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LED Lighting

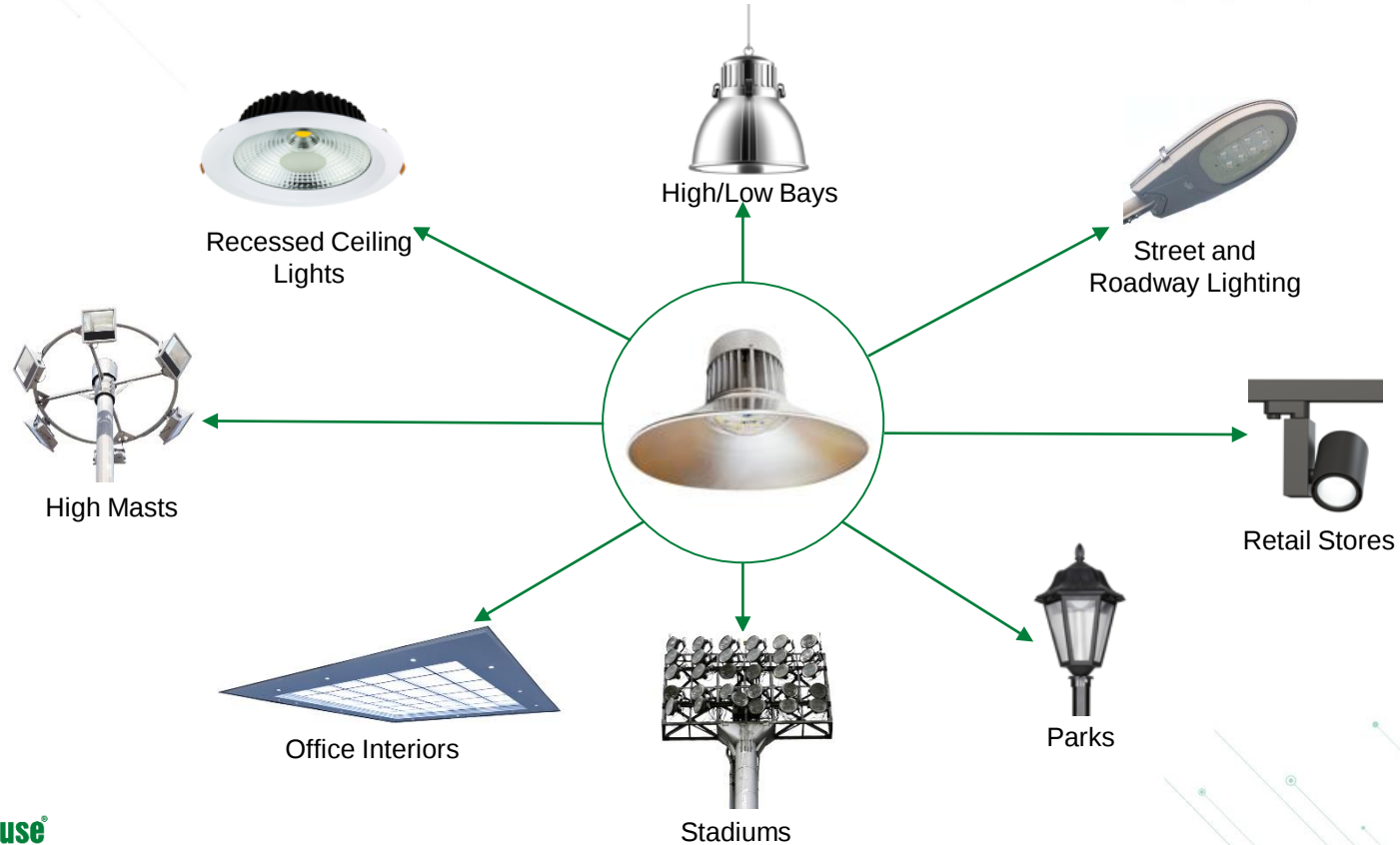
Illuminating the path to our future



LED Lighting

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Various lighting applications now include smart features



Smart LED lighting market trends and drivers

Market trends and drivers

The global LED lighting market size was valued at USD 55.5 billion in 2021 and is expected to expand at CAGR of 10.5% from 2022 to 2030

Increasing construction activities and stringent government regulations to lower the adoption of inefficient lighting technologies, are the major driving factors

LED manufacturers are focused on integrating solutions such as Wi-Fi, occupancy sensor, and daylighting which is attracting consumers

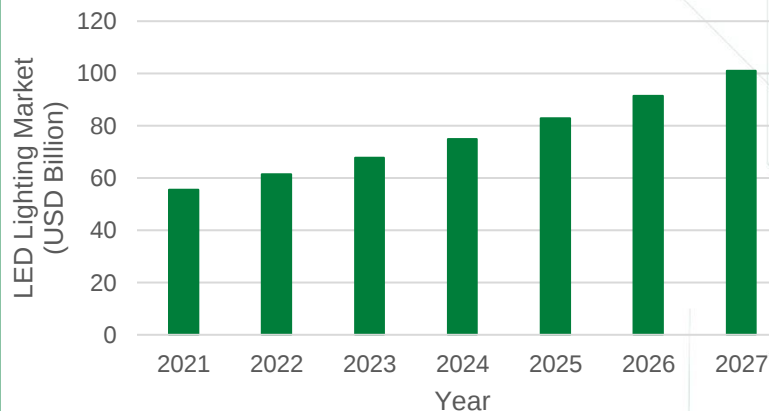
The indoor segment accounted for over 68.0% revenue share in the global market in 2021. This can be attributed to increasing demand from supermarkets, malls, and retail stores for efficient lighting solutions

The outdoor segment is expected to witness moderate growth which can be attributed to increase in public infrastructure projects and increasing government initiatives to attain net-zero emission

In terms of regional growth, Asia Pacific accounted for a revenue share of over 42.8% in 2021. North America and Europe accounted for 57.2%. This can be attributed to increase in infrastructure projects and stringent government regulations and initiatives pertaining to energy efficiency

From September 2021, under EU regulations the minimum efficiency requirement for general service lighting was set at 91 lm/W. Likewise, in 2017, European Union started using an A (efficient) to G (inefficient) scale which is expected to help the customers make better-informed purchasing choices

LED lighting market is growing at ~10.5% CAGR



Source: [LED Lighting Market](#), [Markets&Markets](#)

Industrial and commercial luminaires

1 AC input

- Fuse
- MOV

2 Filter and Regulator

- MOSFET
- LED Driver IC



3 Line Rectifier

- SIDCator® + MOV
- Rectifier Diode

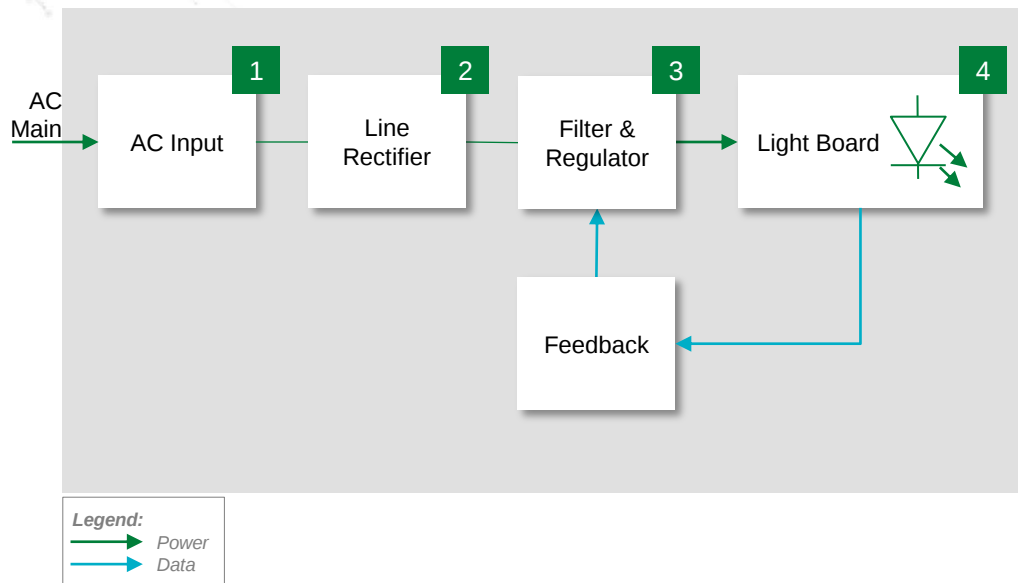
4 Light Board

- TVS Diode
- LED Protector



Click on the product series in the table below for more info

Industrial and commercial luminaire block diagram



	Technology	Product Series
1	Fuse ^I	209 , 392 , 383 , or 476
	MOV	UltraMOV , Xtreme
2	SIDACtor + MOV ^{II}	P3500SCLRP + UltraMOV or Xtreme
	Rectifier Diode	Schottky Gen² Diodes
3	LED Driver	CPC9909 , MXHV9910
	MOSFET	N-Channel Ultra Junction
4	TVS Diode	SMBJ , 1.5KE
	LED Protector	PLED

Notes:

- I. Many different fuse options available based on current, voltage, mounting method, and surge withstand required.
- II. For protection in more harsh environments and when enhanced reliability is critical. For 110 V power regions, like North America, Japan, we recommend P1900xxx + UltraMOV.



Click on the product series in the table below for more info

Industrial and commercial luminaire solution details

	Technology	Function in Application	Product Series	Benefits	Features
1	Fuse	Overcurrent protection	209 , 392 , 383 , or 476	Avoids nuisance tripping; multiple mounting options	Up to 300 Vac; high I ² t rating
	MOV	Primary surge protection	UltraMOV , Xtreme	Passes appropriate surge level testing	Up to 15 kA I _{max} ; up to 125 °C operating temp
2	SIDACtor + MOV	Transient voltage suppression	P3500SCLRP + UltraMOV or Xtreme	Enhanced system reliability	Low peak let-through voltage
	Rectifier Diode	Converting AC to DC	Schottky Gen² Diodes	Efficient energy conversion	I _{FAV} 10 to 300 A
3	LED Driver	Constant current driver with dimming and PFC	CPC9909 , MXHV9910	Energy efficient; built-in power factor correction	Up to 600 V input operating voltage range; > 90% efficiency
	MOSFET	Power conversion	N-Channel Ultra Junction	High power density	400–1000 V Class
4	TVS Diode	Transient protection for LEDs	SMBJ , 1.5KE	Better protected light board	600 W or 1500 W peak pulse rating
	LED Protector	Bypasses LEDs failed-open	PLED	Higher percentage of light output when LED fail-open	6, 9, 13, or 18 V _{DRM}

Street & outdoor LED luminaire

1 Photocontrol

- MOV
- LED Surge Protection Module

2 AC Input

- Fuse
- Surge Protection Module



3 LED Driver

- Multiple control products
- Multiple protection products

4 Light Board

- MOSFET
- TVS Diode
- LED Protector

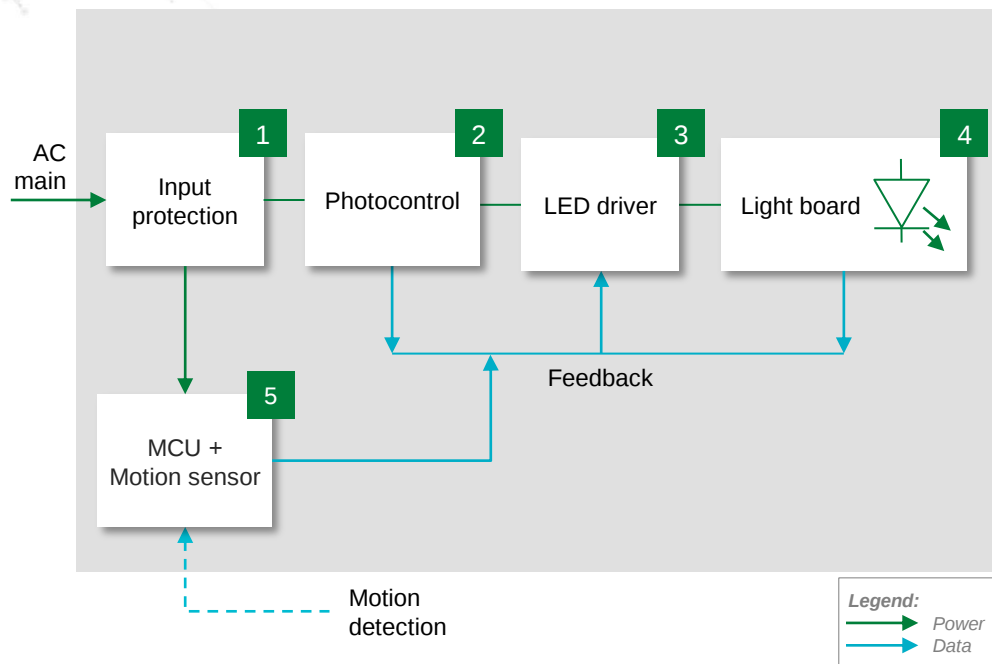
5 Motion Sensor

- PIR Sensor



Click on the product series in the table below for more info

Street & outdoor LED luminaire block diagram



	Technology	Product Series
1	Fuse	328
	LED Surge Protection Module	LSP
2	MOV	UltraMOV , Xtreme
3	See LED driver block diagram	
4	MOSFET	N-Channel Depletion Mode
	TVS Diode	SMBJ
	LED Protector	PLED
5	PIR sensor	ZSFG469711
	MCU	ZMOTION™



Click on the product series in the table below for more info

Street & outdoor LED luminaire solution details

	Technology	Function in Application	Product Series	Benefits	Features
1	Fuse	Overcurrent protection	328	High transient surge withstand	4800 A ² s 300 Vac
	Surge Protection Module	Lightning surge protection	LSP	Coordinated protection with driver and photocontrols	Up to 20 kA I _{max} UL 1449 Type 4
2	MOV	Surge protection	UltraMOV , Xtreme	Longer photocontrol life	Up to 15 kA I _{max} Up to 125 °C operating temp
3	See LED driver block diagram				
4	MOSFET	Filtering	N-Channel Depletion Mode	Current regulation	350–800 V Class
	TVS Diode	Transient voltage protection	SMBJ	Better protected light board	600 W Peak pulse capable
	LED Protector	Bypass failed-open LEDs	PLED	Helps maintain long-term reliability as required by “L70” and “B10” standards	6, 9, 13 or 18 V _{DRM}
5	PIR sensor	Motion detection	ZSFG469711	Low power consumption; high reliability	Dual element sensor; wide-angle detection; improved coverage pattern; low voltage operation
	MCU	Provides control signals per PIR sensing and other inputs	ZMOTION™	Optimized for sensor application; reduces component count and saves space; allows for cheaper ceramic capacitors	Real-time control of motion sensitivity; ambient light sensing; serial or RF communication protocol; over-the-air firmware updates

AC Line voltage LED driver

1 AC input

- Fuse
- MOV

2 Input Rectification and Filter

- SIDCAtor® + MOV
- Rectifier Diode



3 PFC

- MOSFET

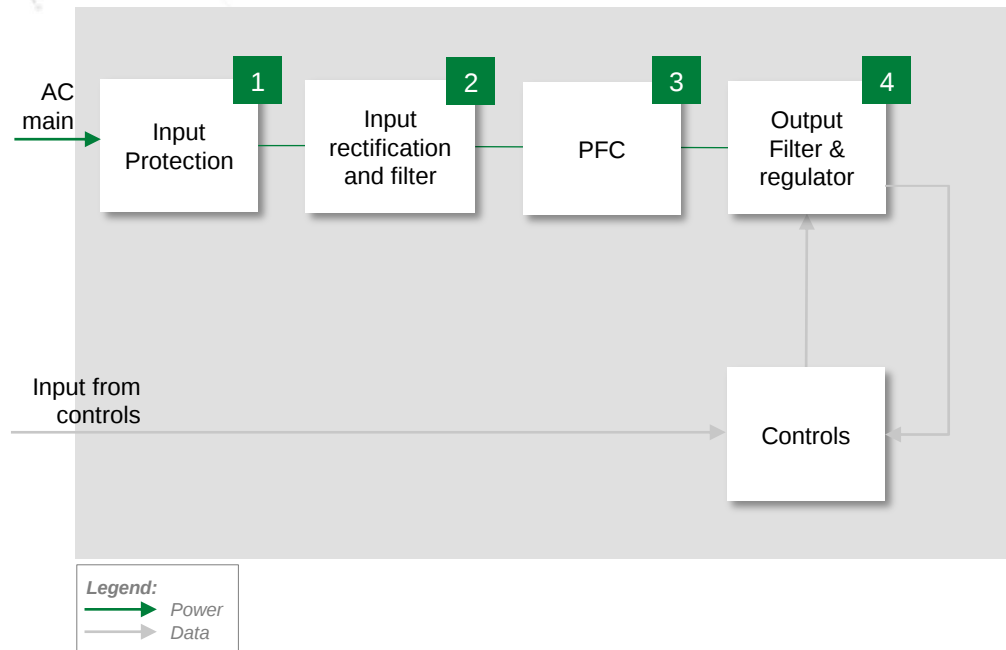
4 Output Filter and Regulator

- MOSFET
- LED Driver IC



Click on the product series in the table below for more info

Line voltage LED driver block diagram



	Technology	Product Series
1	Fuse ^I	369
	MOV	UltraMOV , Xtreme
2	SIDACtor + MOV ^{II}	P3500SCLRP + UltraMOV or Xtreme
	Rectifier Diode	Schottky Gen² Diodes
3	MOSFET	X2-class
4	LED Driver	CPC9909 , MXHV9910
	MOSFET	N-Channel Ultra Junction

Notes:

- I. Many different fuse options available based on current, voltage, mounting method, and surge withstand required.
- II. For protection in more harsh environments and when enhanced reliability is critical. For 110 V power regions, like North America, Japan, we recommend P1900xxx + UltraMOV.



Click on the product series in the table below for more info

LED driver solution details

	Technology	Function in Application	Product Series	Benefits	Features
1	Fuse	Overcurrent protection	369	Avoids nuisance tripping; multiple mounting options	Up to 300 Vac; high I^2t rating
	MOV	Primary surge protection	UltraMOV , Xtreme	Passes appropriate surge level testing	Up to 15 kA I_{max} ; up to 125 °C operating temp
2	SIDACtor + MOV	Transient voltage suppression	P3500SCLRP + UltraMOV or Xtreme	Enhanced system reliability	Low peak let-through voltage
	Rectifier Diode	Converting AC to DC	Schottky Gen² Diodes	Efficient energy conversion	I_{FAV} 10 to 300 A
3	MOSFET	High frequency switching in PFC circuit	X2-class	Fast response time and low heat signature	Low $R_{ds(on)}$; dv/dt ruggedness
4	LED Driver	Constant current driver with dimming and PFC	CPC9909 , MXHV9910	Energy efficient; built-in power factor correction	8–550 V input voltage range; >90% efficiency
	MOSFET	Power conversion	N-Channel Ultra Junction	High power density	400–1000 V class

Select standards for LED lighting equipment

Standard	Title	General Scope	Region
DOE MSSSLC	Department of Energy Municipal Solid-State Street Lighting Consortium	First organization to write a specification for LED Streetlighting	North America
IEEE C62.41.2-2002	Recommended practice on characterization of surges in low-voltage AC power circuits	Provides standard waveforms for testing, which are often referenced in other lighting standards	Global
ANSI C136.2-2018	Roadway and area lighting equipment–dielectric withstand and electrical transient	Luminaires and control devices designated for up to 600 V operation and intended for use in roadway and area lighting applications	North America
ANSI C82.77-5-2017	Standard for lighting equipment–voltage surge requirements	All types of lighting equipment used for general illumination	North America
IEC/EN 61000-4-5	Part 4-5: Testing and measurement techniques–Surge immunity test	Referenced within many standards	Global
UL 1598	Luminaires	Nonhazardous location luminaires classified for up to 600 V operation	North America
IEC 60598	Luminaires	All luminaires up to 1000 V	Global
IEC 62560	Self-ballasted LED–lamps for general lighting services > 50 V	Self-ballasted LED-lamps up to 60 W	Global
UL 8750	LED equipment for use in lighting products	LED drivers	North America
IEC 61347	Lamp control-gear	LED drivers	Global
UL 1449	Surge Protection Devices	All devices used to limit and protect against surge	North America
IEC 61643-11	Part 11: Surge protective devices connected to low-voltage power systems–Requirements and test methods	All devices used to limit and protect against surges	Global
UL 773	Plug-in locking type photocontrols for use with area lighting	Photocontrols for area lighting	North America
ANSI C136.41	Dimming control between an external locking type photocontrol and ballast or driver	Photocontrols	North America
IEC/EN 61000-3-2: 2014	Electromagnetic compatibility (EMC)	Limits for harmonic current emissions (equipment input current ≤ 16 A per phase) This is the PFC need	Global
IEC/EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment	This standard applies to the emission (radiated and conducted) of radiofrequency disturbances from: – all lighting equipment with a primary function of generating and/or distributing light intended.	Global

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