MAFELEC

TSL-ESCHA

LED-LIGHTING FOR RAILWAY

MAFELEC and TSL-ESCHA GmbH

MAFELEC develops control and signaling solutions for harsh environments. From push buttons to switches, from complete control panels to door control solutions, the company offers products that are best suited to the needs of our partners.

TSL stands for Touch, Signal and Light. Door opening push buttons, signal lights, sounders, indicator and display devices as well as LED lighting are part of the product portfolio. TSL-ESCHA develops, manufactures, and distributes individual customer solutions for public transportation.

Members of the MAFELEC TEAM

TSL-ESCHA based in Halver (Germany) and MAFELEC in Chimilin (France) are part of the MAFELEC TEAM. The owner-managed group of companies offers solutions for HMI, lighting and sensors and is active in the markets of bus and railway, industrial vehicle, industry, energy, defense, aerospace, and elevators.

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LED-LIGHTING FOR RAILWAY

LED-LIGHTING FOR RAILWAY
INTERIOR AND EXTERIOR

MAFELEC and TSL-ESCHA together offer a large portfolio for LED lighting for rail vehicles for interior and exterior applications. TSL's expertise lies particularly in the interior. The popular EL series built-in spotlights are used in the door area and lavatories. With the new ceiling lighting series LL there is now a long-term and expandable solution. This offers a customized lighting concept as well as an intelligent luminaire system for easy and predictive maintenance.

For more than 15 years, MAFELEC has distinguished itself with multiple solutions for exterior LED lighting. The M-Light series features a wide range of headlights, marker lights and tail lights – whether as a standard product or as a customized version.

- Intelligent and individual lighting solutions
- Space-saving lighting solution for tight spaces
- Maintenance assistance
- Various forms for plug-&-play systems
- Compliance with railway standards and regulations

Versatile lighting solutions for new vehicles and modernization of rolling stock.

The linear lights of TSL-ESCHA, like here the new ceiling lighting series LL, meet the demanding requirements.

LINEAR LIGHT SERIES LL AND PL
SLIM DESIGN, EFFICIENT LIGHT

TSL-ESCHA's LED lighting requirements are particularly demanding. This is because the products are used worldwide on both the interior and exterior as well as in the lavatories of rail vehicles and are thus often exposed to harsh conditions. In addition to reliable operation, the products focus on the needs of passengers and operating personnel. Brightness adapted to the operating conditions and optimal recognition of the LED linear lights ensure passengers a comfortable ride.

- Optimized efficiency in mechanics, electronics and lighting technology
- Needs-based luminosity
- Standards-compliant development
- Reliable and high availability

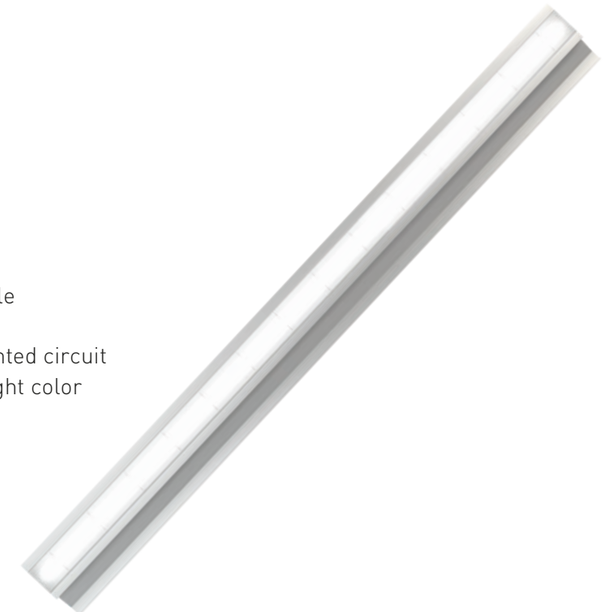
LINEAR LIGHT SERIES LL
INTELLIGENT AND INDIVIDUAL

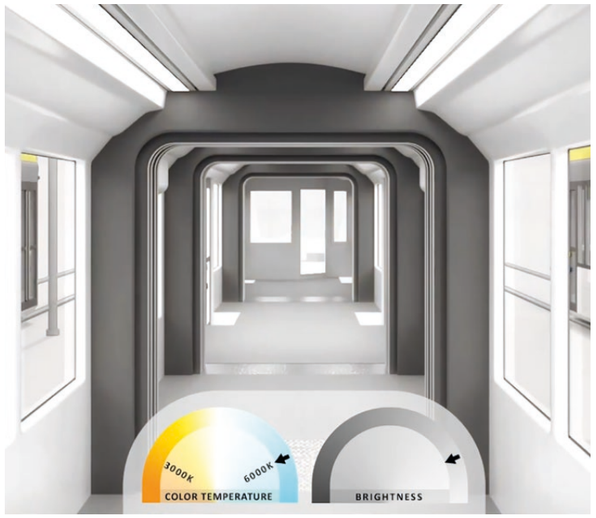
Light can have a calming and relaxing effect. This is an enormous advantage in the often hectic everyday life of public transportation. Accordingly, more and more operators are relying on an intelligent lighting system. This means a greater comfort for passengers but also optimum safety. A smart lighting system also offers added value for the vehicle manufacturer. Because who doesn't want a product that is maintenance-free, durable and reliable? In addition, it can withstand continuous loads for many years and at the same time reduce ongoing operating costs.

TSL-ESCHA has developed the perfect solution for LED ceiling lighting for rail vehicles with the new linear light series LL.

With the new LL series, TSL-ESCHA offers a universal, innovative and intelligent lighting concept for ceiling lighting in trains. Fixed light colors or colors adapted to the respective situation from warm white to cold white light (from 3,000 K to 6,500 K) can be realized. A homogeneous light without transitions can be achieved over the entire length of the vehicle with the LL series.

- Intelligent and individual lighting solution
- Variable light lengths allow installation in any vehicle
- Subsequent parameterization possible, as each printed circuit board is individually adjustable in brightness and light color
- Cost and time savings during maintenance
- Predictive planning of repairs possible (predictive maintenance)





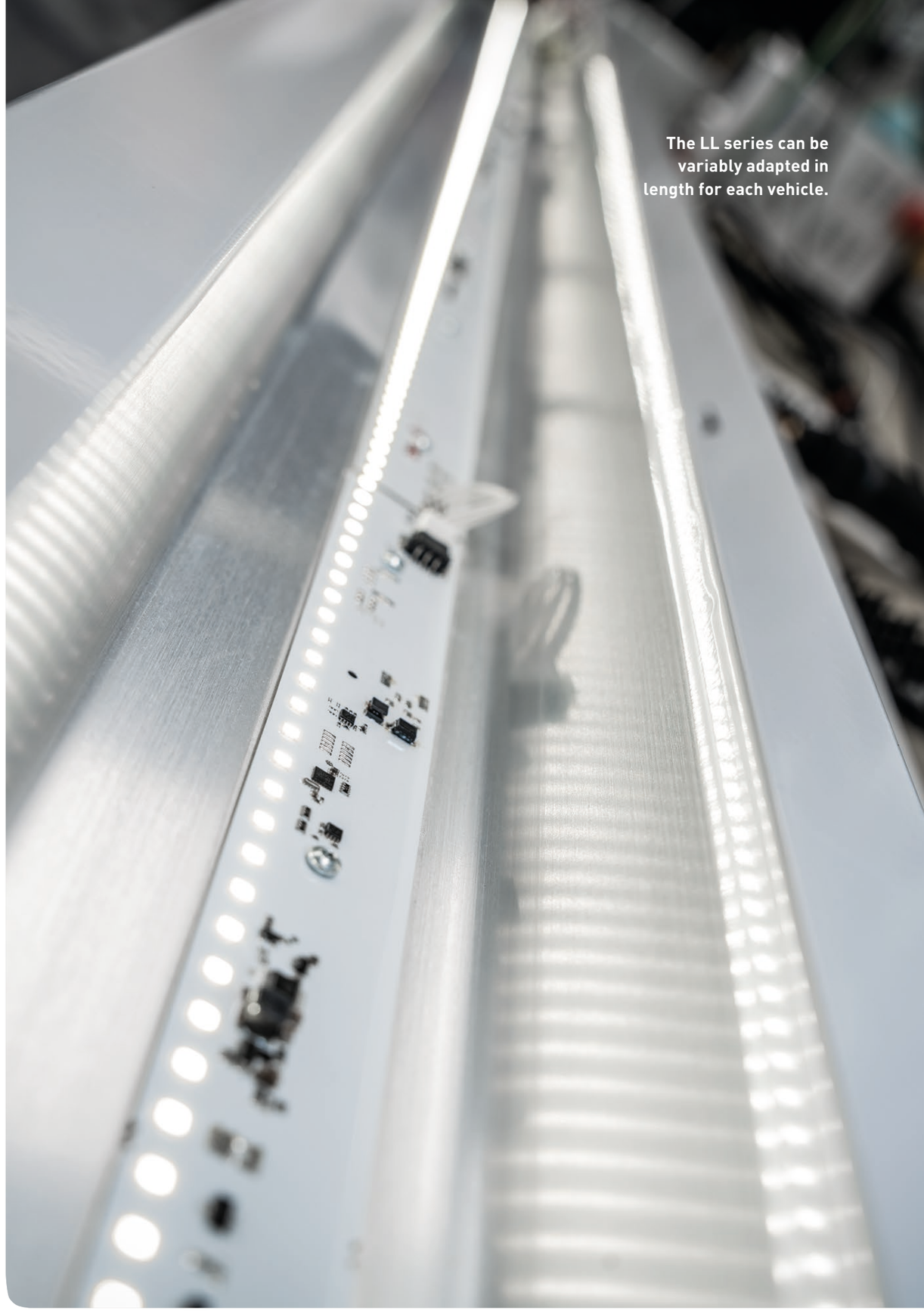
LL SERIES
LIGHT FOR PRESENT AND FUTURE

The advantage of the linear light series is its simple and intelligent wiring. This makes the system a cost-effective option that is also easy to assemble. Each Printed circuit board can be individually adjusted in terms of brightness and light color. This makes it easy to implement individual customer requirements. The same applies to compliance with standards such as for electronic equipment (EN 50155), photometric requirements (EN 13272-2) and fire protection (EN 45545-2 up to Hazard Level 3).

The light color according to individual customer requirements is already set in advance at the TSL-ESCHA factory. On site at the vehicle manufacturer, it is then possible to make a simple adjustment of the brightness in the installed state. This is how modern lighting technology works. It makes things easy for the vehicle operator and ensures that passengers feel even safer and more comfortable.

The linear lights can be connected to the existing communication system of the vehicle, as it is gateway-capable. This enables higher-level control. This is done via Ethernet or CAN bus, which are frequently used in the rail industry. By analyzing and evaluating the collected data, correct maintenance work can be carried out, suitable spare parts can be provided, and the downtime can be kept as short as possible. The magic word in this area is predictive maintenance.

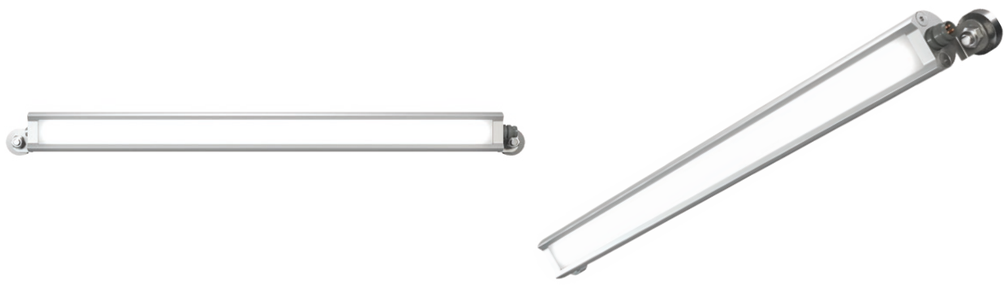
- Plug-&-play system components – from diffusers to profiles
- The LL system is a cost-effective variant that already has a basic intelligence. This can be upgraded by a gateway as a high-end variant
- Long-lasting and expandable solution
- Networking of the different systems enables higher-level control and monitoring (Railway 4.0)



The LL series can be variably adapted in length for each vehicle.

PL14
FLAT AND VARIABLE

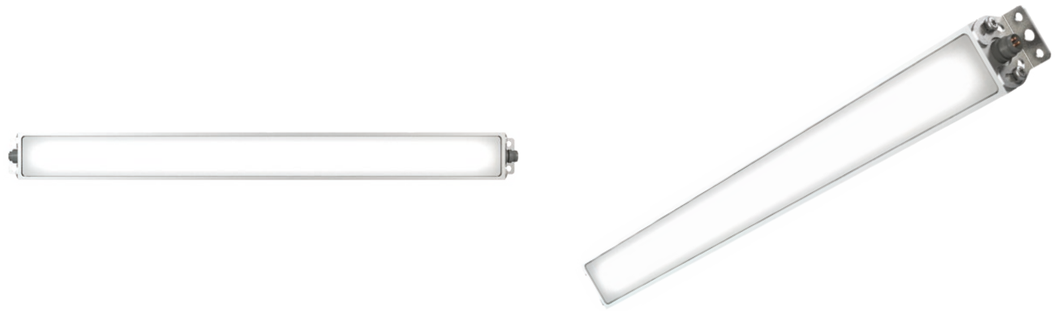
- Installation in rail vehicles at the driver's desk or general workstations
- Compact construction type with matt PC cover
- Available in three lengths (278, 538 or 798 mm)
- Luminous colors: neutral white 5,000 K or cold white 6,500 K
- Beam angle: 90° (PL14x3: <496 lm)
- Special features: as a supplement to the PL151 workstation light for illuminating shelves (48 VDC)
- PL14 HT complements the product family with an extended operating temperature of up to +80 °C; length 172 mm
- Mounting variants: on inclinable mounting brackets using pot magnets or back side bolts



Nominal voltage	24 VDC
Nominal power	14 W @ 24 VDC with a length of 538 mm
Operating temperature	-40 ... +40 °C
Degree of protection	IP20
Visible external dimensions (L x W x H)	278 ... 798 x 23 x 18

PL14 M
DURABLE AND HIGH DEGREE OF PROTECTION

- Installation in rail vehicles for mirror lighting in the lavatories or on the desks of drivers
- Compact construction type with robust glass cover
- Available in three lengths (289, 549 or 809 mm)
- Luminous colors: neutral white 5,000 K
- Beam angle: 98° (PL14x3M: 496 lm)
- Special features: shock and vibration resistant
- Mounting variants: can be tilted ± 35° with mounting bracket



Nominal voltage	24 VDC
Nominal power	11 W @ 24 VDC with a length of 549 mm
Operating temperature	-40 ... + 60 °C
Degree of protection	IP67
Visible external dimensions (L x W x H)	289 ... 810 x 28 x 14 mm

PL30
ROBUST AND VIBRATION RESISTANT

- Installation in rail vehicles
- Compact construction type with robust glass cover
- Available in two lengths (420 or 820 mm)
- Luminous colors: warm white 3,200 K or cold white 6,300 K
- Beam angle: 80° (PL30x4: 673 lm) with high power LEDs
- Special features: robust housing, shock and vibration resistant
- Mounting variants: using tiltable mounting brackets

Nominal voltage	24 ... 36 VDC
Nominal power	16 W @ 24 VDC with a length of 420 mm
Operating temperature	-20 ... +50 °C
Degree of protection	IP67
Visible external dimensions (L x W x H)	420 ... 820 x 46 x 27 mm

The LED Light PL30 was especially designed for harsh applications.

Due to the stainless steel housing, the built-in spotlights of the EL series are particularly robust.

BUILT-IN LIGHTS SERIES EL
CONSTANT BRIGHTNESS AND DURABLE

Good lighting means that the focus is not only on standards, but primarily on people, their requirements and their well-being. TSL-ESCHA built-in lights are compact and powerful. The small spotlights can be found particularly in the door area and in lavatories of rail vehicles.

- Multiple built-in variants
- Robust housing technology, high degree of protection and wide operating temperature range
- Complies with the current standards for rail vehicles (EN 50155, EN 45545-2 and EN 61373)
- Ideal solution for the lighting of lavatories

EL50
COMPACT AND POWERFUL

Although TSL-ESCHA's built-in lights are compact and discreet, everything that matters is visible once they light up. The small built-in spotlights are often found on the exterior and interior door areas and lavatories of trains. The EL series is characterized in particular by its compact design and easy installation

The proven EL50 has a wide beam angle of 32 degrees. As a spot, this illuminates over five meters. Due to a product extension, the EL50 series gets two new beam characteristics in clear and diffuse.

The 70 degree beam angle with a clear cover illuminates a lavatory on the walls much better, for example, as it radiates more broadly. This makes the light even more homogeneous.

The new variant with a 70 degree beam angle with diffuse cover radiates the light even more homogeneously. This ensures less glare. This is achieved by means of an inserted diffuse foil. Around 30 percent less light shines through this. That makes the EL50 70° diffuse suitable for use in lavatories and especially for a placement above changing tables or at mirrors.

EL50 70° clear

EL50 70° diffuse

EL50 32°

Nominal voltage	24 ... 36 VDC or 110 VDC
Nominal power	5 W @ 24 VDC or 4 W @ 110 VDC
Operating temperature	-40 ... +50 °C
Degree of protection	IP67
Visible external dimensions (L x W x H)	Ø90 x 20mm

EL50 70° clear

EL50 70° diffuse

EL50 32°

- Flat construction type with robust, flat glass cover
- Various luminous colors and beam angles possible
- Luminous colors: from warm white 2,700 K to cold white 6,500 K
- Mounting variants: mounted from the front side using mounting claws; screwed on from the back side; snap-in ball studs or mounted from the back side without a front panel

ELK50
MANY MOUNTING OPTIONS

- Installation on the interior door area of rail vehicles
- For signaling or illumination in a spherical glass dome
- Flat construction type with robust, domed glass cover (glass height of 14 mm)
- Luminous colors: from warm white 2,700 K to cold white 6,500 K
- Beam angle: 120°
- Special features: Front side made of special frosted glass
- Mounting variants: mounted from the front side using mounting claws; screwed on from the back side; snap-in ball studs or mounted from the back side without a front panel

Nominal voltage	24 ... 36 VDC or 110 VDC
Nominal power	5 W @ 24 VDC or 4 W @ 100 VDC
Operating temperature	-40 ... +50 °C
Degree of protection	IP67
Visible external dimensions (L x W x H)	Ø90 x 14 mm

ELK63
GOOD SPATIAL ILLUMINATION

- Installation on the interior door area of rail vehicles
- For signaling or illumination in a spherical glass dome
- Flat construction type with robust, domed glass cover (glass height of 22 mm)
- Luminous color: cold white 6,500 K
- Beam angle: 120° through spherical body
- Special features: Front panel made of special frosted glass, optimal lateral recognition and very good spatial illumination
- Mounting variants: mounted from the front side using mounting claws; screwed on from the back side

Nominal voltage	24 ... 36 VDC
Nominal power	5 W @ 24 VDC
Operating temperature	-40 ... +80 °C
Degree of protection	IP67
Visible external dimensions (L x W x H)	Ø100 x 24 mm

ELS52
MINIMAL INSTALLATION DEPTH

- Installation as ceiling spotlight in lavatories or in the door area of rail vehicles
- Similar to EL50 with less light output, but with the MLS52's construction type
- Flat construction type with robust glass cover
- Luminous colors: from warm white 2,700 K to cold white 6,500 K
- Beam angle: 32°
- Special features: minimal installation depth of only 25 mm, front side made of single-layer safety glass
- Mounting variants: can be mounted from the front or back side

Nominal voltage	24 ... 36 VDC
Nominal power	3 W @ 24 VDC
Operating temperature	-40 ... +50 °C
Degree of protection	IP67
Visible external dimensions (L x W x H)	Ø87 x 7 mm

EL spotlights are ideal for lighting the lavatories and the PL14 as light for the mirror.

M-LIGHT SERIES
FRONT LIGHTING FOR RAILWAY VEHICLES

For more than 15 years, MAFELEC has been a key player in the front lighting for rolling stock in the world.Our optical, electronic and mechanical expertise allows us to offer a wide range of products for front lighting. The M-Light range consists of standard LED headlights and marker lights, but also specific solutions fully adapted to the design requested by the customer.

- Certified product range for the European market
- Optical variants available according to the country of operation
- Development of specific solutions including signalization and signature optical functions
- Compliance with railway standards and regulations

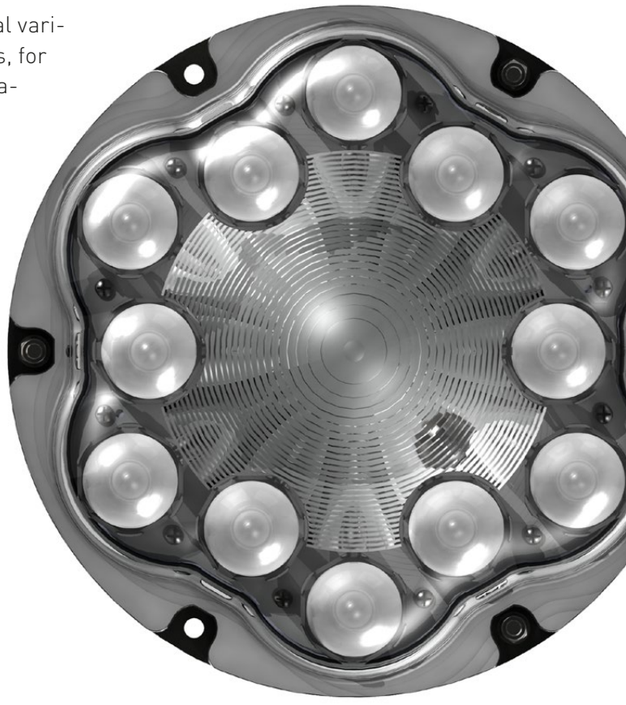
For each project of new equipment or refurbishment, a relevant M-Light solution is available.

ML5-1/170 DAISY-SHAPED
MULTIFUNCTIONAL AND RELIABLE

The ML5-1/170 is a LED light that combines the various lighting functions expected on the front of a rail vehicle to ensure the visibility of the trainset and to illuminate the track.

Thanks to the diversity of optical, electrical and mechanical variants, the ML5-1/170 can be adapted to all integration cases, for new or refurbished equipment projects intended for circulation in Europe or in the USA.

The ML5-1/170 was the first LED combination light in the railway market and has gained excellent feedback. It has a distinctive daisy-shaped design and perfectly integrated optical functions.



- Combined railway LED light
- Up to five functions: headlight (F&D), white marker light (F&D) and red tail light
- Adaptable optical requirements
- Different mechanical variants
- Compliance with railway standards and regulations
- Excellent operational experience

ML5-1/170 – a compact and proven solution for railway front lighting.

Our combined light ML5-1/170 equips the greatest train builders. More than 40 000 pieces are in operation worldwide.

ML5-1/170 DAISY-SHAPED FOR OPERATION IN EUROPE

OVERVIEW OF DIFFERENT VARIANTS

Within the European Union, rolling stock must be equipped with front lights complying with the EN 15153-1 standard and certified according to the TSI LOC & PAS directive.

The ML5-1/170 is a compact product that meets these requirements and combines the various lighting functions in one product: full headlight, dimmed headlight, full white marker light, dimmed white marker light and red tail light.

It can be adapted to different integration cases thanks to the mechanical variants available: front or rear mounting, plastic or glass front cover including defrosting option, alignment adjustment system +/- 1,0°. The cable length and the addition of a connector can be adjusted according to the needs of the project.

For each project, the ML5-1/170 is optically calibrated to account for integration constraints, including attenuation caused by integration behind a customer glass.

The anti-glare option according to table 3 of EN 15153-1, commonly called cut-off, is also available.

Nominal power	24 ... 36 VDC or 72 ... 110 VDC (-30 % / +25 %)
Lit area	Ø170 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP66 front, IP65 rear
Service life	60,000 h

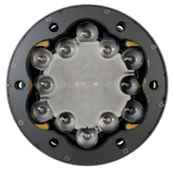
VARIANT 1 - BASIC

- Front or rear mounting; plastic cover
- Up to five functions: headlight, white marker light and red tail light
- Alignment adjustment system +/-1,0°
- For lower light or upper light when including headlight function

VARIANT 2 - MARKER LIGHT ONLY

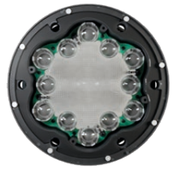
- Front or rear mounting; plastic cover
- Only marker light function
- Ideal for upper light

VARIANT 3



- Front or rear mounting; heated glass cover
- Up to five functions : headlight, white marker light and red tail light
- For lower or upper light
- Non regulated defrosting - 24VDC only

VARIANT 4 - CUT OFF



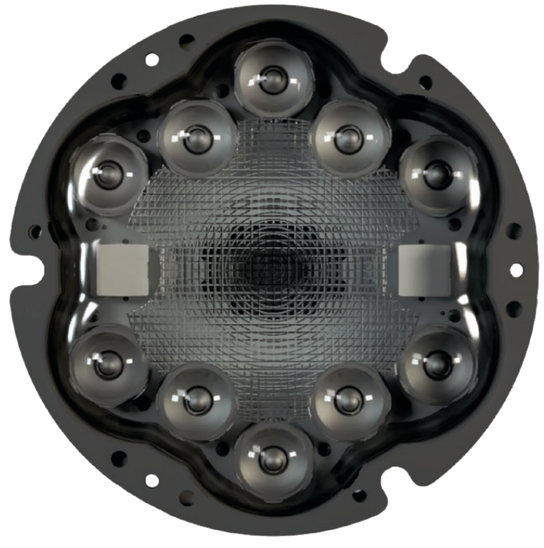
- Front or rear mounting; glass cover
- Up to five functions : headlight, white marker light and red tail light
- Anti-glaring headlight, compliant with Table 3 of EN 15153-1
- For lower light

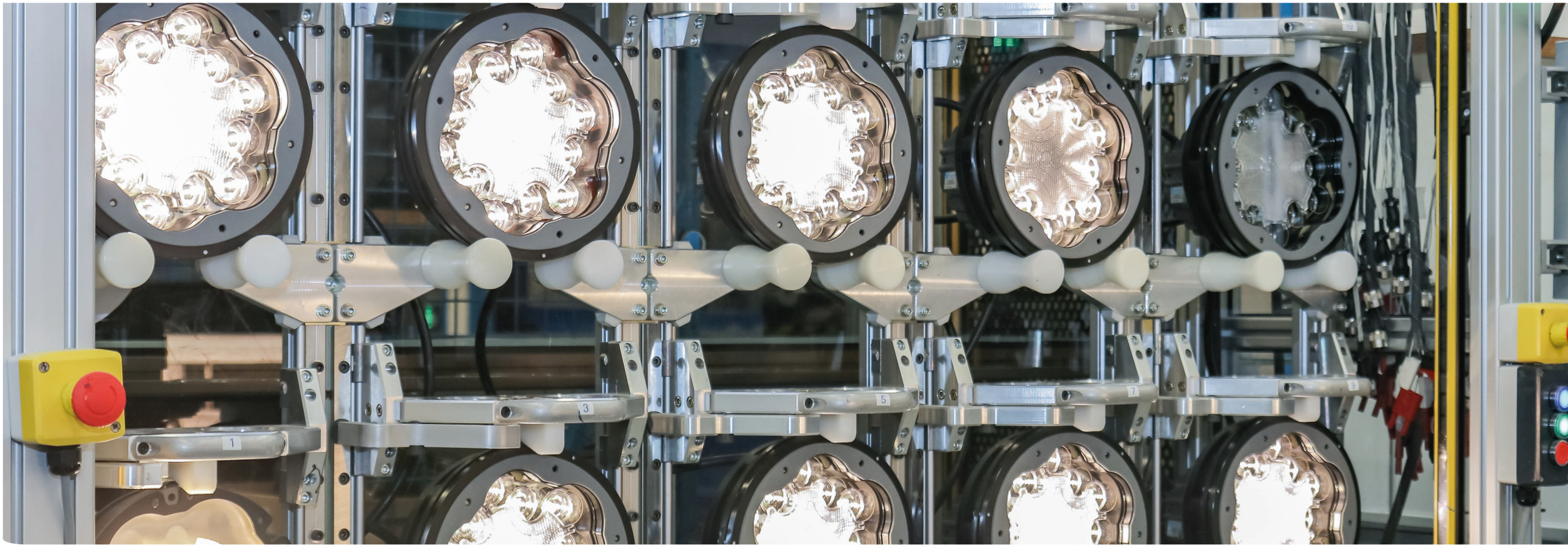
ML5-1/170 FOR USA AND OTHER MARKETS
ADAPTED OPTICAL VARIANTS

The optical requirements of railway front lights vary according to the type of equipment and the operation area.

In order to satisfy the requirements of the American market, MAFELEC has developed an optical variant of the ML5-1/170 which allows to combine the headlight, auxiliary light and red marker light functions, described in the 49 CFR 229.125, 49 CFR 238.443 and 49 CFR 221.14 standards.

Thanks to MAFELEC optical expertise, other variants can be realized for other markets, on expression of the need such as the luminous intensity in the axis and at certain angles, or a given colorimetry.





ML5-1/170 NEO
NEW AND IMPROVED

Based on more than 10 years of experience with the ML5-1/170, MAFELEC introduces a new version of the LED combined light: ML5-1/170 NEO.

More compact and lighter, the ML5-1/170 NEO can be easily integrated on rail vehicles, where the available space is always a critical issue. At the electronic level, the reduction in current draw allows the system integrator to reduce the sizing of the upstream equipment. A control function has been added to the defrosting option.

SIL2 certified, the ML5-1/170 NEO guarantees a high level of reliability in the operation of the lighting system.

- Railway LED combined light
- Up to five functions : headlight, white marker light and red tail light
- Compact and light
- European and U.S. optical versions
- Reduced inrush currents
- Regulated defrosting option
- Compliance with railway standards
- SIL2

Nominal power	24 ... 36 VDC or 72 ... 110 VDC (-30 % / +25 %)
Lit area	Ø170 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP66
Service life	60,000 h

ML5-1/170 NEO – VARIANTS
OVERVIEW OPTICS AND MOUNTING

The ML5-1/170 NEO is available in three optical variants. Two of them (with and without cut-off) comply with the requirements of the European market and are TSI LOC&PAS certified. The third is for the U.S. market, with compliance with 49 CFR 229.125, 49 CFR 238.443 and 49 CFR 221.14.

On the mechanical side, it is possible to choose between four variants: front mount or rear mount, with or without alignment adjustment system.

OPTICAL VARIANTS

ML5-1/170 NEO

- Combined headlight, white marker light and red tail light
- EN 15153-1
- TSI LOC & PAS certified

ML5-1/170 NEO CUT-OFF

- Combined headlight, white marker light and red tail light
- EN 15153-1
- Headlight with cut-off according Table 3 of EN 15153-1
- TSI LOC & PAS certified

ML5-1/170 NEO U.S.

- Combined headlight/auxiliary light & red marker light
- 49 CFR 229.125, 49 CFR 238.443 et 49 CFR 221.14.

MOUNTING VARIANTS

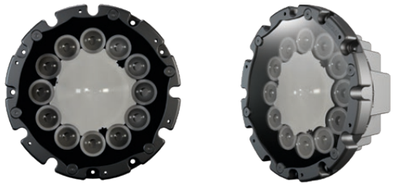
FRONT MOUNTING WITH ADJUSTMENT SYSTEM

- Alignment adjustment system +/-1,5°
- Typical configuration when headlight function is present

REAR MOUNTING WITH ADJUSTMENT SYSTEM

- Alignment adjustment system +/-1,5°
- Typical configuration when headlight function is present

FRONT MOUNTING WITHOUT ADJUSTMENT SYSTEM



- Typical configuration for product without headlight function

REAR MOUNTING WITHOUT ADJUSTMENT SYSTEM

- Typical configuration for product without headlight function

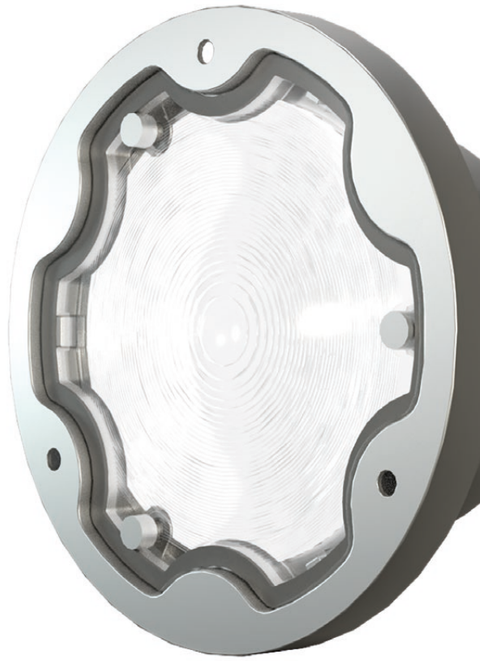
MLMT/120
SMALL AND EFFICIENT

MLMT/120 is a compact LED marker light, ideal for installation on subways and renovation projects.

The basic version is a bicolor white/red marker light for the European market, meeting the criteria of EN 15153-1 and TSI LOC& PAS certified. Adaptations were then made, in terms of type of LEDs or light intensity adjustment, to realize signalling options existing in other countries.

One example is the flashing amber function, common in India.

- Compact railway LED marker light
- Single color or bicolor
- Basic variant according EN 15153-1/ TSI LOC & PAS certified
- Three modes available, steady, autonomous flashing, non- autonomous flashing
- Optical variants adapted to different operating areas
- Improved lifetime



Nominal power	24 ... 110 VDC (-30 % / +25 %)
Lit area	Ø120 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP66
Service life	60,000 h

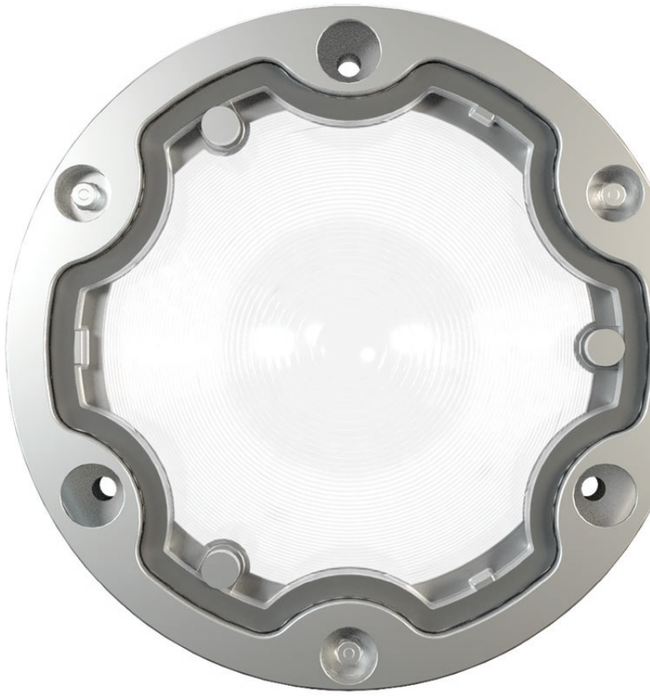
MLHE/120
COMPACT AND ADAPTABLE

Equipped with two levels of light intensity, the MLHE/120 is a LED light intended to ensure the function of white headlight on trains and subways.

Meeting the lighting requirements of EN 15153-1 (with the exception of the lit area) and TSI LOC & PAS certified, the MLHE/120 is the alternative to the ML5-1/170 combined product for installations where the headlight remains separate from the marker lights.

Its compact size and wide supply voltage range make it easy to integrate, especially on retrofit projects and subways.

- Compact railway white LED headlight
- Three modes availables, steady, autonomous flashing, non- autonomous flashing
- Basic variant according EN 15153-1/ TSI LOC & PAS certified
- Optical variants adapted to different operating areas and applications
- Front cover variants : Fresnel lens, optical collimators
- Improved lifetime



Nominal power	24 ... 110 VDC (-30 % / +25 %)
Lit area	Ø120 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP66
Service life	60,000 h

MLHE/PAR56
EASY FITTING AND BRIGHT

The MLHE/PAR56 is a white LED headlight that has the particularity of being compatible with PAR56 type lights, commonly found on American and Asian locomotives. In the case of renovation projects or the desire to reduce power consumption, it is easy to replace filament lights with LED lights.

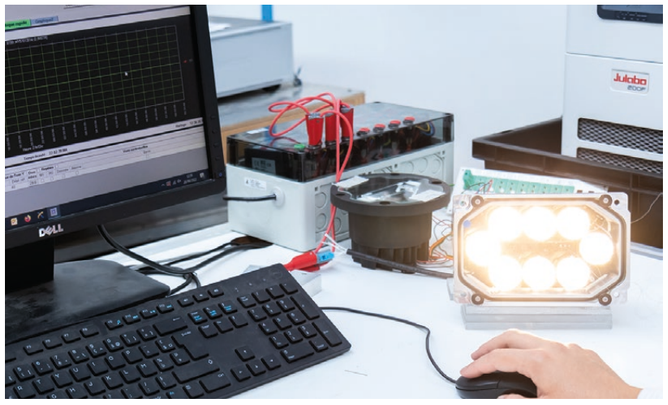
Two optical variants are available:
- The American variant allows to reach a luminous intensity higher than 200,000 candelas in the axis, according to the 49 CFR requirements.
- The Indian variant meets the requirements of the Indian Railways standards.

- Railway white LED headlight
- Dimensions compatible with PAR56 lamps
- Two modes available
- Two optical variants, american and indian version
- Compliant with US CFR regulations or Indian Railways
- Improved lifetime

Nominal power	24 ... 110 VDC (-30 % / +25 %)
Lit area	Ø170 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP66
Service life	60,000 h

MLHE/RT160
RECTANGULAR AND FLEXIBLE

- Railway LED headlight
- Rectangular shape
- Two modes available : high and low beam
- Various optical variants are possible
- European variant according to EN 15153-1/TSI LOC & PAS
- Other optical variants : white flood light (detrainment light), amber flasher light or specific light according to customer requirements
- Improved lifetime



Nominal power	24 ... 110 VDC (-30 % / +25 %)
Lit areac (W x H)	around 160 x 135 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP66
Service life	60,000 h

MLHE/RT200
SQUARE AND POWERFUL

- Railway white LED headlight
- Rectangular shape
- High light intensity > 1 million candela
- Two modes available: high and low beam
- Dedicated to chinese railway market
- One product meets the requirements for EMUs and shunting locomotives
- Two products are needed on trunk lines
- Improved lifetime

Nominal power	72 ... 110 VDC (-30 % / +25 %)
Lit area (W x H)	around 200 x 200 mm
Operating temperature	-40 ... +70 °C
Degree of protection	IP65
Service life	60,000 h

CUSTOM LIGHTS
FULLY ADAPTED TO YOUR DESIGN

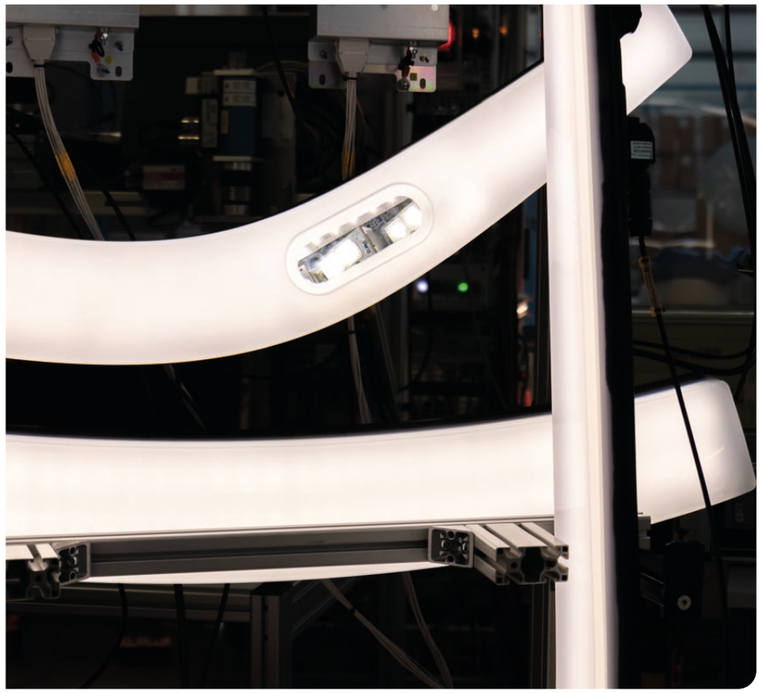
The aesthetics of trains has become a major element, especially on urban and suburban lines, of which front lighting is an integral part. This results in the need for specially shaped lights, a flexibility made possible by LED technology. MAFELEC brings together all the technical, industrial and project management skills to support train builders in the development and manufacture of customized solutions, from simple light module to complete front lighting solutions.

- Product designed according to customer specifications
- Functional or merely aesthetic lighting
- From simple light module to complete front lighting solutions including signalization and signature optical functions
- Technical expertise in many fields: optics, electronics, thermics, mechanics, materials
- Compliance with railway standards and regulations
- DIN 6701 A1 / EN 17460 bonding certification
- SIL development capability

TYPES OF CUSTOMIZATION
FROM SIMPLE MODULE TO FRONT LIGHTING SOLUTION

MAFELEC develops front lighting solutions, fully adapted to the customer's needs and optimized in terms of energy consumption and maintenance. Depending on the project, the scope of supply varies as regards the degree of integration and customization required. With the realization of about twenty different projects in the last 10 years, a strong experience has been acquired on the design of complex railway optical blocks, both in terms of optical and mechanical control. In addition, MAFELEC is equipped with a dedicated and efficient industrial tool, including a dedicated DIN6701 bonding room.

Some examples of projects are presented hereafter to illustrate the different types of technical solutions.



OPTICAL MODULES - OPEN FRAME

The open frame architecture offers a cost-effective solution designed for installation either within the cab, behind the windshield, or directly integrated into the customer's optical block. The signalization and signature LED PCBAs and modules are engineered to meet specific customer requirements. The PSU Controller can be either the standard M-LIGHT ADCTRL or a custom controller.

OPTICAL BLOCKS - SEMI CUSTOM

Semi-custom optical blocks are designed for integration into the front-end of the train, suitable for both upper and lower positions. The architecture features a robust custom casing combined with a standard M-LIGHT product. The optical block comprises a composite casing and a bonded front cover glass, which includes an optional defrosting system.

OPTICAL BLOCKS - FULL CUSTOM

Full custom optical blocks are designed to be integrated into the front-end of the train, meeting the aesthetic requirements of the customer. These blocks are primarily positioned in the lower sections. The architecture is based on a robust custom casing that incorporates several custom LED PCBAs, dedicated entirely to signalization and signature optical functions, along with a standard M-LIGHT ADCTRL controller. The optical block features an aluminum casing for optimal heat dissipation and a bonded front cover, which includes an optional defrosting system.

FRONT LIGHTING SYSTEM - FULL CUSTOM

The front lighting solution is designed to illuminate the entire front-end of the train while meeting the customer's aesthetic requirements. It is seamlessly integrated into the FRP around the windshield. The architecture is based on multiple robust custom casings that incorporate custom LED PCBAs dedicated to signalization and signature optical functions, along with an M-LIGHT ADCTRL controller or a custom controller. The optical blocks feature aluminum casings for optimized heat dissipation and bonded front covers.

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