way for integrated light fixtures that allow a heat sink to be as large as needed, enabling higher efficiency and reliability. Dedicated fixtures also enable electronics to be thermally separated from the light source, which allows for better components and smoother electrical driving. Manufacturers are also free to create unique designs that meet customers' functional and aesthetic requirements.

The use aluminum extrusions offers endless design possibilities to incorporate interfaces for lenses, circuit boards, and end caps, while allowing the lighting designer to create the shape they desire and "put the metal where it is needed." Custom extrusions can incorporate built-in hinges, screw bosses, receptors, and grooves, and can integrate assembly options such as built-in dovetail, snap fit spring, and slots.



Extrusion dies are relatively inexpensive and can be easily cut, formed, bent, machined, and finished with anodizing or painting to create beautiful, high-efficiency lighting. Extrusions have the added benefit of integrating other materials into the fixture itself, such as reflectors and mountings, and enable the creation of dual-purpose lighting designs that are compact, easy to install, and offer a streamlined appearance. And, given that aluminum extrusions are infinitely recyclable with no degradation in properties, and can be specified with significant recycled content, extruded aluminum fixtures enhance the sustainability of LED lighting solutions.

The Beauty of Aluminum

One of the great properties of aluminum that is sometimes overlooked by designers is its ability to be shined to an almost chrome-like finish. This feature enables an all-aluminum LED light casing to be quickly and cost-effectively transformed into a sleek, modern design.



The Manufacturing Challenge

Given its small size and design flexibility, LEDs can lead to an unwieldy proliferation of parts and SKUs (and substantial ramp-up costs) for the lighting manufacturer. Fortunately, many of these parts can be eliminated with the use of custom aluminum extrusions.

Extrusion's flexibility allows considerable functionality to be designed into extruded components, improving performance, saving secondary operations, and accelerating subsequent assembly. Not just in new product design, but in existing products substitution of other materials and processes by aluminum extrusions can result in major cost savings through fewer components, reduced finishing, simplified assembly, and improved supply chain logistics. Clip-fits, screw-ports, and circuit-board location grooves are just a few ways to reduce components and simplify assembly at no additional cost.



For example, a major lighting manufacturer has found considerable cost savings by designing aluminum extrusions for its light fixtures that allow for different lenses to be attached to change the distribution of light output. Internally, several different LED circuit boards were added to help control light output, color, and distribution. In addition, to reduce inventory and production costs, the extruded aluminum fixtures were designed to accommodate several end caps that make it easy to change an interior fixture into an IP66-rated exterior fixture.



Meeting Interior Lighting Needs

LED lighting products are quickly making their way into interior lighting plans for residential and commercial applications from kitchens, bathrooms and driveways to office work stations, and have been integrated into stair steps, railings, furniture, and flooring.

LED lighting systems can achieve a sleek, modern look that optimizes versatility by using extruded channel housings with LED ribbon lighting. The design can offer a stable mounting surface for walls, shelves and indoor or outdoor areas to maximize LED strip lighting applications. Extrusion-housed LEDs help create a safe environment indoors with strip lighting built into stair steps, railings, under kitchen cabinets, in flooring, or exit doorways.



Meeting Exterior Lighting Needs

While originally designed for interior use, LED light fixtures are now widely used for both decorative and security functions in exterior applications. Given its uniform high light output that minimizes glare and improves safety and security for drivers and pedestrians, LED lights are being used for roadway and bridge lighting, parking garages and lots, roadway signs, digital display boards, advertising billboards and scoreboards, and commercial exterior building lighting, especially in LEED-certified building and retrofit projects. In addition, its natural corrosion-resistance makes it an ideal housing material for exterior LED light fixtures.



Bottom Line

Whether for new or retrofit uses, a multitude of extruded housing designs are rapidly expanding as LED technology evolves and becomes more cost effective, taking less and less time to pay for itself after initial investment. Utilizing the aluminum extrusion process for LED lighting design provides virtually unlimited opportunities to the product designer with the added benefit of low tooling costs and short lead times. Furthermore, working with an aluminum extrusion partner who understands LED lighting requirements, can offer expertise in Design for Manufacturability (DFM) and CAD modeling, and apply best practices to your design can reduce your cost and increase the quality of your overall design.

Manufacturing custom extrusions takes years of dedication and experience. You need a combination of talented engineers, tool builders and manufacturing staff to produce consistent quality parts and

components every time. Momentum Manufacturing Group Engineered Extrusions has been serving lighting manufacturers throughout the U.S. since 1986, helping them improve their process, product and bottom line.

Contact us today about your next project. We have the best people, processes and machinery to meet the most demanding industry requirements, while delivering shorter lead-times and consistent quality for even the most complex extruded aluminum shapes.

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