Littelfuse®

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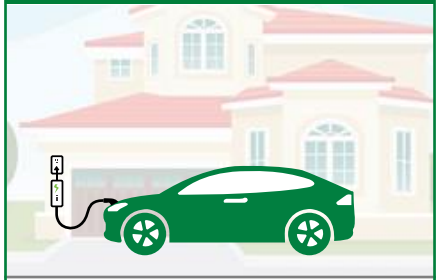
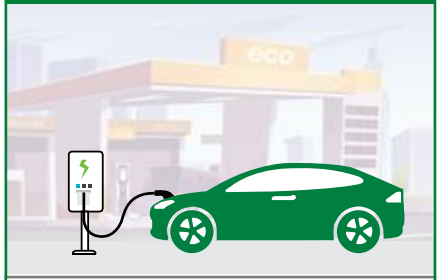
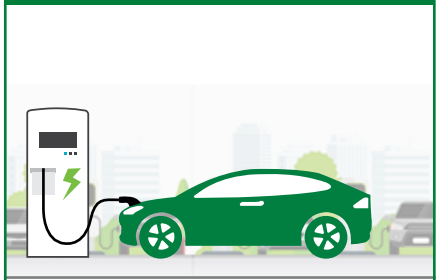
EV Charging Solutions

Supercharged Solutions to Enhance Safety, Efficiency, and Reliability

EV Infrastructure

REV0921

Types of electric vehicle charging stations

AC Level 1*	AC Level 2*	DC Fast Charger*	Wireless Charger‡
			
Basic home installation (Mode 1 or Mode 2)**	**Home and public installation** (Mode 3)**	**Public and commercial installation** (Mode 4)**	**Home and public installation**
Voltage 120 V AC, 1-phase 250 V AC, 1-phase 480 V AC, 3-phase	**Voltage** 208 V–240 V AC, 1-phase 250 V AC, 1-phase 480 V AC, 3-phase	**Voltage** 380 V–600 V AC, 3-phase	**Power levels** WPT1 − 3.7 kW WPT2 − 7.7 kW WPT3 − 11 kW
Current rating 12 A–16 A (32 A for 3-phase)	**Current rating** 12 A–80 A	**Current rating** DC output (up to 400 A)	**Grid to battery efficiency** 94% at a 10″ ground clearance
Charging time 8–12 hours***	**Charging time** 4–6 hours***	**Charging time** 30 mins***	**Vehicle ground clearance** 100−250 mm (3.9″ to 9.8″)

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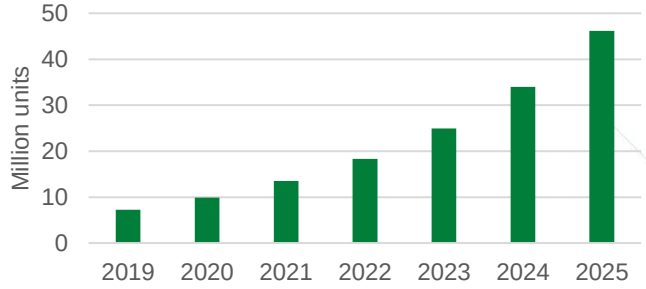
** As defined by SAE J1772*
‡ As defined by SAE J2954
*** As defined by IEC 61851-1*
**** Charge time dependent on vehicle's battery capacity and charge acceptance rate*

Global electric vehicle charging equipment market

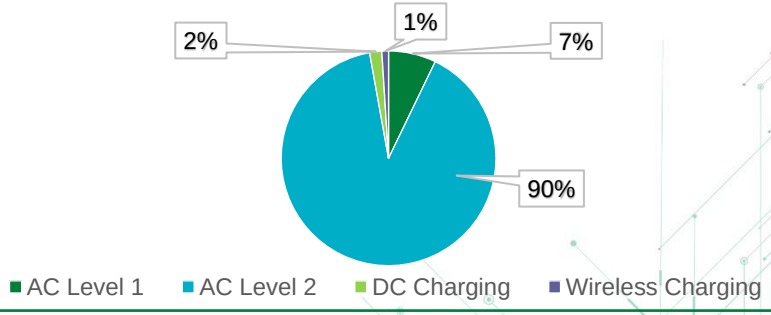
Market trends and drivers

Increasing production of electrified vehicles: estimated 6 million vehicles in 2019 growing to 40 million vehicles in 2025 ⇨ need for higher efficiency
7.3 million chargers are active across the world (as of 2019), of which, nearly 6.5 million are private chargers, 0.6 million are public slow chargers, and 0.26 million are public fast chargers
Currently, more than 70% of the charging is done at home. Convenience, cost-efficient, and a variety of support policies are the main driving.
Majority of charging to occur at home or workplace during a span of several hours (AC charging) ⇨ bidirectional topologies is needed for smart grid
Limited charging grid capacity in most regions ⇨ Emergence of combo ESS+PV with DC charger
Increasing voltage and power output of DC chargers for fast charging ⇨ 500 V to 800 V
Low-power DC charging solution in residential/campus will replace the AC charging solution to make charging faster (20 kW DC versus 7 kW AC)
DC charger create a need for improved safety and additional components, such as advanced liquid-cooled cables, substations, and energy storage systems

Rapid growth of EV Charging at ~36% CAGR



EV charging equipment, by type, in 2019



Source: IEA Report Global EV Outlook 2020; DC Fast Charging; Modor Intelligence; Statista Report; Littelfuse estimates

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AC charging station

1 Service Access Panel

- Reed Sensor

2 Input Protection

- Fuse
- MOV
- GDT
- TVS Diode

3 Auxiliary Power Supply

- PPTC
- Schottky Diode
- SIDACtor® + MOV

4 User Interface

- TVS Diode Array
- Polymer ESD Suppressor

5 Communication

- TVS Diode Array
- Reed Relay

6 Charging Plug

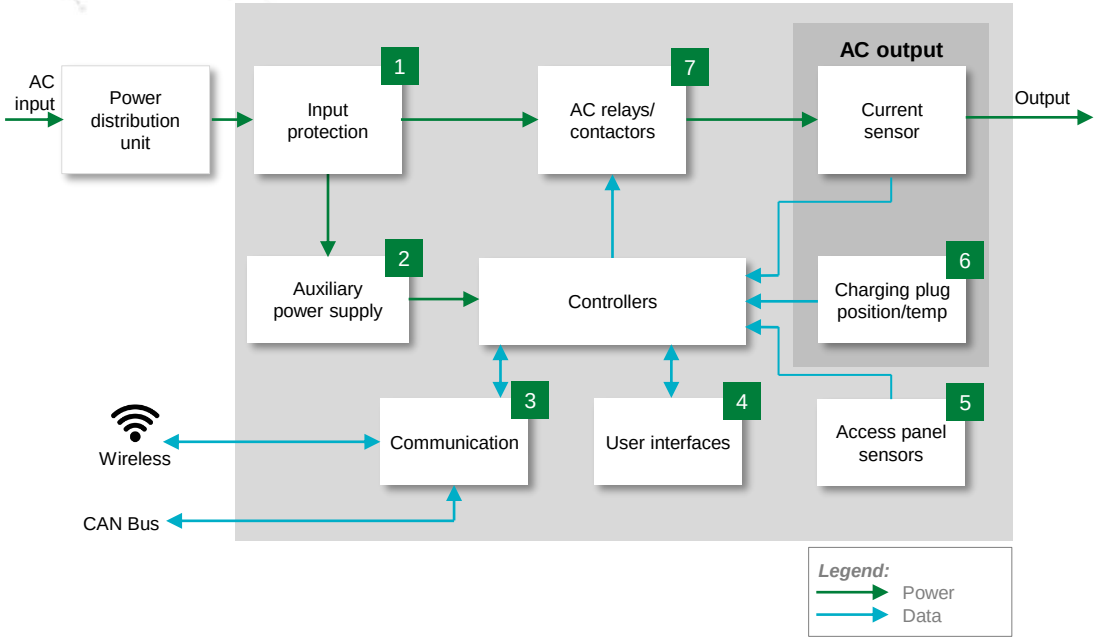
- Temperature Sensor
- Reed Sensor

7 AC Relays/Contactor

- Contactors & Relays

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

AC charger functional block diagram



	Technology	Product series
1	High-current Fuse (Primary protection)	606
	Surge protection (Primary protection)	SPD Type 2
	Fast-acting or Time lag Fuse (Secondary protection)	314, 324, 215
	Metal-Oxide Varistor	TMOV, UltraMOV
	Gas Discharge Tube	CG2, CG3
	TVS Diode	AK6, 1.5SMC
2	PPTC	LVR**
	Schottky Diode	DST, DSA, DSB
	SIDACtor + MOV	Pxxx0FNL + UltraMOV
3	TVS Diode Array	AQ24CAN, SM712
	Reed Relay	HE3600
4	TVS Diode Array Polymer ESD	SP1026 XGD10402
5	Reed Sensor	59060, 59045
6	Temperature Sensor	PPG, USW, Glass Coated Thermistor
	Reed Sensor	59060, 59045
7	Contactors or Relays	HCC 1 & 2 Pole, HCC 3 & 4 Pole, HCD, or SCO1*, SCO2*

*Please contact Littelfuse sales for more details
**Only used in case of Linear transformer

Note: Other Littelfuse solutions may be suitable depending on design-specific requirements

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

Features and benefits of Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	High-current Fuse (Primary Protection)	Primary over-current protection of EV equipment	606	Enables robust yet compact design; can operate in extreme temperature environment	Rated voltage @ 500 VAC; 40−63 A rating available; small footprint
	Surge protection (Primary protection)	Protects from power fluctuations or surges	SPD Type 2	Withstands high-energy transients to prevent disruption, downtime, and degradation	20 kA nominal interrupting rating and 50 kA maximum interrupting rating
	Fast-acting Fuse (Secondary Protection)	Overcurrent protection of auxiliary power supply	314, 324, 215	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	In accordance with UL Standard 248-14; available in cartridge and axial lead format
	MOV	GDT in series with TMOV protects the auxiliary power supply unit from voltage transients induced by lightning	TMOV, UltraMOV	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	High energy absorption capability: 40–530 J (2 ms); integrated thermal protection
	GDT		CG2, CG3	Small form-factor allows for compact system design	High energy absorption capability; small form-factor; low leakage current
	TVS Diode	Protects power line from transient surge transient	AK6, 1.5SMC	Good clamping and fast response time for high-energy transient protection	High power TVS 8/20 µs rating from 1−20 kA in axial-lead or SMT form factor
2	PPTC	Protected linear transformers from damages due to mech overloads, overheating, etc.	LVR**	Fast time to trip; offers boards space savings; reduces customer qual time by complying with UL/IEC	Line voltage ratings of 120 and 240 VAC; low resistance; holding current up to 2 A; compact size
	Schottky Diode	Used for rectification	DST, DSA, DSB	Reduces switching losses; increases system efficiency, reliability and thermal management	High surge capability; negligible reverse recovery current; T_j = 175 °C
	SIDACtor + MOV	Enhancing surge protection for auxiliary power supply	Pxxx0FNL + UltraMOV	Good clamping and fast response time for high-energy transient protection	3 kA, 8/20 µs surge capability to help protect AC lines from harmful transient surges.
3	TVS Diode Array	Protects CAN, Ethernet, RS-485 bus from ESD, EFT, and voltage transient	AQ24CAN, SM712	Ensures reliability of the equipment without performance degradation	Meets ESD protection levels specified under IEC 61000-4-2; ISO10605; low leakage current and clamping voltage
	Reed Relay	Low power switching with up to 2500 V isolation	HE3600	Low power consumption; galvanic isolation; immune to environmental effects	Miniature single in-line package; external magnetic shield option
4	TVS Diode Array Polymer ESD	Protects ICs from ESD through display	SP1026 XGD10402	Smaller form-factor and multi-line protection enables ease of design	SP1026 has high ESD robustness for touchpads; XGD10402 has ultra-low capacitance for I/O
5	Reed Sensor	Access panel for position sensing	59060, 59045	Robust in end application; mount directly into PCB; no standby power requirement	Well suited for usage in high-moisture and contaminated environments; molded stand-off to allow board washing
6	Temperature Sensor	DC contacts hotspot detection	PPG, USW, Glass Coated Thermistor	Offers high accuracy; high reliability; excellent stability at high temperatures	Linear relationship between temp and resistance; temp range -50 °C to +500 °C
	Reed Sensor	Charging plug position sensing	59060, 59045	Robust design; well suited for usage in high-moisture and contaminated environment	Hermetically sealed, magnetically operated contacts; certified tor use in NA and Europe
7	Contactors or Relays	Safety cutoff on the grid (power network) to prevent abnormal current supply.	HCC 1 & 2 Pole, HCC 3 & 4 Pole, HCD	Predetermined life cycle for application to minimize cost; high electrical and thermal conductivity; good resistance to oxidation for longer life	Long electrical life; High surge capability; Certified for use in North America, Europe and Asia
			SCO1*, SCO2*	PCB mount capable; higher flexibility for designers; compact design;	Low heat generation and low coil power consumption; performance to meet regulatory UL/IEC compliance

DC charging station

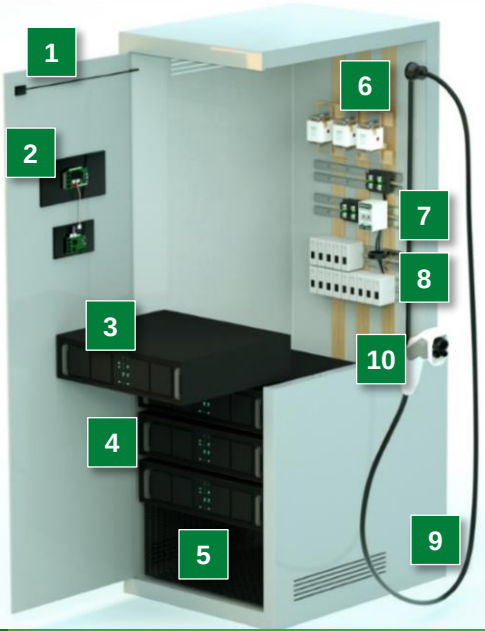
1 Service Access Panel
- Reed Sensor

2 User Interface
- TVS Diode Array
- Polymer ESD Suppressor

3 Communication
- TVS Diode Array

4 Rectification & PFC
- SiC/Si MOSFET
- Rectifier Diode/Module
- Gate Driver
- Temperature Sensor

5 Rectification & PFC
- SiC/Si MOSFET
- Rectifier Diode/Module
- Gate Driver
- Temperature Sensor



10 Charging Plug
- Temperature Sensor
- Reed Sensor

6 Power Distribution Unit
- Fuse

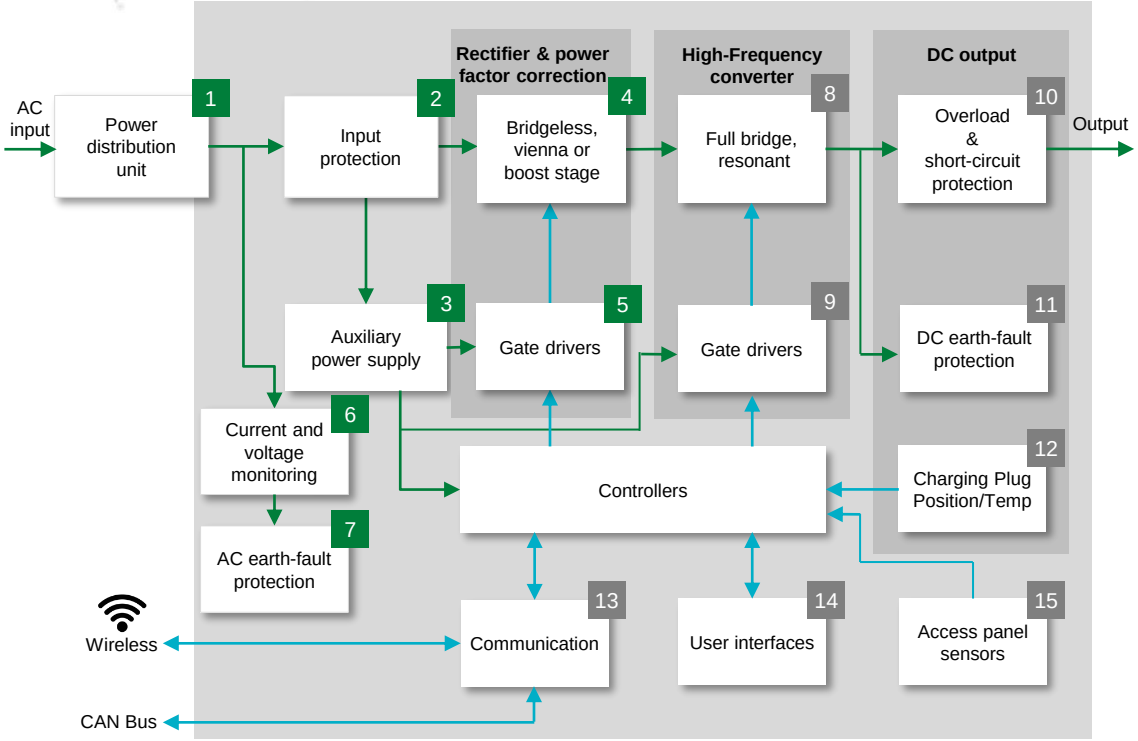
7 Input Protection
- Fuse
- Surge Protection Device
- TVS Diode
- Current Transformer
- AC Earth Fault Relay

8 DC Output Protection
- DC Fuse
- HVDC Contactor
- Earth Fault Relay

9 Auxiliary Power Supply
- Fuse
- MOV, GDT, SIDACtor® + MOV
- Si MOSFET
- Rectifier Diode

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

DC charger functional block diagram



Note: *Power converter topologies may differ based on design-specific requirements.*

Legend:
Power
Data

	Technology	Product series
1	AC Fuse (PDU level)	JLLS, JLLN
2	Overcurrent protection (Primary protection)	PSR, L50QS, L75QS
	Surge protection (Primary protection)	SPD Type 2
	TVS Diode	AK6, 1.5SMC
3	Si MOSFET	Polar™
	Rectifier and Schottky Diode	DMA, DST, DSA, DSB
	AC Fuse (Secondary protection)	314, 324
	Metal-Oxide Varistor	TMOV, UltraMOV
	Gas Discharge Tube	CG2, CG3
	SIDACtor + MOV	Pxxx0FNL + UltraMOV
4	Rectifier Diode	DMA
	Rectifier Module	MDD, VUO, MDNA
	SiC/Si MOSFET/ Discrete IGBT	LSIC1MO/X2-Class/XPT
	Diode	LSIC2SD, DHG, DSEI
	Temperature Sensor	USUR1000, KC
5	Gate Driver	IXDN609, IX4351NE
6	Current Transformer	SE-CS30
7	AC Earth-Fault Relay	SE-704

Note: *Other Littelfuse solutions may be suitable depending on design-specific requirements.*

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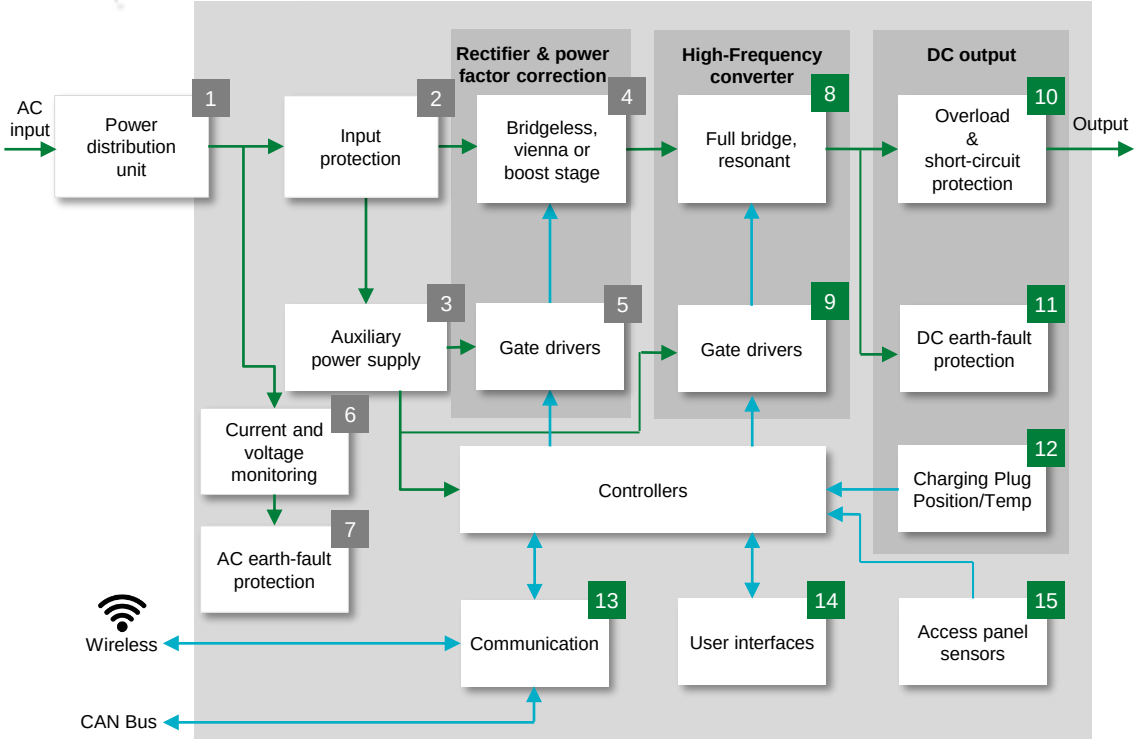
Click on the product series in the table below for more info

Features and benefits of Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
1	AC Fuse (PDU Level)	Provide fast-acting overload and short circuit protection.	JLLS, JLLN	Reduces damage to equipment caused by heating and magnetic effects of short circuit currents;	Extremely current-limiting; Small footprint 200 kA interrupting rating
2	Overcurrent protection (Primary protection)	Protects semiconductor devices	PSR, L50QS, L75QS	Lower I^2t performance allows for quick response to protect devices from higher heat energy	550–1300 V_{AC}, 500–1000 V_{DC}, 40–2000 A
	Surge protection (Primary protection)	Protects from power fluctuations or surges	SPD Type 2	Withstands high-energy transients to prevent disruption, downtime, and degradation	20 kA nominal interrupting rating and 50 kA maximum interrupting rating
	TVS Diode	Protects power line from transient surge transient	AK6, 1.5SMC	Good clamping and fast response time for high-energy transient protection	High power TVS 8/20 µs rating from 1 kA to 20 kA in axial-lead or SMT form factor
3	Si MOSFET	High-speed switching	Polar™	Easy to mount; space-savings; high power density	Low $R_{DS(ON)}$ and Qg; avalanche rated; international standard packages; low package inductance
	Rectifier and Schottky Diode	Provides output rectification in auxiliary power supply	DMA, DST, DSA, DSB	Improves power supply unit efficiency	Low forward voltage drop; high-frequency operation; high junction temperature
	AC Fuse (Secondary protection	Overcurrent protection of auxiliary power supply	314, 324	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	In accordance with UL Standard 248-14; available in cartridge and axial lead format
	MOV	GDT in series with TMOV protects the auxiliary power supply unit from voltage transients induced by lightning	TMOV, UltraMOV	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	High energy absorption capability: 40–530 J (2 ms); integrated thermal protection
	GDT		CG2, CG3	Small form-factor allows for compact system design	High energy absorption capability; small form-factor; low leakage current
	SIDACtor + MOV	Enhancing surge protection for auxiliary power supply	Pxxx0FNL + UltraMOV	Good clamping and fast response time for high-energy transient protection	3 kA, 8/20 µs surge capability to help protect AC lines from harmful transient surges.
4	Rectifier Diode	Converts AC line voltage supplied to the drive to DC	DMA	Small footprint; multiple package options (high voltage, isolated, and standard packages)	Low leakage current and forward voltage drop; improved thermal behavior; high robustness
	Rectifier Module		MDD, VUO, MDNA	Compact design, better electrical isolations	Package with DCB ceramic; very low forward voltage drop and low leakage current
	SiC/Si MOSFET/ Discrete IGBT	Boost converter for high-frequency switching in the PFC circuit	LSIC1MO/X2-Class/XPT	Optimized for high-frequency applications	Ultra-low output capacitance and on-resistance
	Diode		LSIC2SD, DHG, DSEI	Reduces switching losses; increases efficiency	High surge capability; negligible I_{RR}; Tj 175 °C
	Temperature Sensor	Temp sensing for semiconductors	USUR1000, KC	Rapid thermal response and long-time reliability	UL recognized; temperature range: -40−125 °C
5	Gate Driver	Controls the switching MOSFETs/IGBTs	IXDN609, IX4351NE	Quick turn-on and turn-off of MOSFETs/IGBTs; eliminates the need for separate supply	9 A peak current; low propagation delay time; low output impedance
6	Current Transformer	Offers ground-fault detection and protection	SE-CS30	Specifically designed for low level detection; flux conditioner is included to prevent saturation	Turns ratio 600:1 and current rating 30:0.05 A
7	AC Earth-Fault Relay		SE-704	No calibration; low level protection and system coordination; low maintenance	Microprocessor-based; adjustable pickup (10 mA-5 A); Adjustable time delay (30 ms−2 s)

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

DC charger functional block diagram



Note: Power converter topologies may differ based on design-specific requirements.

	Technology	Product
8	SiC or Si MOSFET	LSIC1MO, X-Class, X2-Class, HiPerFET™
	Diode	LSIC2SD, DHG, DSEI
	Temperature Sensor	USUR1000, KC
9	Gate Driver	IXDN609, IX4351NE
10	DC Fuse	PSR, SFPJ
	Diode	DMA, DHG, DSEI
	HV DC Contactor	DCNxx
11	DC Earth-Fault Relay	SE-601
	Earth Reference Module	SE-GRM
12	Temperature Sensor	PPG, USW, Glass Coated Thermistor,
	Reed Sensor	59060, 59045
13	TVS Diode Array	AQ24CAN, SM712
14	TVS Diode Array Polymer ESD	SP1026 XGD10402
15	Reed Sensor	59060, 59045

Note: Other Littelfuse solutions may be suitable depending on design-specific requirements.

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Features and benefits of Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
8	SiC or Si MOSFET	High-frequency switching and rectification	LSIC1MO, X-Class, X2-Class, HiPerFET™	Optimized for high-frequency applications	Ultra-low output capacitance and on-resistance
	Diode		LSIC2SD, DHG, DSEI	Reduces switching losses; increases efficiency	High surge capability; negligible I_{RR}; Tj 175 °C
	Temperature Sensor	Semiconductor temperature measurement	USUR1000, KC	Rapid thermal response and long-time reliability	UL recognized; wide range of temperature: -40 °C to 125 °C
9	Gate Driver	Controls the switching MOSFETs	IXDN609, IX4351NE	Quick turn-on and turn-off of MOSFETs; eliminates the need for separate supply	9 A peak current; low propagation delay time; low output impedance
10	DC Fuse	Protects semiconductor devices	PSR, SFPJ	Lower I^2t performance allows for quick response to protect devices from higher heat energy	550–1300 V_{AC}, 500–1000 V_{DC}, 40–2000 A
	Diode	CHAdeMO standard requires safety diode for secondary protection	DMA, DHG, DSEI	Compact design; low turn-on loss; lower power dissipation	High voltage options; very low forward voltage drop; small form factor
	HV DC Contactors	The main contactors connect and disconnect the DC charging unit	DCNxx	Allows a low-voltage signal to switch the contacts for a high voltage signal	Wide range of capabilities–can switch from 10's of amps to 1000's of amps, and 10's of volts to 1000's of volts
11	DC Earth-Fault Relay	Offers low-level ground-fault protection. Ground-fault current is sensed using a Ground-Reference Module	SE-601	Provides a wide range of low-level protection; adjustable trip delay allows quick protection or delayed response	Adjustable pickup (1–20 mA); adjustable time delay (50 ms–2.5 s); CSA certified, UL Listed (E340889), CE (European Union), C-Tick
	Earth Reference Module		SE-GRM		
12	Temperature Sensor	DC contacts hotspot detection	PPG, USW, Glass Coated Thermistor,	Offers high accuracy; high reliability; excellent stability at high temperature	Linear relationship between temp and resistance; temp range -50 °C to +500 °C
	Reed Sensor	Charging plug position sensing	59060, 59045	Robust design; well suited for usage in high-moisture and contaminated environment	Hermetically sealed, magnetically operated contacts. Certified tor use in NA and Europe
13	TVS Diode Array	Protects CAN, Ethernet, RS-485 bus from ESD, EFT, and voltage transient	AQ24CAN, SM712	Ensures reliability of the equipment without performance degradation	Meets ESD protection levels specified under IEC 61000-4-2; ISO10605; low leakage current and clamping voltage
14	TVS Diode Array Polymer ESD	Protects ICs from ESD through display	SP1026 XGD10402	Smaller form-factor and multi-line protection enables ease of design	Low capacitance of 1.0 pF per I/O
15	Reed Sensor	Access panel for position sensing	59060, 59045	Robust design; well-suited for usage in high-moisture and contaminated environment	Hermetically sealed; magnetically operated contacts; certified for use in NA and Europe

Wireless charging station

1 Service Access Panel
- Reed Sensor

2 User Interface
- TVS Diode Array
- Polymer ESD Suppressor

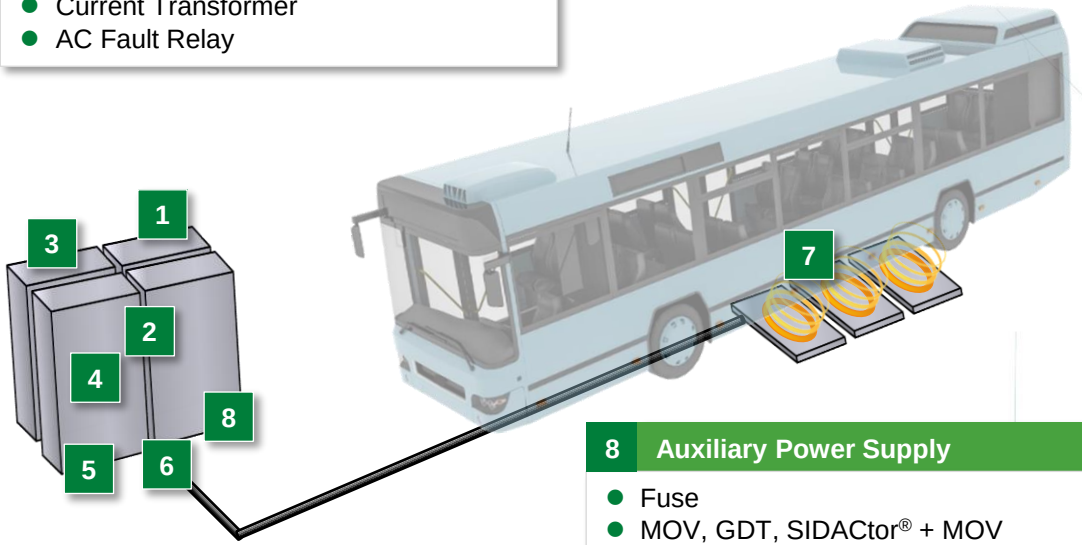
3 Communication
- TVS Diode Array

4 Rectification & PFC
- SiC/Si MOSFET
- Rectifier Diode/Module
- Gate Driver
- Temperature Sensor

5 High-frequency Converter
- SiC MOSFET
- Gate Driver
- Temperature Sensor

6 Input Protection
- Fuse
- Surge Protection Device
- TVS Diode
- Current Transformer
- AC Fault Relay

7 Power Distribution Unit
- Fuse



8 Auxiliary Power Supply
- Fuse
- MOV, GDT, SIDACtor® + MOV
- Si MOSFET
- Rectifier Diode

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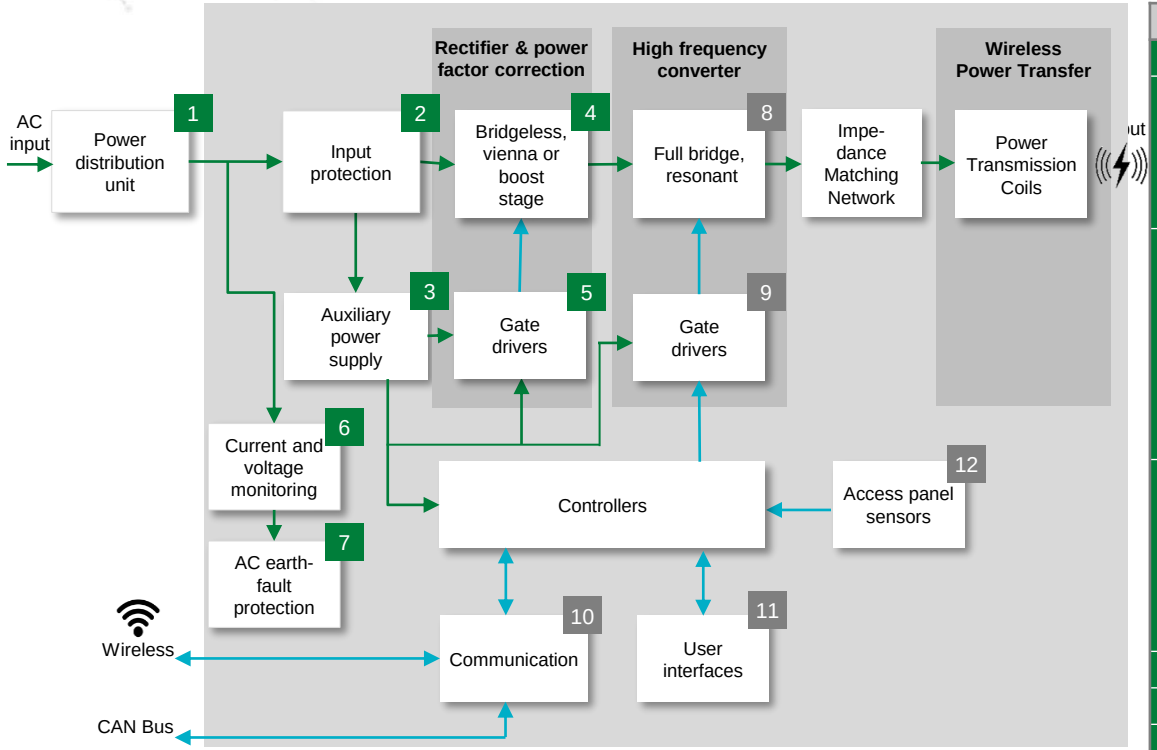
Wireless Charger Functional Block Diagram



Note: Power converter topologies may differ based on design-specific requirements.

	Technology	Product
1	AC Fuse (PDU level)	JLLS, JLLN
2	Overcurrent protection (Primary protection)	PSR, L50QS, L75QS
	Surge protection (Primary protection)	SPD Type 2
	TVS Diode	AK6, 1.5SMC
3	Si MOSFET	Polar™
	Rectifier and Schottky Diode	DMA, DST, DSA, DSB
	AC Fuse (Secondary protection)	314, 324
	Metal-Oxide Varistor	TMOV, UltraMOV
	Gas Discharge Tube	CG2, CG3
	SIDACtor + MOV	Pxxx0FNL + UltraMOV
4	Rectifier Diode	DMA
	Rectifier Module	MDD, VUO, MDNA
	SiC/Si MOSFET/ Discrete IGBT	LSIC1MO/X2-Class/XPT
	Diode	LSIC2SD, DHG, DSEI
	Temperature Sensor	USUR1000, KC
5	Gate Driver	IXDN609, IX4351NE
6	Current Transformer	SE-CS30
7	AC Earth-Fault Relay	SE-704

Note: Other Littelfuse solutions may be suitable depending on design-specific requirements.

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	Technology	Function in application	Product series	Benefits	Features
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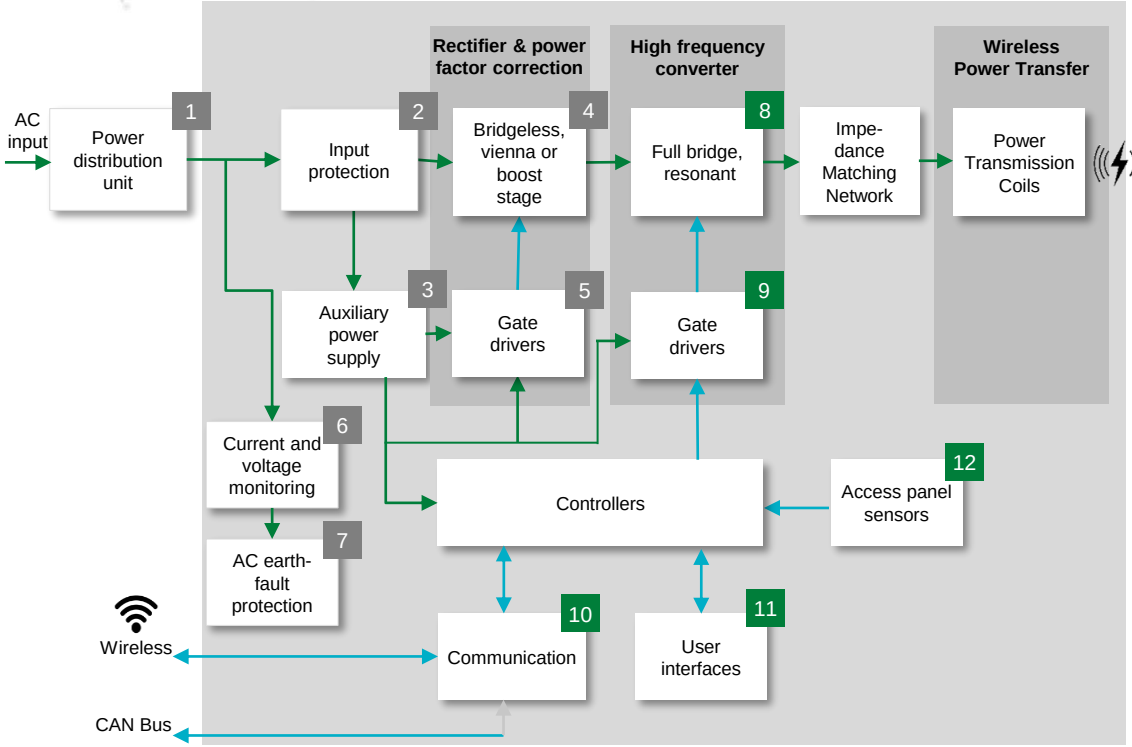
2	Overcurrent protection (Primary protection)	Protects semiconductor devices	PSR, L50QS, L75QS	Lower I^2t performance allows for quick response to protect devices from higher heat energy	550–1300 V_{AC}, 500–1000 V_{DC}, 40–2000 A
	Surge protection (Primary protection)	Protects from power fluctuations or surges	SPD Type 2	Withstands high-energy transients to prevent disruption, downtime, and degradation	20 kA nominal interrupting rating and 50 kA maximum interrupting rating
	TVS Diode	Protects power line from transient surge transient	AK6, 1.5SMC	Good clamping and fast response time for high-energy transient protection	High power TVS 8/20 µs rating from 1 kA to 20 kA in axial-lead or SMT form factor
3	Si MOSFET	High-speed switching	Polar™	Easy to mount; space-savings; high power density	Low $R_{DS(ON)}$ and Qg; avalanche rated; international standard packages; low package inductance
	Rectifier and Schottky Diode	Provides output rectification in auxiliary power supply	DMA, DST, DSA, DSB	Improves power supply unit efficiency	Low forward voltage drop; high-frequency operation; high junction temperature
	AC Fuse (Secondary protection	Overcurrent protection of auxiliary power supply	314, 324	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	In accordance with UL Standard 248-14; available in cartridge and axial lead format
	MOV	GDT in series with TMOV protects the auxiliary power supply unit from voltage transients induced by lightning	TMOV, UltraMOV	Reduces customer qualification time by complying with third-party safety standards such as UL/IEC	High energy absorption capability: 40–530 J (2 ms); integrated thermal protection
	GDT		CG2, CG3	Small form-factor allows for compact system design	High energy absorption capability; small form-factor; low leakage current
	SIDACtor + MOV	Enhancing surge protection for auxiliary power supply	Pxxx0FNL + UltraMOV	Good clamping and fast response time for high-energy transient protection	3 kA, 8/20 µs surge capability to help protect AC lines from harmful transient surges.
4	Rectifier Diode	Converts AC line voltage supplied to the drive to DC	DMA	Small footprint; multiple package options (high voltage, isolated, and standard packages)	Low leakage current and forward voltage drop; improved thermal behavior; high robustness
	Rectifier Module		MDD, VUO, MDNA	Compact design, better electrical isolations	Package with DCB ceramic; very low forward voltage drop and low leakage current
	SiC/Si MOSFET/ Discrete IGBT	Boost converter for high-frequency switching in the PFC circuit	LSIC1MO/X2-Class/XPT	Optimized for high-frequency applications	Ultra-low output capacitance and on-resistance
	Diode		LSIC2SD, DHG, DSEI	Reduces switching losses; increases efficiency	High surge capability; negligible I_{RR}; Tj 175 °C
	Temperature Sensor	Temp sensing for semiconductors	USUR1000, KC	Rapid thermal response and long-time reliability	UL recognized; temperature range: -40−125 °C
5	Gate Driver	Controls the switching MOSFETs/IGBTs	IXDN609, IX4351NE	Quick turn-on and turn-off of MOSFETs/IGBTs; eliminates the need for separate supply	9 A peak current; low propagation delay time; low output impedance
6	Current Transformer	Offers ground-fault detection and protection	SE-CS30	Specifically designed for low level detection; flux conditioner is included to prevent saturation	Turns ratio 600:1 and current rating 30:0.05 A
7	AC Earth-Fault Relay		SE-704	No calibration; low level protection and system coordination; low maintenance	Microprocessor-based; adjustable pickup (10 mA-5 A); Adjustable time delay (30 ms−2 s)

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

Wireless Charger Functional Block Diagram



	Technology	Product
8	SiC MOSFET	LSIC1MO
	Temperature Sensor	USUR1000, KC
9	Gate Driver	IXDN609, IX4351NE
10	TVS Diode Array	AQ24CAN, SM712
11	TVS Diode Array Polymer ESD	SP1026 XGD10402
12	Reed Switch	59060, 59045

Note: *Power converter topologies may differ based on design-specific requirements.*

Legend:
Power
Data

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

Features and benefits of Littelfuse solutions

	Technology	Function in application	Product series	Benefits	Features
8	SiC MOSFET	High-frequency switching and rectification	LSIC1MO	Optimized for high-frequency applications	Ultra-low output capacitance and on-resistance
	Temperature Sensor	Semiconductor Temperature measurement	USUR1000, KC	Rapid thermal response and long-time reliability	UL recognized; wide range of temperature: -40 °C to 125 °C
9	Gate Driver	Controls the switching MOSFETs/IGBTs	IXDN609, IX4351NE	Quick turn-on and turn-off of MOSFETs/IGBTs; eliminates the need for separate supply	9 A peak current; low propagation delay time; low output impedance
10	TVS Diode Array	Protects CAN, Ethernet, RS-485 bus from ESD, EFT, and voltage transient	AQ24CAN, SM712	Ensures reliability of the equipment without performance degradation	Meets ESD protection levels specified under IEC 61000-4-2; ISO10605; low leakage current and clamping voltage
11	TVS Diode Array Polymer ESD	Protects ICs from ESD through display	SP1026 XGD10402	Smaller form-factor and multi-line protection enables ease of design	Low capacitance of 1.0 pF per I/O
12	Reed Switch	Charging plug position sensing	59060, 59045	Robust design; well suited for usage in high-moisture and contaminated environment	Hermetically sealed; magnetically operated contacts; certified tor use in NA and Europe

Select standards for EV charging equipment

Standard	Title	General Scope	Region
IEC 61851 Series	Electric Vehicle Conductive Charging System	Various parts of this standard cover general requirements, along with AC chargers and DC chargers specifically.	Global
IEC 62196 Series	Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets - Conductive Charging of Electric Vehicles	Standards for charging plugs, sockets, and connectors.	Global
IEC 61980 Series	Electric Vehicle Wireless Power Transfer (WPT) Systems	Various parts of this standard cover general requirements for wireless charging systems, along with specific technology-based requirements.	Global
GB/T 18487 Series	Electric Vehicle Conductive Charging System	Various parts of this standard cover general requirements, along with AC chargers and DC chargers specifically.	China
GB/T 20234 Series	Connection Set for Conductive Charging of Electric Vehicles	Standards for charging plugs in China.	China
SAE J1772*	Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler	Physical, electrical, functional and performance standard for charging plugs in North America.	North America
SAE J2954*	Wireless Power Transfer for Light-Duty Plug-In/Electric Vehicles and Alignment Methodology	Interoperability, electromagnetic compatibility, EMF, minimum performance, safety and testing for wireless chargers in North America.	North America
UL 2594	Standard for Electric Vehicle Supply Equipment	Safety standard for supply equipment (charging stations, cord sets, power outlets, etc.) in North America. Tri-national standard for U.S., Canada, and Mexico (known as CAN/CSA C22.2 No. 280 in Canada and NMX-J-677-ANCE in Mexico).	North America
UL 2202	Standard for Electric Vehicle (EV) Charging System Equipment	Safety standard for electric vehicle charging equipment	U.S.

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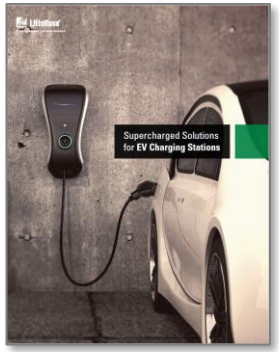
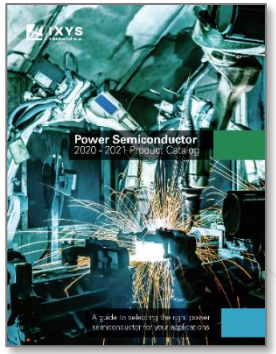
EV Charging Application Guide



Circuit Protection Catalog

Sensor Selection Guide

Power Semiconductor Catalog

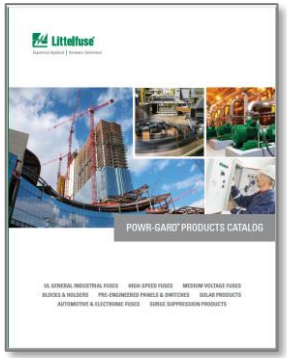


Click on images to open the catalogs

Integrated Circuits Catalog

Surge Protection Devices Catalog

Industrial Fuses Catalog



Power Relay & Control Catalog

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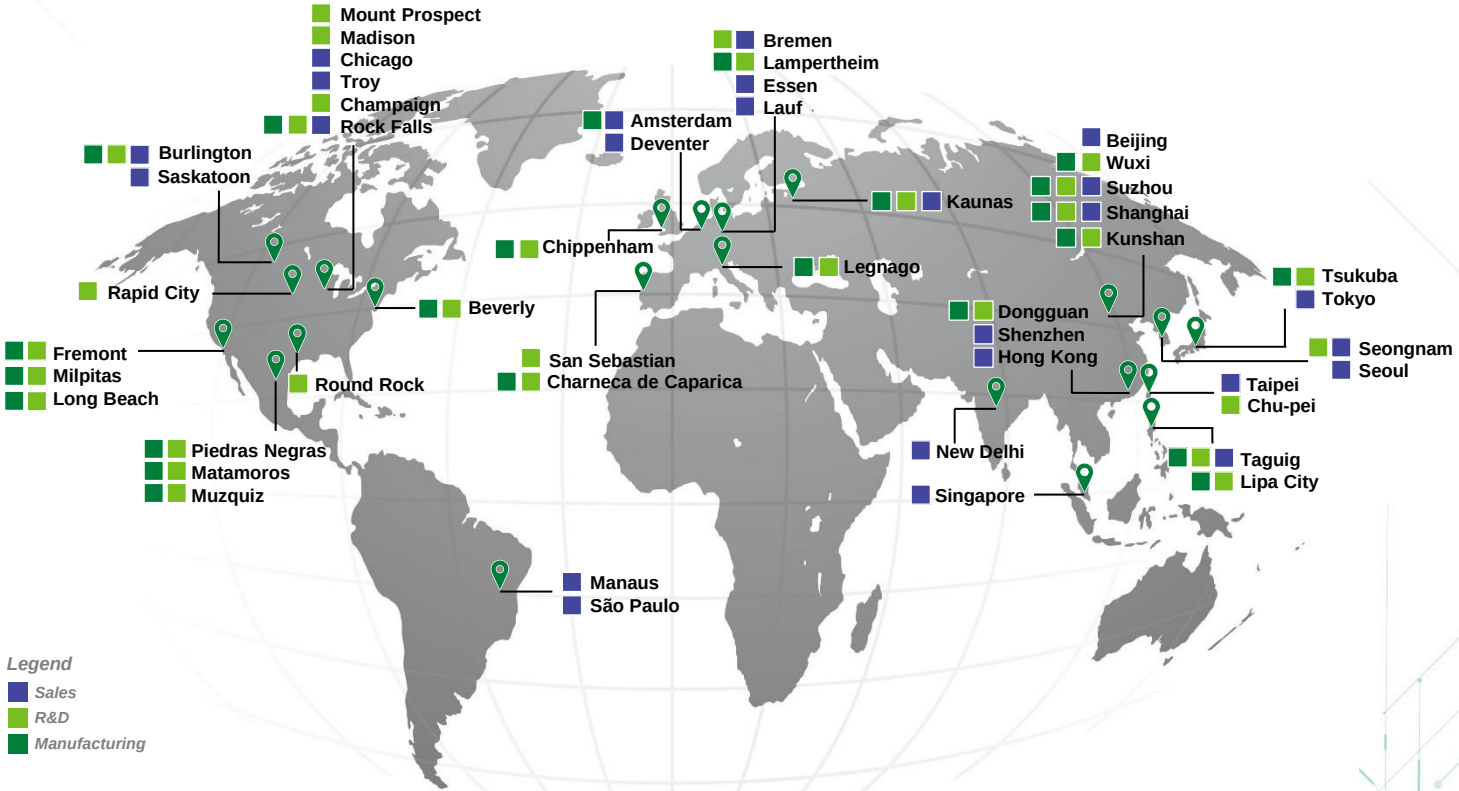
Local resources supporting our global customers



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Supplementary slide

Types of electric vehicle charging stations

As defined by SAE J1772
As defined by IEC 61851-1

AC Level 1

- 120V AC, 1-phase, 12 A or 16 A max. continuous current

Mode 1 (AC)

- 250 V AC, 1-phase, 16 A max. -OR- 480 V AC, 3-phase, 16 A max.
- Cord with no pilot or auxiliary connections

Mode 2 (AC)

- 250 V AC, 1-phase, 32 A max. -OR- 480 V AC, 3-phase, 32 A max.
- Cord with control pilot & shock protection

- Delivers AC power from the wall socket to vehicle's on-board charger
- Typically takes 8-12 hours* to charge fully depleted battery

AC Level 2

- 208 V-240 V AC, 1-phase, ≤ 80 A max. continuous current

Mode 3 (AC)

- 250V AC, 1-phase, 32A max. -OR- 480 V AC, 3-phase, 32 A max.
- Permanently connected to AC supply with control pilot & shock protection

- Delivers AC power from the electrical supply to vehicle's on-board charger
- Typically takes 4-6 hours* to charge fully depleted battery

DC Fast Charger

- 380 V-600 V AC, 3-phase input; DC output

Mode 4 (DC)

- AC or DC input supply, cord or permanently connected, with control pilot & shock protection

- Delivers DC power, bypassing the vehicle's on-board charger
- Typically provides 80% charge of fully depleted battery within 30 minutes*

** Charge time dependent on vehicle's battery capacity and charge acceptance rate*