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# 4G/5G Radio and Access Equipment

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Datacenter & Cloud

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# New radio access network (RAN) installations required to realize the promise of 5G

## Market trends and drivers

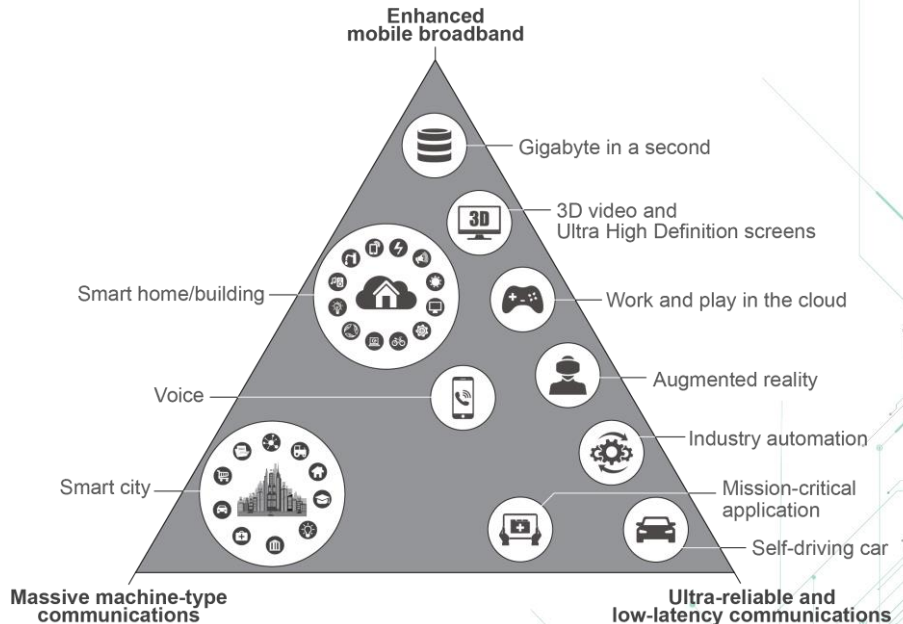
New installations of 4G cellular base stations increase network coverage.

Next generation 5G installations are enhancing existing consumer experiences and creating new use cases for special services such as autonomous driving.

Small cell and micro-base stations provide high-speed 5G service.

Open RAN initiatives are increasing buyer power and the increasing competitiveness of new equipment suppliers.

## 5G builds on 4G and creates opportunities for new applications



Source: 3<sup>rd</sup> Generation Partnership Project (3GPP)

# Importance of circuit protection

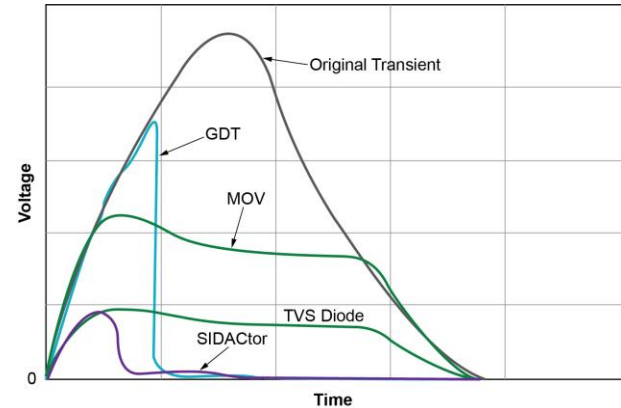
**Five sources of electrical hazards affect the lifetime and reliability of communications infrastructure equipment:**

1. Lightning-induced surges
2. Transient voltage surge from load switching
3. Electrostatic discharge (ESD)
4. Overload current
5. Short-circuit current



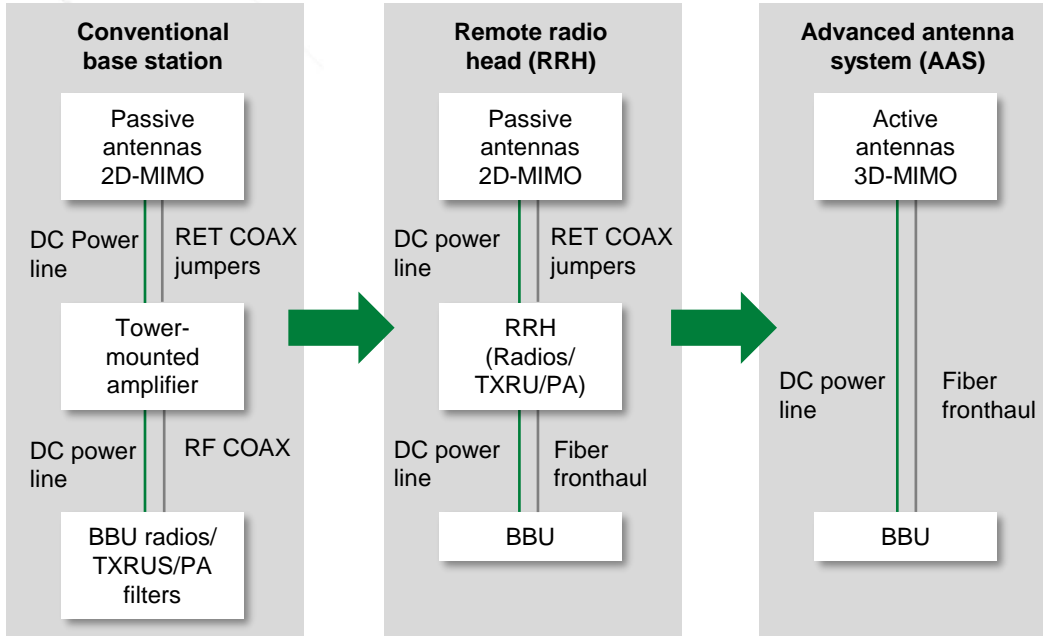
# Select voltage protection based on hazard level, frequency of occurrence, and sensitivity of equipment

- Voltage protection will absorb transient energy during abnormal high-voltage conditions.
- Reaction time and energy handling capability varies based on technology.
- Using multiple technologies together can help maximize features and benefits.



Selection Criteria	GDT	MOV	TVS Diode	SIDACtor®
Protection mechanism	Crowbar	Clamping	Clamping	Crowbar
Response time	Medium	Fast	Faster	Fastest
Peak let-through voltage	High	Medium	Low	Low
Max Surge-handling capability	High	High	Low	Medium
Leakage current	No	Low	Low	Low
Surge life	Good	Good	Excellent	Excellent
Follow-on current	Yes	No	No	Yes
Capacitance	Very low	High	High	Medium

# 4G and 5G use advanced antennas



## Advantages of antenna evolution:

- Reduced footprint
- More efficient delivery of power
- Higher capacity for 5G
- Faster data transmission to network

RET = remote electrical tilt  
COAX = coaxial cable  
AAS = Advanced antenna system  
RRH = remote radio head  
BBU = baseband unit

Protecting DC power lines is critical for high reliability antenna.

# Macro base station with active antenna

## Advanced antenna

- Fuse
- TVS Diode
- MOV
- GDT
- SIDACtor
- Diode Array
- PPTC
- Polymer ESD



## Tower mount amplifier

- Fuse
- TVS Diode



## Baseband unit

- Fuse
- MOV
- SIDACtor
- GDT
- Diode Array



## Power supply

- Fuse
- MOV
- TVS Diode
- GDT
- Magnetic Sensor
- MOSFET
- Schottky Diode



## Battery backup

- TVS Diode
- Fuse
- Diode Array
- PPTC
- Battery Protector
- Temperature Sensor
- Battery Mini-breaker



## Surge protection device

- MOV
- TVS Diode
- Fuse



Protect

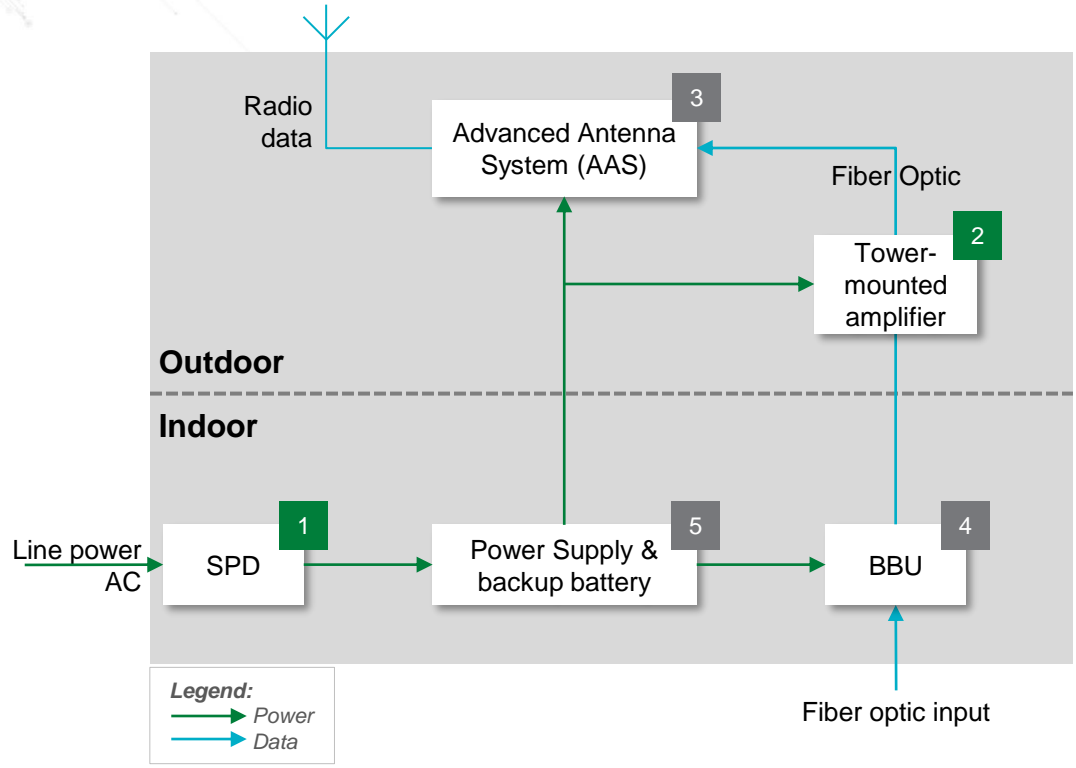


Control



Sense

# Cellular tower with active antenna block diagram



	Technology	Series
1	MOV	<a href="#">TMOV, LST</a>
	GDT	<a href="#">CG2, CG3</a>
	TVS Diode	<a href="#">LTKAK10</a>
2	Fuse	<a href="#">LVSP</a>
	TVS Diode	<a href="#">LTKAK10</a>
3	Fuse	<a href="#">881, 456, TLS</a>
	<a href="#">Advanced Antenna System (AAS) block diagram</a>	
4	<a href="#">Baseband unit (BBU) block diagram</a>	
5	<a href="#">Power supply and battery backup block diagram</a>	



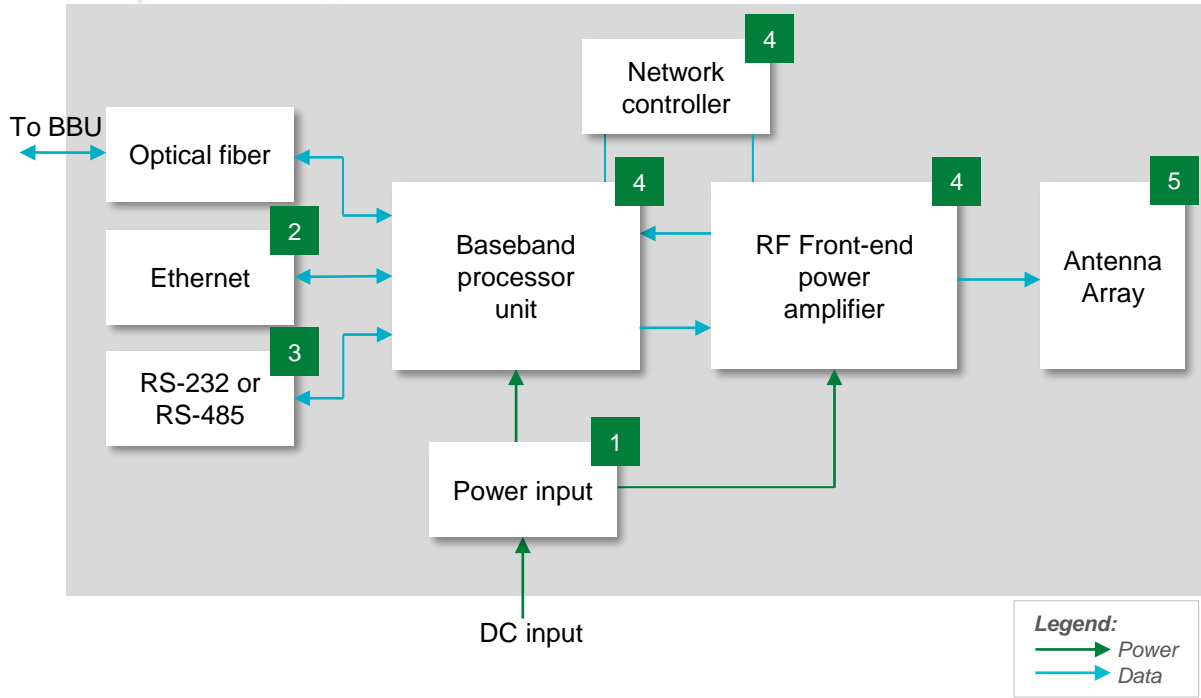
Click the product series in the table below for more info

# Benefits of recommended Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	MOV	Voltage surge protection with thermal disconnect	<a href="#">TMOV</a> , <a href="#">LST</a>	Same footprint for 50 kA and 75 kA $I_{max}$ for same PCB layout (LST)	Normally open and normally closed options for remote indication
	GDT	Voltage surge protection with no significant leakage current	<a href="#">CG2</a> , <a href="#">CG3</a>	Surge protection for AC lines	Rugged ceramic metal construction
	TVS Diode	Transient voltage protection	<a href="#">LTKAK10</a>	Low clamping voltage, allowing lower voltage rating components downstream	High transient current rating (10 kA; 8/20 $\mu$ s) with lower clamping voltage compared to alternative technologies
	Fuse	Overcurrent protection specifically for SPD products	<a href="#">LVSP</a>	Designed to survive surges caused by lightning as described in IEC and UL standards	Complements Littelfuse MOVs and high-power TVS Diodes
2	TVS Diode	Clamps transient voltages	<a href="#">LTKAK10</a>	Low clamping voltage, allowing lower voltage rating components downstream	High transient current rating (10 kA; 8/20 $\mu$ s) with lower clamping voltage compared to alternative technologies
	Fuse	Overcurrent protection	<a href="#">881</a> , <a href="#">456</a> , <a href="#">TLS</a>	Flexible design options with multiple form factors, sizes, and current rating, and voltage ratings	Surface mount versions up to 115 Vdc; up to 170 Vdc rated in cartridge and leaded options
3	<a href="#">Advanced Antenna System (AAS) block diagram</a>				
4	<a href="#">Baseband unit (BBU) block diagram</a>				
5	<a href="#">Power supply and battery backup block diagram</a>				



# Advanced Antenna System (AAS) block diagram

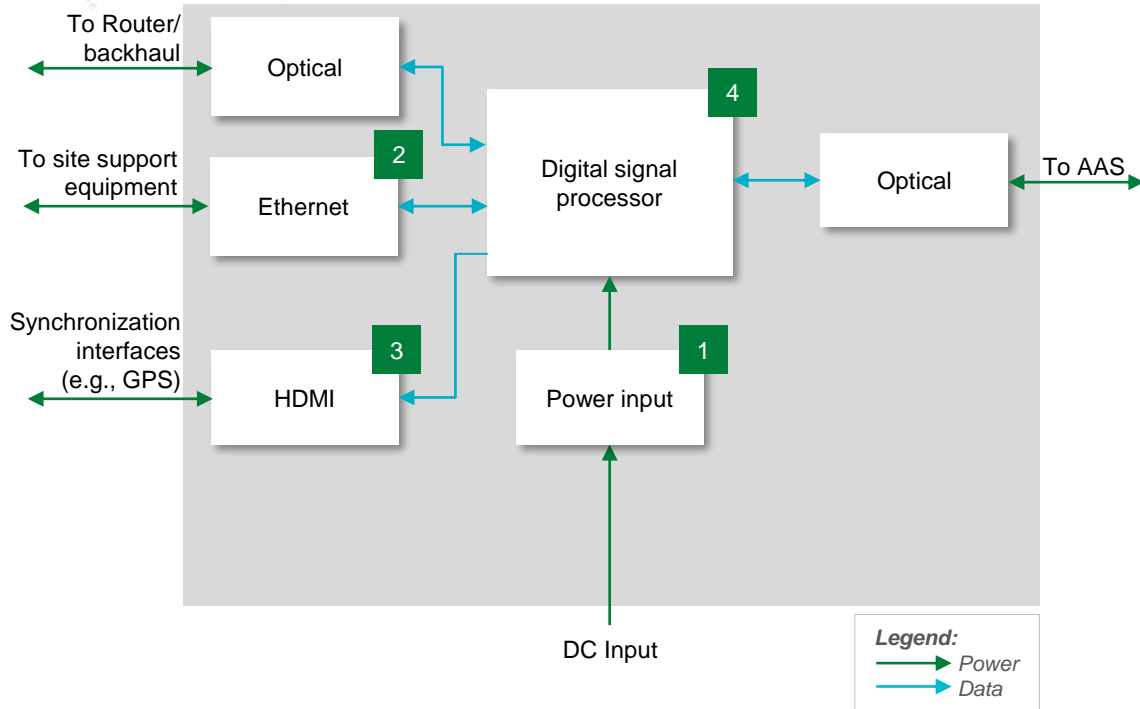


	Technology	Series
1	Fuse	<a href="#">881</a> , <a href="#">456</a> , <a href="#">TLS</a>
	MOV	<a href="#">LV UltraMOV</a>
	GDT	<a href="#">CG</a>
	TVS Diode	<a href="#">LTKAK10</a>
2	Fuse	<a href="#">461</a>
	SIDACtor	<a href="#">SEP</a>
	Diode Array	<a href="#">SP3400</a>
	GDT	<a href="#">SL0902A090SM</a>
3	GDT	<a href="#">GTCxx</a>
	SIDACtor	<a href="#">P0220S4BLRP</a>
	PPTC	<a href="#">PolySwitch T-Line</a>
4	TVS Diode	<a href="#">SMBJ</a> , <a href="#">SMCJ</a> , <a href="#">SMDJ</a>
5	Polymer ESD	<a href="#">XGD</a>

# Benefits of recommended Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Overcurrent protection	<a href="#">881</a> , <a href="#">456</a> , <a href="#">TLS</a>	Flexible design options with multiple form factors, sizes, and current and voltage ratings	Surface mount versions up to 115 Vdc; up to 170 Vdc rated in cartridge and leaded options
	MOV	Surge protection	<a href="#">LV UltraMOV</a>	Saves board space without compromising surge-handling capability	High peak surge current rating up to 10 kA (8/20 $\mu$ s pulse)
	GDT	Voltage surge protection with no significant leakage current	<a href="#">CG</a>	Surge protection for AC lines	Rugged ceramic metal construction
	TVS Diode	Clamps transient voltages	<a href="#">LTKAK10</a>	Low clamping voltage, allowing lower voltage rating components downstream, leading to reduce overall design costs	High transient current rating with lower clamping voltage compared to alternative technologies
2	Fuse	Protects against power-cross faults	<a href="#">461</a>	Enables compliance with regulatory standards	Surface mount; surge tolerant-fuse designed specifically for high-speed telecom applications
	SIDACtor	Surge protection for PoE	<a href="#">SEP</a>	Space-saving design with integrated overvoltage and steering Diodes	Compatible with 1000Base-T and PoE
	Diode Array	Multi-stage, coordinated surge protection for data port	<a href="#">SP3400</a>	Continued operation of PHY after surge events	Fast clamping and low capacitance
GDT	<a href="#">SL0902A090SM</a>		Withstands high surge levels with protection on primary side of isolation transformer	High surge rating; UL recognized	
3	GDT	Lightning protection utilizing a GDT with SIDACtor; when lightning occurs, the SIDACtor will react first, causing voltage to increase across PPTC until GDT fires.	<a href="#">GTCxx</a>	Coordinated protection against high surge levels; low clamping voltage	Wide range of voltages and form factors; low capacitance and insertion loss; low voltage overshoot; low on-state voltage
	SIDACtor		<a href="#">P0220S4BLRP</a>		
	PPTC	Protects equipment from short circuits and power-cross faults	<a href="#">PolySwitch T-Line</a>	Product choices give engineers increased design flexibility; helps improve line balance	Available in various form factors; low parasitic capacitance
4	TVS Diode	Voltage transient protection	<a href="#">SMBJ</a> , <a href="#">SMCJ</a> , <a href="#">SMDJ</a>	Helps protect the most sensitive parts of design from surge events	Multiple sizes and multiple surge capabilities
5	Polymer ESD	ESD protection of antenna	<a href="#">XGD</a>	Protection without signal distortion	Extremely low capacitance and small size

# Baseband Unit (BBU) block diagram



	Technology	Series
1	Fuse	<a href="#">881, 456, TLS</a>
	MOV	<a href="#">LV UltraMOV</a>
	GDT	<a href="#">CG</a>
	TVS Diode	<a href="#">LTKAK10</a>
2	Fuse	<a href="#">461</a>
	SIDACTor	<a href="#">SEP</a>
	Diode Array	<a href="#">SP3400</a>
	GDT	<a href="#">SL0902A090SM</a>
3	Diode Array	<a href="#">SP1004U-ULC-04UTG</a>
4	TVS Diode	<a href="#">SMBJ, SMCJ, SMDJ</a>

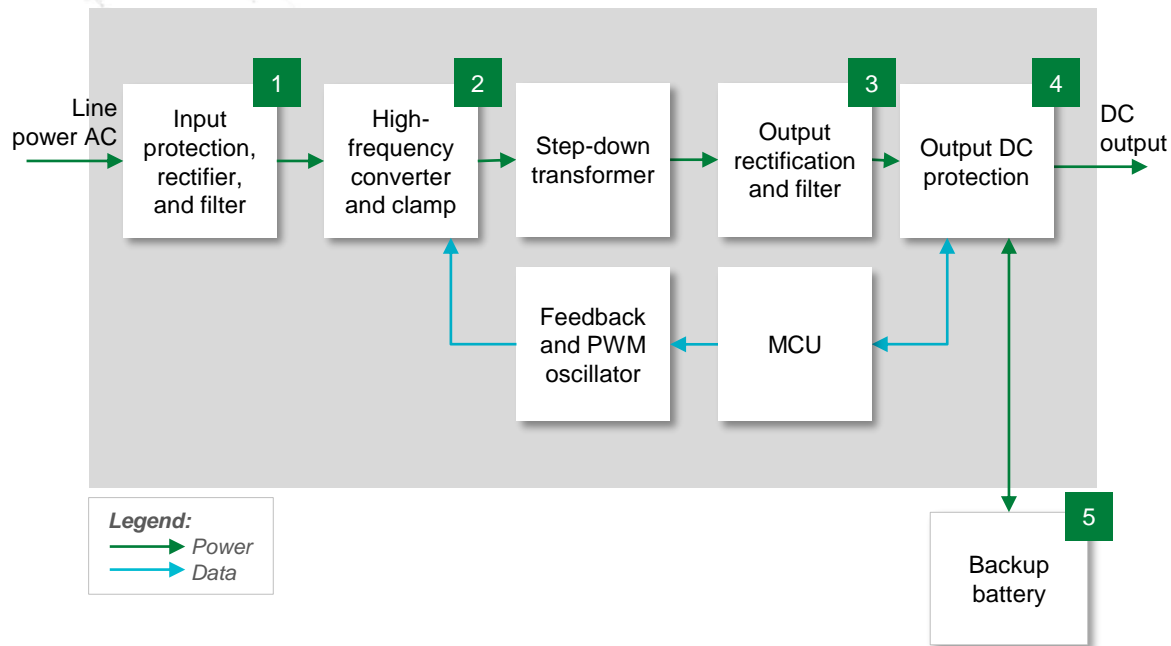
# Benefits of recommended Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Overcurrent protection	<a href="#">881</a> , <a href="#">456</a> , <a href="#">TLS</a>	Flexible design options with multiple form factors, sizes, and current and voltage ratings	Surface mount versions up to 115 Vdc; Up to 170 Vdc rated in cartridge and leaded options
	MOV	Surge protection	<a href="#">LV UltraMOV</a>	Saves board space without compromising surge handling capability	High peak surge current rating up to 10 kA (8/20 $\mu$ s pulse)
	GDT	Voltage surge protection with no significant leakage current	<a href="#">CG</a>	Surge protection for AC lines	Rugged ceramic metal construction
	TVS Diode	Clamps transient voltages	<a href="#">LTKAK10</a>	Low clamping voltage, allowing lower voltage rating components downstream, leading to reduce overall design costs	High transient current rating with lower clamping voltage compared to alternative technologies
2	Fuse	Protects against power-cross faults	<a href="#">461</a>	Enables compliance with regulatory standards	Surface mount; surge-tolerant fuse designed specifically for high-speed telecom applications
	SIDACtor	Surge protection for PoE	<a href="#">SEP</a>	Space-saving design with integrated overvoltage and steering Diodes	Compatible with 1000Base-T and PoE
	Diode Array	Multi-stage, coordinated, surge protection for data port	<a href="#">SP3400</a>	Continued operation of PHY after surge events	Fast clamping and low capacitance
	GDT		<a href="#">SL0902A090SM</a>	Withstands high surge levels with protection on primary side of isolation transformer	High surge rating; UL recognized
3	Diode Array	Protection of data signal lines from ESD	<a href="#">SP1004U-ULC-04UTG</a>	Low capacitance; small form factor allows designers layout flexibility	Low capacitance of 0.2 pF; low clamping voltage of 9.2 V @ IPP = 2.0 A ( $t_p$ = 8/20 $\mu$ s); industry standard DFN footprint
4	TVS Diode	Voltage transient protection	<a href="#">SMBJ</a> , <a href="#">SMCJ</a> , <a href="#">SMDJ</a>	Helps protect the most sensitive parts of design from surge events	Multiple sizes and surge capabilities



Click the product series in the table below for more info

# Power supply and backup battery



	Technology	Product series
1	Fuse	<a href="#">JLLN, PSR</a>
	MOV	<a href="#">TMOV34S</a>
	GDT	<a href="#">CG3</a>
	TVS Diode	<a href="#">LTKAK10</a>
	Magnetic Sensor	<a href="#">MDCG</a>
2	TVS Diode	<a href="#">P6KE, 1.5SMB, SMF4L</a>
	MOSFET	<a href="#">X2-class</a>
3	Schottky Diode	<a href="#">MBR, DST</a>
4	Fuse	<a href="#">463, 881, TLS, PSR</a>
	Fuse	<a href="#">463, 881, TLS, PSR</a>
5	Temperature Sensor	<a href="#">RB</a>
	Diode Array	<a href="#">AQ05C</a>
	PPTC	<a href="#">zeptoSMDC</a>
	Battery Protector	<a href="#">ITV</a>
	Battery Mini-breaker	<a href="#">MHP-TAM</a>



Click the product series in the table below for more info

# Benefits of recommended Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Overcurrent protection	<a href="#">JLLN, PSR</a>	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	Compliance with third-party safety standards such as UL/IEC; low internal resistance;
	MOV	GDT and TMOV connected in series to protect against voltage transients	<a href="#">TMOV34S</a>	Enables product to comply with IEC 62368-1	High energy absorption capability; integrated thermal protection
	GDT		<a href="#">CG3</a>		
	TVS Diode	Transient voltage suppression	<a href="#">LTKAK10</a>	Increases surge immunity and long-term reliability	Up to 10 kA (8/20 $\mu$ s) transient current rating up to 10 kA (8/20 $\mu$ s) with lower clamping voltage
	Magnetic Sensor	Detects when equipment is open	<a href="#">MDCG</a>	Helps to ensure power is off when equipment is opened	Normally open switch capable of switching 200 Vdc or 0.5 A at up to 10 W
2	TVS Diode	Transient voltage suppression	<a href="#">P6KE, 1.5SMB, SMF4L</a>	Improves system reliability by protecting downstream components from transients	Peak pulse capability of 600 W; compatible with lead-free solder reflow temperature profile
	MOSFET	High switching speed in power supply units	<a href="#">X2-class</a>	Fast response time and low heat signature	Low $R_{ds(on)}$ ; dv/dt ruggedness
3	Schottky Diode	Rectification and blocking in power supply units	<a href="#">MBR, DST</a>	Enables the design of high-efficiency power supply units	Ultra-low forward voltage drop; high-frequency operation
4	Fuse	Output overcurrent protection	<a href="#">463, 881, TLS, PSR</a>	Meets exact needs of design with multiple options	Wide range of sizes and electrical ratings
5	Fuse	Input overcurrent protection	<a href="#">463, 881, TLS, PSR</a>	Meets exact needs of design with multiple options	Wide range of sizes and electrical ratings
	Temperature Sensor	Monitors battery temperature	<a href="#">RB</a>	Enables robust system operation	Tight tolerance; wide range of temperature sensing
	Diode Array	Transient Voltage Suppression	<a href="#">AQ05C</a>	Excellent clamping capability; meets automotive industry standards; fast response time	AEC-Q101 qualified; meets IEC standards for ESD protection
	PPTC	Protects battery fuel gauge I <sup>2</sup> C lines	<a href="#">zeptoSMDC</a>	Resets to normal operation after fault is cleared; saves space due to small footprint	Maximum electrical rating: 13 VDC; short circuit current: 82~200 mA; small footprint: 0201 size
	Battery Protector	Overcurrent and overvoltage protection	<a href="#">ITV</a>	Space saving and reliable protection	Low internal resistance; surface mount;
	Battery Mini-breaker	Secondary overtemperature and overcurrent protection for battery	<a href="#">MHP-TAM</a>	Extends battery life; sensitive thermal protection	$I_{hold}$ up to 15 A milliohm resistance; 72 to 90 °C cut-off temperature

# Small cell antenna site

## Antenna Array

- Polymer ESD



## Power Supply

- Fuse
- MOV
- TVS Diode
- GDT
- Magnetic Sensor
- MOSFET
- Schottky Diode



## Baseband Processor and RF Amplifier

- TVS Diode



## Battery Backup

- SIDACTor
- TVS Diode
- Fuse
- Diode Array
- PPTC
- Battery Protector
- Temperature Sensor
- Battery Mini-breaker



Protect

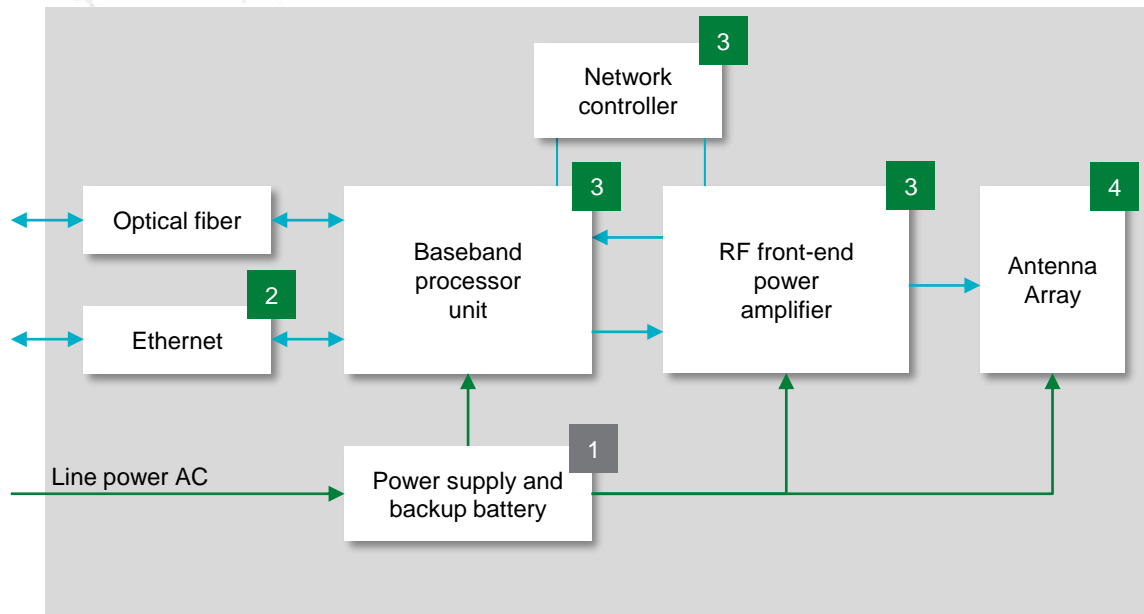
Control

Sense



Click the product series in the table below for more info

# Small cell block diagram



**Legend:**

- Power
- Data

	Technology	Series
1	See <a href="#">Power Supply &amp; Battery Backup Block Diagram</a>	
2	Fuse	<a href="#">461</a>
	SIDACtor	<a href="#">SEP</a>
	Diode Array	<a href="#">SP3400</a>
	GDT	<a href="#">SL0902A090SM</a>
3	TVS Diode	<a href="#">SMBJ</a> , <a href="#">SMCJ</a> , <a href="#">SMDJ</a>
4	Polymer ESD	<a href="#">XGD</a>





Click the product series in the table below for more info

# Benefits of recommended Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	See <a href="#">Power Supply &amp; Battery Backup Block Diagram</a>				
2	Fuse	Protects against power-cross faults	<a href="#">461</a>	Enables compliance with regulatory standards	Surface mount; surge-tolerant fuse designed specifically for high-speed telecom applications
	SIDACtor	Surge protection for PoE	<a href="#">SEP</a>	Space-saving design with integrated overvoltage and steering Diodes	Compatible with 1000Base-T and PoE
	Diode Array	Multi-stage, coordinated, surge protection for data port	<a href="#">SP3400</a>	Continued operation of PHY after surge events	Fast clamping and low capacitance
GDT	<a href="#">SL0902A090SM</a>		Withstands high surge levels with protection on primary side of isolation transformer	High surge rating; UL recognized	
3	TVS Diode	Voltage transient protection	<a href="#">SMBJ</a> , <a href="#">SMCJ</a> , <a href="#">SMDJ</a>	Helps protect the most sensitive parts of design from surge events	Multiple sizes and surge capabilities
4	Polymer ESD	ESD protection of antenna	<a href="#">XGD</a>	Protection without signal distortion	Extremely low capacitance and small size

# Select safety standards for wireless communication

Standard	Title of standard	General scope	Region
GR 1089	Electromagnetic compatibility (EMC) and electrical safety– Generic criteria for network telecommunications equipment	ESD, EFT, lightning, and power fault test requirements for telecom equipment	Global
ITU-T K.20	Resistibility of telecommunication equipment installed in a telecommunications center to overvoltage and overcurrent	Lightning surge and power fault test requirements	Global
ITU-T K.45	Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltage and overcurrent	Lightning surge and power fault test requirements	Global
IEC 62368-1	Audio/video, information and communication technology equipment– Part 1: safety requirements	This part of IEC 62368 is a product safety standard that classifies energy sources; prescribes safeguards against those energy sources; and provides guidance on the application of, and requirements for, those safeguards	Global
ETSI EN 300 132	Environmental Engineering (EE); Power supply interface at the input of information and communication technology (ICT) equipment	Multiple parts provide guidance for various voltage applications including -48 Vdc, AC, and 400 Vdc	Global
ITU-T L.1200	Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment	Voltage surges & transient test requirements	Global

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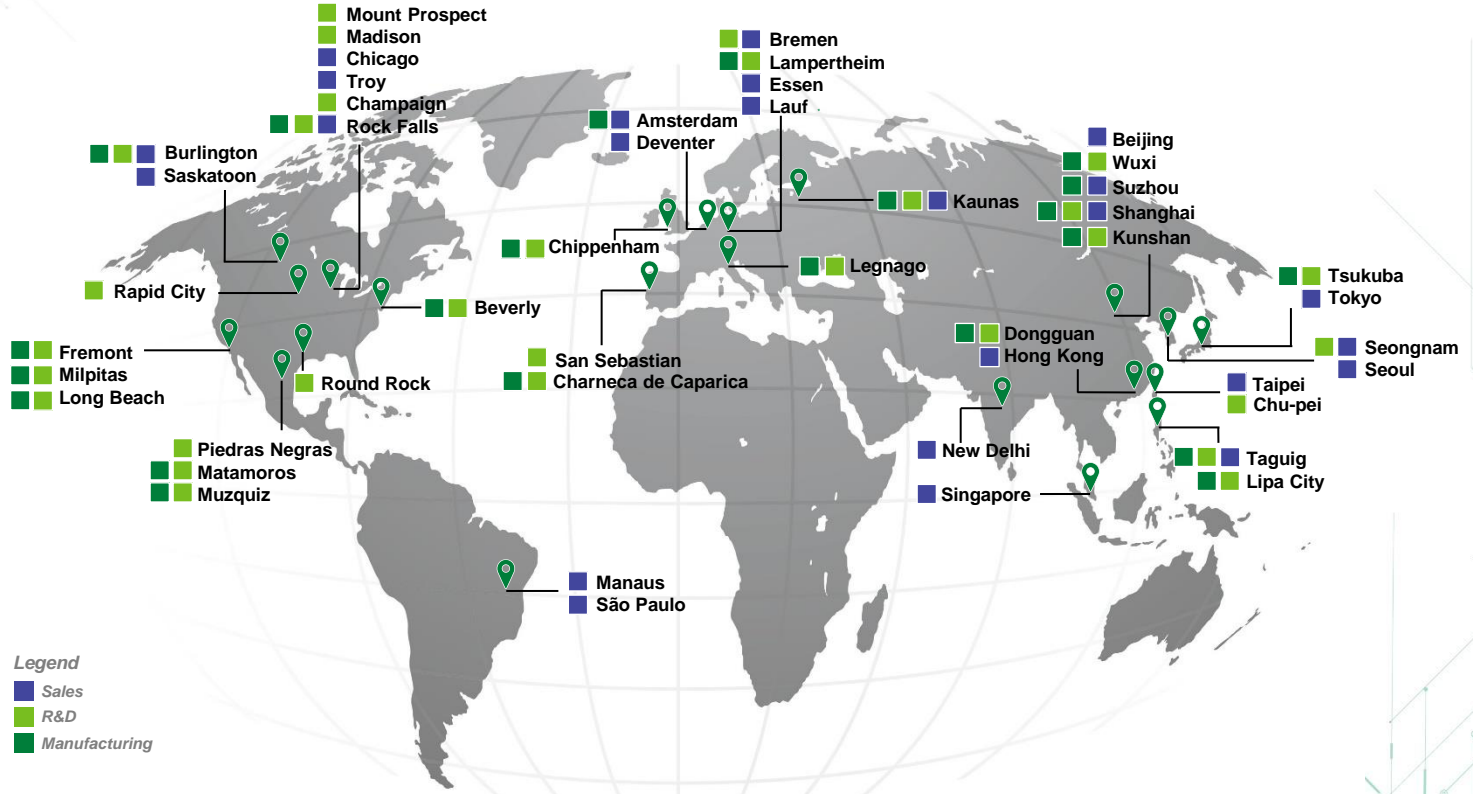
Integrated Circuits Catalog



Industrial Fuses Catalog



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 Manufacturing

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A global leader with a broad product portfolio, covering every aspect of protection, sensing, and control

## Application expertise

Our engineers partner directly with customers to help speed up product design and meet their unique needs

## Global customer service

Our global customer service team is with you to anticipate your needs and ensure a seamless experience

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## Testing capabilities

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## Global manufacturing

High-volume manufacturing that is committed to the highest quality standards



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