



Smart LED Lighting

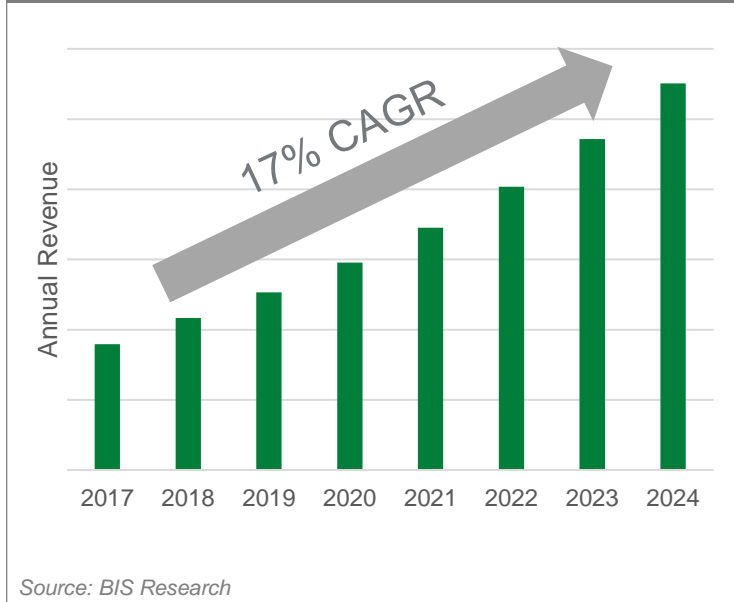
Illuminating the path to our future

 LED Lighting

 **Littelfuse®**
Expertise Applied | Answers Delivered

Smart LED lighting market

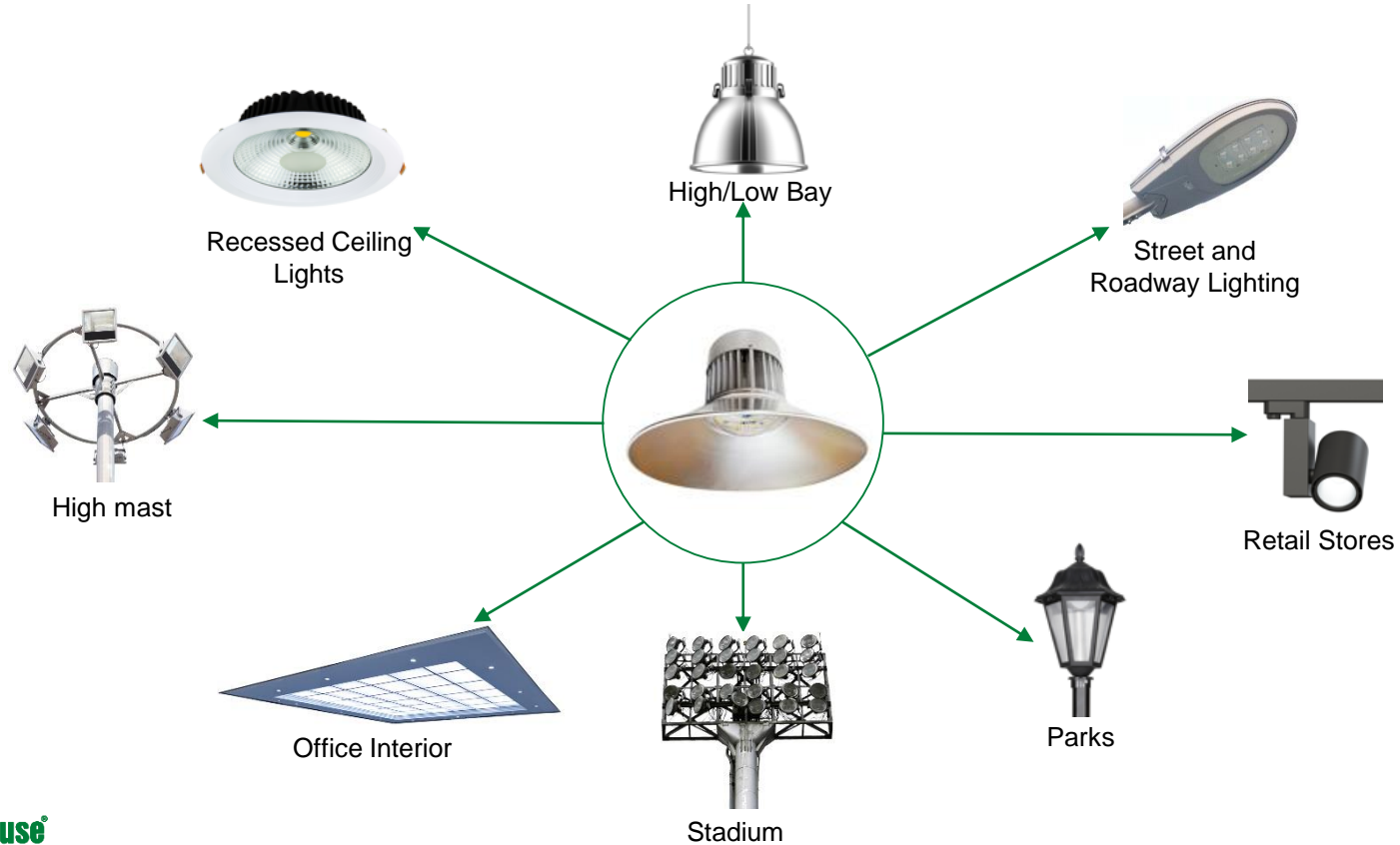
Market revenue worldwide



Market data and drivers

- Integral component of smart cities and buildings
- Includes many types of features: dimming, color tuning, occupancy sensing, communications, and more
- Increasing adoption globally, led by USA, UK, and China
- Intelligent controls are being used in commercial, residential, outdoor, indoor farming, and industrial lighting

Various lighting applications now include smart features



Industrial and commercial luminaires

AC Input:



- Fuse for Overcurrent Protection
- MOV for Surge Protection
- NTC for In-rush Current Limiters

Line Rectifier:



- Hybrid voltage suppression
- Rectifier diodes

Feedback:



- Optically Isolated Error Amplifier

Filter and Regulator:

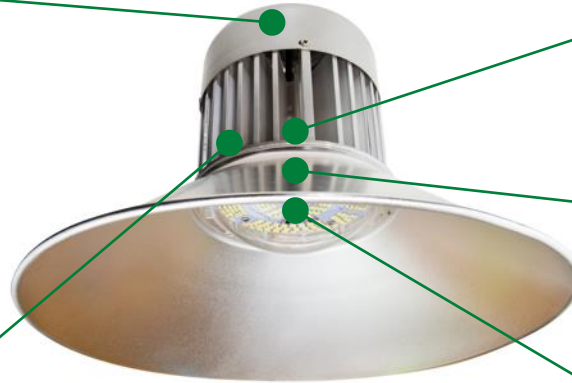


- MOSFET for power conversion
- LED Driver IC

Light Board:



- Transient protection
- Open-LED bypass



Protect

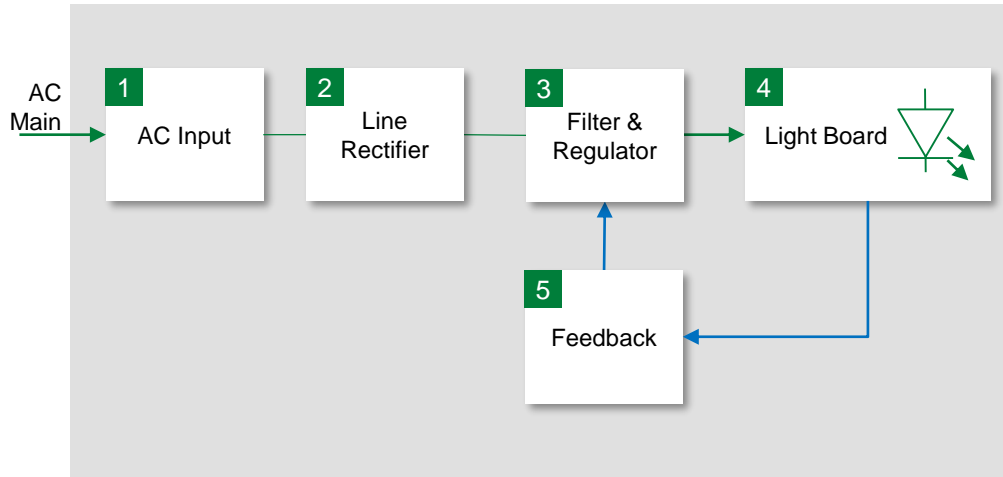


Control



Sense

Industrial and commercial luminaire block diagram



Legend:

- Power Line
- Signal Line

| | Technology | Product Series |
|---|------------------------------|--|
| 1 | Fuse ^I | 209 , 392 , 383 , or 476 |
| | MOV | UltraMOV |
| | NTC | ST |
| 2 | SIDACTor + MOV ^{II} | P3500SCLRP and LA |
| | Rectifier diodes | Schottky Gen² Diodes |
| 3 | LED Driver | IX9908 |
| | MOSFET | N-Channel Ultra Junction |
| 4 | TVS Diode | SMBJ , 1.5KE |
| | LED Protectors | PLED |
| 5 | Linear Error Amplifier | LIA130 |

Table 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

Industrial and commercial luminaire solution details

| | Technology | Function in Application | Product Series | Benefits | Features |
|---|------------------------------|--|--|--|--|
| 1 | Fuse ^I | Overcurrent protection | 209 , 392 , 383 , or 476 | Avoid nuisance tripping Multiple mounting options | Up to 300 Vac High I ² t rating |
| | MOV | Primary surge protection | UltraMOV | Pass appropriate surge level testing | Up to 10 kA I _{max} Up to 125°C operating temp |
| | NTC | In-rush current limitation | ST | Enhanced system reliability | Radial leaded Up to 13A max steady state current |
| 2 | SIDACtor + MOV ^{II} | Transient voltage suppression | P3500SCLRP and LA | Enhanced system reliability | Low Peak let-thru voltage |
| | Rectifier diodes | Converting AC to DC | Schottky Gen² Diodes | Efficient energy conversion | I _{FAV} 10 to 300A |
| 3 | LED Driver | Constant current driver with dimming and PFC | IX9908 | Energy efficient Built in power factor correction | Up to 600V operating > 90% efficiency |
| | MOSFET | Power conversion | N-Channel Ultra Junction | High power density | 400V - 1,000V Class |
| 4 | TVS Diode | Transient protection for LEDs | SMBJ , 1.5KE | Better protected light board | 600W or 1,500W Peak pulse rating |
| | LED Protectors | Bypass LEDs failed-open | PLED | Higher % of light output when LED fail-open | 6, 9, 13, or 18V _{DRM} |
| 5 | Linear Error Amplifier | Feedback to control output voltage | LIA130 | Isolated feedback system | 2.7V V _{REF} |

LED driver

AC Input:



- Fuse for Overcurrent Protection
- MOV for Surge Protection
- NTC for In-rush Current Limiters

Line Rectifier:



- Hybrid voltage suppression
- Rectifier diodes

Filter & Regulator:

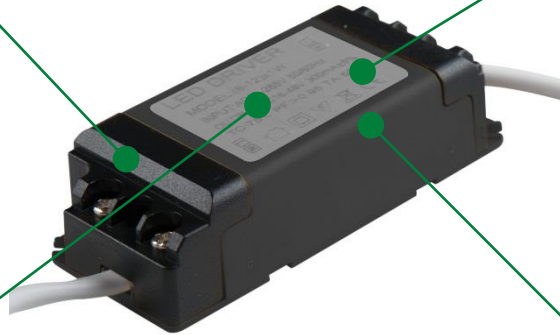


- MOSFET for power conversion
- LED Driver IC

Feedback:



- Optically Isolated Error Amplifier



Protect

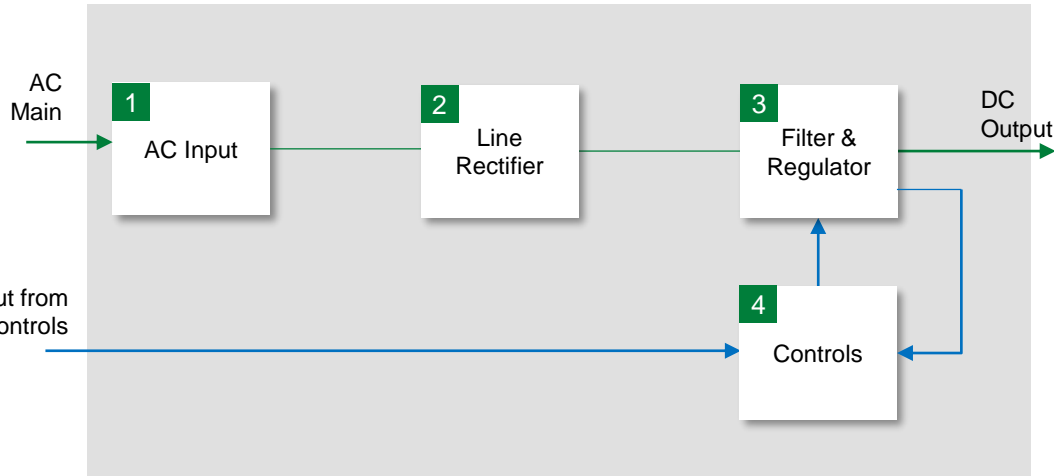


Control



Sense

LED driver block diagram



Legend:
 → Power Line
 → Signal Line

| | Technology | Product Series |
|---|------------------------------|---|
| 1 | Fuse ^I | 369 |
| | MOV | UltraMOV |
| | NTC | ST |
| 2 | SIDACTor + MOV ^{II} | P3500SCLRP and LA |
| | Rectifier diodes | Schottky Gen² Diodes |
| 3 | LED Driver | IX9908 |
| | MOSFET | N-Channel Ultra Junction |
| 4 | Linear Error Amplifier | LIA130 |

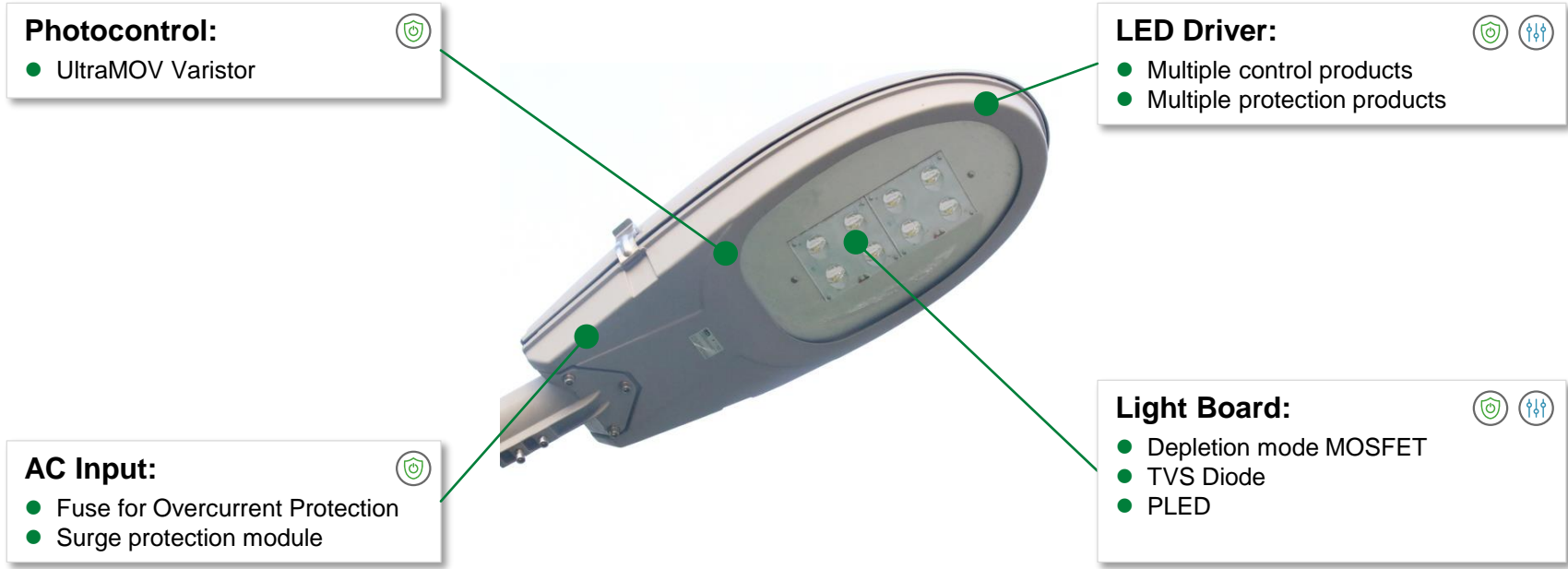
Table Notes:

- 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

LED driver solution details

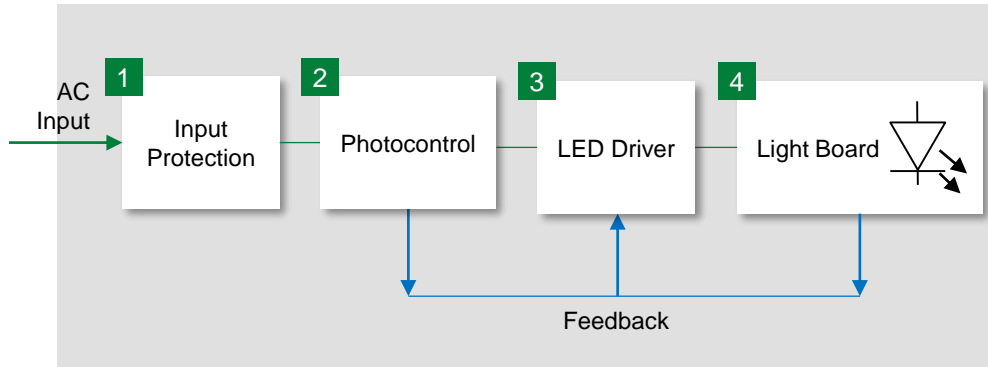
| | Technology | Function in Application | Product Series | Benefits | Features |
|---|------------------------------|---|---|--|--|
| 1 | Fuse ^I | Overcurrent protection | 369 | Avoid nuisance tripping | 300 Vac 800mA up to 6.3A |
| | MOV | Surge protection | UltraMOV | Pass appropriate surge level testing | Up to 10 kA I _{max} Up to 125°C operating temp |
| | NTC | In-rush current limitation | ST | Enhanced system reliability | Radial leaded Up to 13A max steady state current |
| 2 | SIDACtor + MOV ^{II} | Transient protection of sensitive components | P3500SCLRP and LA | Enhanced system reliability | Low Peak let-thru voltage |
| | Rectifier diodes | Converting AC input power to DC | Schottky Gen² Diodes | Efficient energy conversion | I _{FAV} 10 to 300A |
| 3 | LED Driver | Constant current driver with dimming and PFC | IX9908 | Energy efficient Built in power factor correction | Up to 600V operating > 90% efficiency |
| | MOSFET | Power conversion | N-Channel Ultra Junction | High power density | 400V - 1,000V Class |
| 4 | Linear Error Amplifier | Isolation and feedback to help control output voltage | LIA130 | Isolated feedback system | 2.7V V _{REF} |

Street and outdoor LED luminaire



Protect Control Sense

Street & outdoor LED luminaire block diagram



Legend:

-  Power Line
-  Signal Line

| | Technology | Product Series |
|---|--|--|
| 1 | Fuse | 328 |
| | Surge protection module | LSP |
| 2 | MOV | UltraMOV |
| 3 | See LED driver block diagram | |
| 4 | MOSFET | N-Channel Depletion Mode |
| | TVS Diodes | SMBJ |
| | LED Protector | PLED |

Table 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

Street & outdoor LED luminaire solution details

| | Technology | Function in Application | Product Series | Benefits | Features |
|---|--|------------------------------|--|---|--|
| 1 | Fuse | Overcurrent protection | 328 | High transient surge withstand | 4,800 A ² s 300 Vac |
| | Surge protection module | Lightning surge protection | LSP | Coordinated protection with Driver & Photocontrols | Up to 20 kA I _{max} UL 1449 Type 4 |
| 2 | MOV | Surge protection | UltraMOV | Longer photocontrol life | Up to 10 kA I _{max} Up to 125°C operating temp |
| 3 | See LED driver block diagram | | | | |
| 4 | MOSFET | Filtering | N-Channel Depletion Mode | Current regulation | 350V - 800V Class |
| | TVS Diodes | Transient voltage protection | SMBJ | Better protected light board | 600W 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} |

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 is 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 classified for up to 600V 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 | Non-hazardous location luminaires classified for up to 600V operation | North America |
| IEC 60598 | Luminaires | All luminaires up to 1,000V | Global |
| IEC 62560 | Self-ballasted LED-lamps for general lighting services > 50V | Self-ballasted LED-lamps up to 60W | 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 surge | 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 |

Key links

Circuit Protection Solutions:

https://www.littelfuse.com/~media/electronics/product_catalogs/littelfuse_product_selection_guide.pdf.pdf

Choosing the Right Circuit Protection for LEDs

http://info.littelfuse.com/hubfs/ESBU-1-Choosing_the_Right_Circuit_Protection_Lights_for_LEDs.pdf

LED Design Guide

https://www.littelfuse.com/~media/electronics/design_guides/led_protectors/littelfuse_led_lighting_design_guide.pdf.pdf

MOV + SIDACTor Whitepaper

https://www.littelfuse.com/~media/electronics/application_notes/littelfuse_high_power_semiconductor_crowbar_protector_for_ac_power_line_application_note.pdf.pdf

Horticulture Lighting Article

https://www.littelfuse.com/~media/electronics/application_notes/littelfuse_horticulture_application_note.pdf.pdf

General

www.littelfuse.com

Why choose Littelfuse

- Global leader with broad product portfolio covering every aspect of protection, sensing, and control
- Application expertise combined with product designed guidelines to help you determine best component for your application
- Testing capabilities and assistance to support confirmation of product selection
- Standards compliance expertise including product compliance to many standards and approval support
- High-volume manufacturing, committed to the highest quality standards
- Global company with local support

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Expertise Applied | Answers Delivered



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