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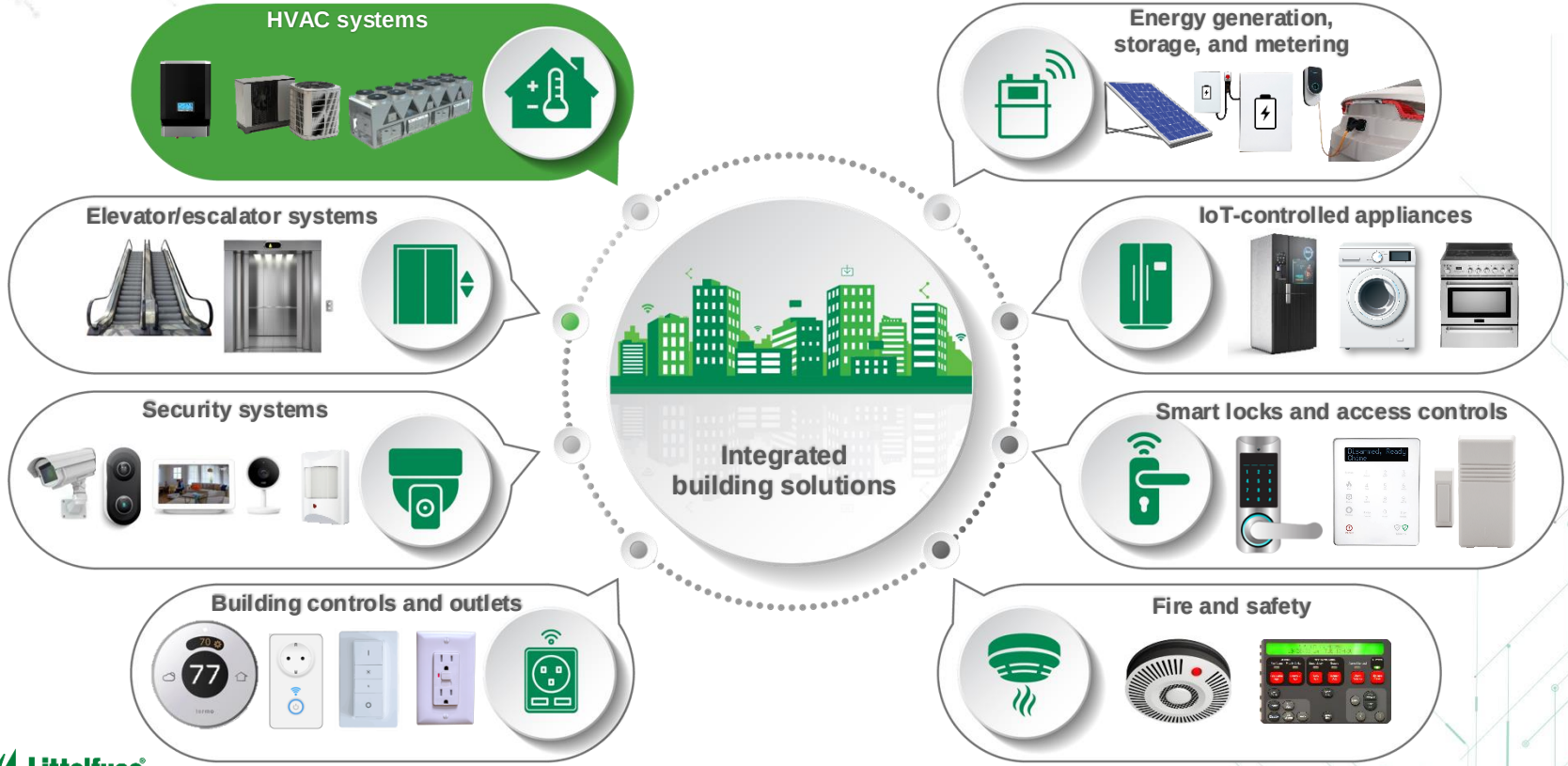
Heat Pumps

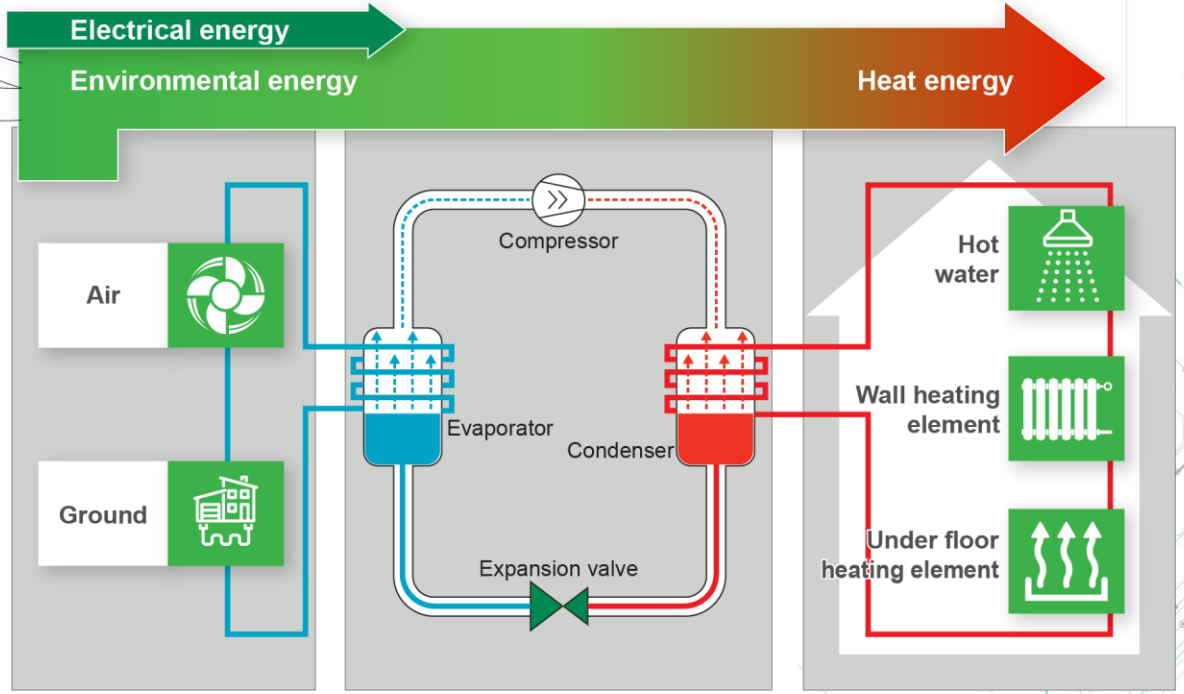
Building Solutions

REV0424

Buildings are evolving into networks of electric and electronic systems to help reach net zero goals



Heat pump function overview



A **heat pump** uses electrical energy to provide both heating and cooling to a building. In the winter, it pulls heat from the air or ground and transfers it inside. In the summer, the system is reversed, pulling heat out of indoor air to provide cooling.

An example of a heat pump system in heating mode, providing warm water and air to a home.

Market trends of heat pumps

Market trends and drivers

The Net Zero Emissions (NZE) initiatives in over 80 countries aim to reduce greenhouse gas emissions by 50% by 2030 and to net zero by 2050. Heat pumps are a critical part of emission reduction strategy.

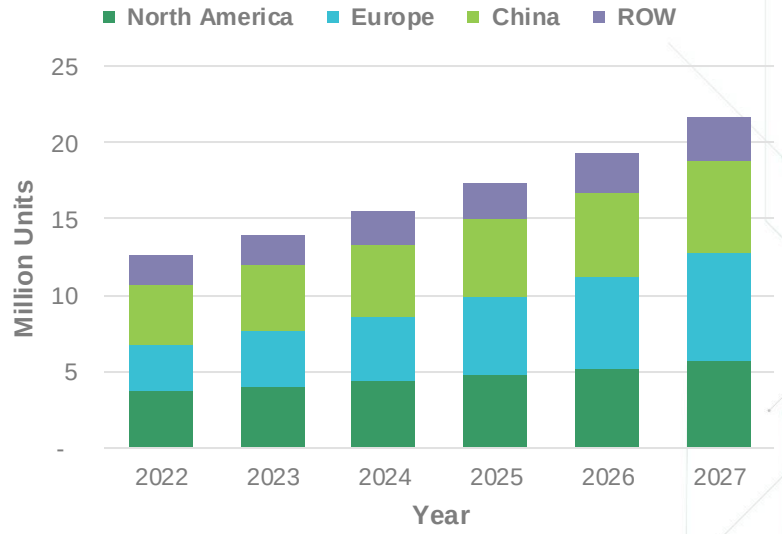
Global annual installations are expected to increase from 14M units in 2023 to 22M units in 2027, a 10.3% CAGR.

The residential market accounts for 81% of the volume due to installations in newly constructed homes and retrofits of aging systems.

Inverter-driven motors are improving system efficiencies and performance, making heat pumps suitable in a wider range of climates.

To reach NZE targets, annual installations expected to approach 85M units by 2030. Rebates and government initiatives will help close the gap to facilitate heat pump adoption into building systems.

Heat pump installations



Sources: *Heat Pumps (IEA, 2021), EHPA 2023 Market Report (EHJPA, 2023), internal marketing estimates*

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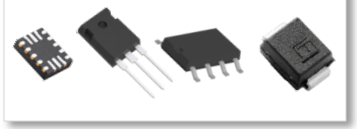
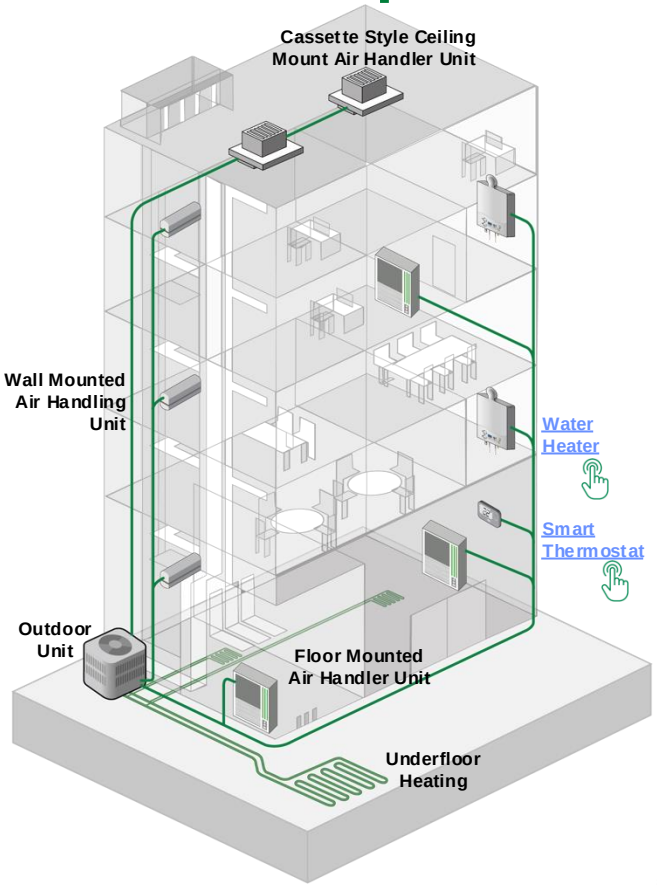
Recommended Littelfuse components for heat pumps

Input protection
Fuse, MOV, GDT

Auxiliary power supply
eFuse, MOSFET,
Optical Isolator, TVS Diode

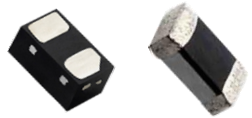


Settings/maintenance
DIP Switch, Tactile Switch



Rectifier + PFC + Inverter
MOSFET, IGBT, Diode, Gate Driver,
Rectifier Module, Temperature Sensor

Wireless interface
TVS Diode Array, Polymer ESD



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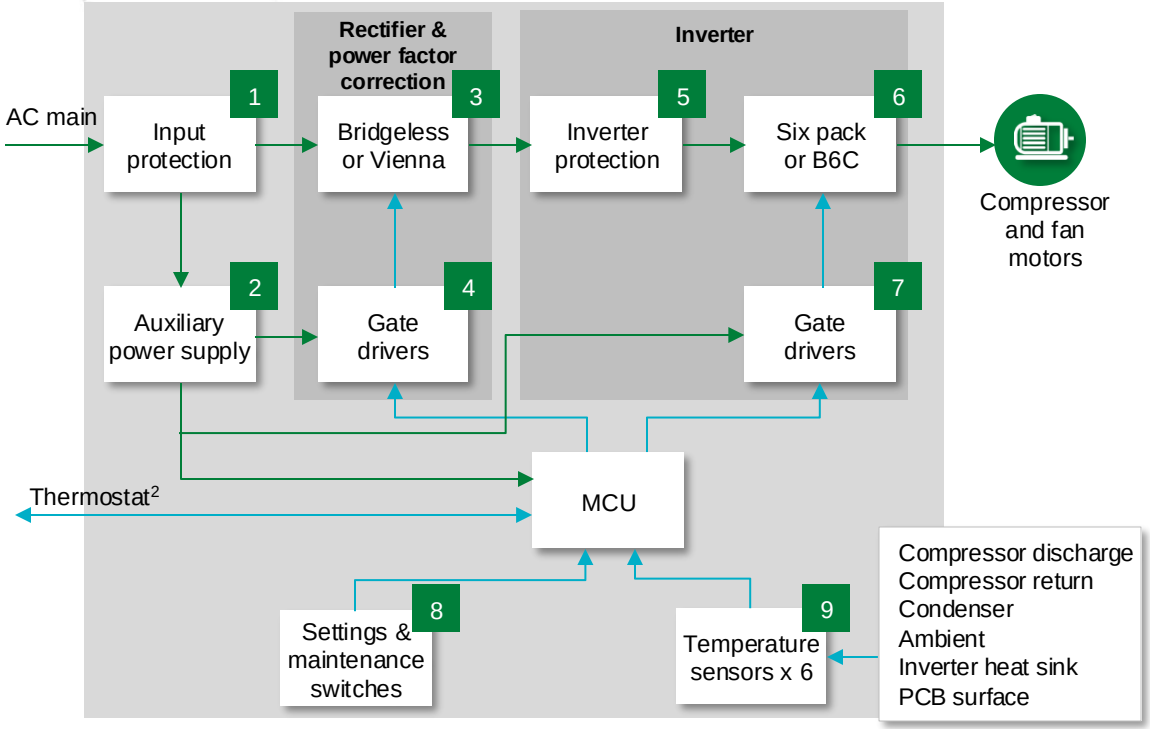
Click the product series in the table below for more info

Heat pump outdoor unit block diagram



	Technology	Product series
1	Fuse	216, 505
	Fuseholder	100, 102
	MOV	UltraMOV, TMOV
	GDT	CG2, CG3
2	MOSFET	HiPerFET™
	Optical Isolator	LOC11x
	TVS Diode	SACB, SMAJ, SMF3.3
3	Rectifier Module[1] or MOSFET	MDMA/MDD, VUO, MDMA/MDNA
		X2-Class, X3-Class
	Integrated PFC Boost[1] or MOSFET + Diode	X2-Class Boost
		X-Class, X2-Class, HiPerFET™, LSIC2SD, SONIC, FRED, HiPer FRED
4	Gate Driver	IX4310TTR
5	Fuse	QS, PSR
6	IGBT Module or IGBT	MIXA, MIXG
		SMPD XPT, SMPD TRENCH
7	Gate Driver	LF2136BTR, LF2388BTR
8	DIP Switch	SDA
	Tactile Switch	KSC
9	Temperature Sensors	USPXXX, SM

Notes:
1. *Complete rectifier + PFC module available; see VUB/VUI and MDMA/MDNA.*
2. *To see suggested Littelfuse technologies for thermostats, click here.*

Legend:
Power
Data

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Benefits of Littelfuse components used in heat pumps

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Protects equipment and users from hazards due to overcurrent equipment faults	216, 505	Reduces customer qualification time by complying with regulatory safety standards such as UL/IEC	Compliant with UL/IEC standards; low internal resistance; shock safe; vibration resistant
	Fuseholder	Provides enclosure between PCB and fuse	100, 102	Enables easy fuse installation and replacement	Compliant with UL/IEC standards
	MOV	Helps protect equipment from voltage surges and grid fluctuations	UltraMOV, TMOV	Reduces qualification time for compliance with UL/IEC safety standards	High energy absorption capability
	GDT	Used with an MOV to provide more robust voltage surge protection	CG2, CG3	Small form factor allows compact system design; enables product to comply with IEC/UL standards	High energy absorption capability; small form-factor; low leakage current
2	MOSFET	High-frequency switching for auxiliary power supply	HiPerFET™	Optimized for high-frequency applications	Ultra-low output capacitance and on-resistance
	Optical Isolator	Isolated main voltage sensing in the system	LOC11x	High gain stability; low input/output capacitance; low power consumption	LED operating range: 2−10 mA; isolation: 3750 V_{RMS}
	TVS Diode	Power unit protection from voltage transients	SACB, SMAJ, SMF3.3	Protects ICs and other sensitive components	Excellent clamping capability
3	Rectifier Module[1] or MOSFET	Converts AC line voltage to DC	MDMA/MDD, VUO, MDMA/MDNA	Easy mounting for optimized system size, performance, and reliability	Industry standard packages, compact design with screw terminals, solder or press fit terminals
			X2-Class, X3-Class	Low power consumption; high-efficiency system operation	Ultra-low on-resistance $R_{DS(ON)}$ and gate charge Q_g; fast body diode dv/dt ruggedness
	Integrated PFC Boost[1] or MOSFET + Diode	Switching for PFC to improve power supply unit efficiency	X2-Class Boost	High power density; reduces component count; PCB space savings	Integrated MOSFET with FRED diode in a single package
			X-Class, X2-Class, HiPerFET™, LSIC2SD, SONIC, FRED, HiPer FRED	Optimized for high-frequency applications	Ultra-low output capacitance and on-resistance
4	Gate Driver	Controls the IGBT/MOSFET	IX4310TTR	TTL and CMOS compatible; 24 V supply voltage range	2 A peak driver in small SOT23-5 package

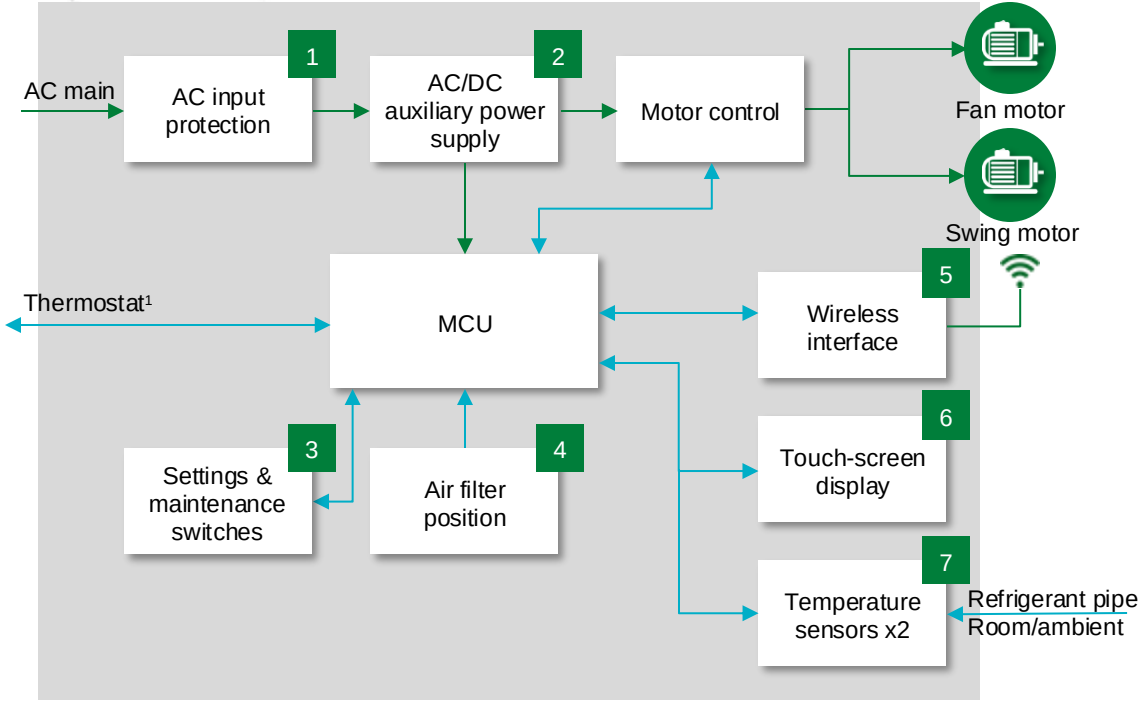
Click the product series in the table below for more info

Benefits of Littelfuse components used in heat pumps

	Technology	Function in application	Product series	Benefits	Features
5	Fuse	Protects power semiconductor components from overcurrent faults	QS, PSR	Best-in-class DC performance	Busbar mount
6	IGBT Module or IGBT	Converts DC to AC for compressor and fan motor control	MIXA, MIXG	Low profile packages for compact, robust and flexible designs; optimized losses for better performance	Low-profile packages for compact, robust and flexible designs; optimized losses for better performance
			SMPD XPT, SMPD TRENCH	Board space savings; offers more design flexibility	Ultra-low and compact package profile; low package inductance; excellent thermal capability; high power cycling capability
7	Gate Driver	Controls the IGBT/MOSFET	LF2136BTR, LF2388BTR	Single-chip driver solution; minimal torque ripple	Matched propagation delays, integrated protection
8	DIP Switch	Switch for function controlling, resetting, etc.	SDA	Low-profile design; through-hole and surface mount models	25 mA @ 24 VDC or 100 mA @ 5 VDC
	Tactile Switch		KSC	Available in a wide range of operating forces; rugged sealing and resistant to corrosion; very long operating life	Ultra-low current consumption; operating life up to 1 million cycles
9	Temperature Sensor	Temperature sensing of various motor coils, refrigerant lines, ambient, semiconductors	USPXXX, SM	Allows for high-precision temperature measurement in harsher environments	UL recognized with ring lug mounting; SM NTCs is in hermetically sealed MELF package suitable for operation up to 220 °C

Click the product series in the table below for more info

Heat pump indoor unit block diagram



	Technology	Product series
1	Fuse	215, 216, 314 / 324, 325 / 326
	Fuseholder	100, 102, 122
	MOV	UltraMOV, TMOV
2	Fuse	287
	eFuse (Protection IC)	LS2406ERQ23
	TVS Diode	SACB, SMAJ, SMF3.3
3	DIP Switch	SDA, RTE
	Tactile Switch	KSC
4	Reed Sensor + Actuator	59140 + 57140
5	TVS Diode Array	SP3213-01UTG
	Polymer ESD	PESD
6	TVS Diode	SMAJ, SMBJ, SMF4L
7	Thermistor Probe	USPXXX

Note:
1. To see suggested Littelfuse technologies for thermostats, click here

Benefits of Littelfuse components used in heat pump indoor unit

Click the product series in the table below for more info

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Helps protect equipment and users from hazards due to overcurrent equipment faults	215, 216, 314 / 324, 325 / 326	Reduces customer qualification time by complying with regulatory safety standards such as UL/IEC	Compliant with UL/IEC standards; low internal resistance; shock safe; vibration resistant
	Fuseholder	Provides enclosure between PCB and fuse for easy replacement	100, 102, 122	Enables easy fuse installation and replacement	Compliant with UL/IEC standards
	MOV	Helps protect equipment from voltage surges	UltraMOV, TMOV	Reduces qualification time for compliance with UL/IEC safety standards	High energy absorption capabilities
2	Fuse	Protects components on control board from overcurrent faults	287	Easy to remove and replace	Automotive style blade fuse; color-coding indicates amperage rating
	eFuse (Protection IC)	Provides overload, short circuit, input voltage surge, over-temperature, excessive inrush current, and reverse current protection	LS2406ERQ23	Integrated alternative to discrete components that provides several functions in a single package	Wide operation voltage range from 3 V to 24 V; low profile 16 leads QFN 2.5mm x 3.2mm package
	TVS Diode	Power unit protection from voltage transients	SACB, SMAJ, SMF3.3	Improves system reliability by clamping the voltage at safe levels during transients	Excellent clamping capability
3	DIP Switch	Switch for function controlling, resetting, and so on	SDA, RTE	Low profile design; through-hole and surface mount models	25 mA @ 24 VDC or 100 mA @ 5 VDC
	Tactile Switch		KSC	Available in a wide range of operating forces; rugged sealing and resistant to corrosion; very long operating life	Ultra-low current consumption; operating life up to 1 million cycles
4	Reed Sensor + Actuator	Detects the position of the filter in the air handling unit	59140 + 57140	Hermetically sealed, suitable for humid, wet, or contaminated environments	Application-specific customization available, wide range of sensitivity available
5	TVS Diode Array	Protects IC chipsets from ESD	SP3213-01UTG	Ultra-low capacitance with high level of protection	0.2 µA leakage current; 0.09 pF capacitance
	Polymer ESD		PESD	Ultra-low leakage current; available in many form factors	<0.01 µA leakage current; 0.25 pF capacitance
6	TVS Diode	Protects IC chipsets from ESD	SMAJ, SMBJ, SMF4L	Protects ICs and other sensitive components	Excellent clamping capability
7	Thermistor Probe	Temperature sensing of refrigerant lines and ambient	USPXXX	Allows for high-precision temperature measurement in harsher environments	UL recognized with ring lug mounting

Applicable standards

Standard	Title	General scope	Region
EN 14511	Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, and process chiller with electrically driven compressors	This document specifies the following: ▪ Terms and definitions (Part 1) ▪ Test conditions (Part 2) ▪ Test methods (Part 3) ▪ Requirements (Part 4) for the rating and performance of air conditioners, liquid chilling packages, and heat pumps, using either air, water, or brine as heat transfer media, with electrically driven compressors when used for space heating and/or cooling as well as for process chillers. It does not apply to heat pumps for domestic hot water.	Europe
EN 60335-2-40	Household and Similar Electrical Appliances–Safety–Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers	This standard deals with the safety of electric heat pumps, including sanitary hot water heat pumps, air conditioners, and dehumidifiers incorporating motor-compressors and hydronic fan coils units, their maximum rated voltages being not more than 250 V for single-phase appliances and 600 V for all other appliances. Partial units are within the scope of this international standard. Appliances not intended for normal household use, but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard.	Europe
IEC 60335-2-40			Global
UL/CSA 60335-2-40			North America

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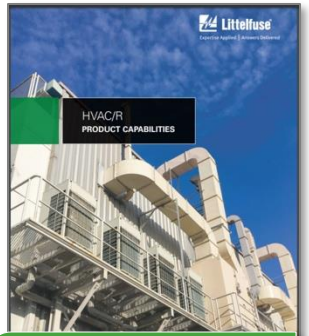
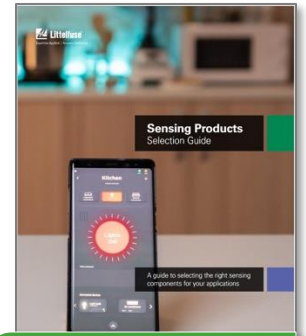
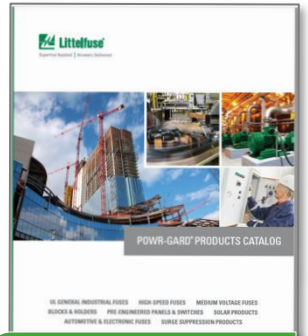
Building Automation Guide



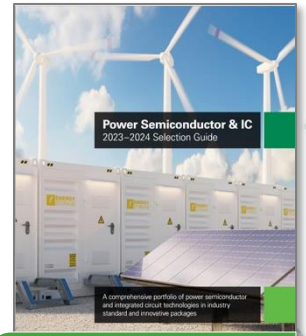
HVAC Capability Brochure



Sensor Selection Guide

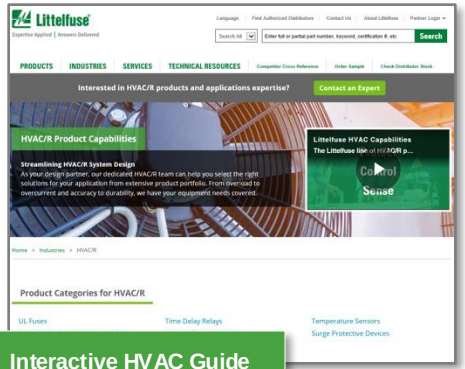


Industrial Fuses Catalog

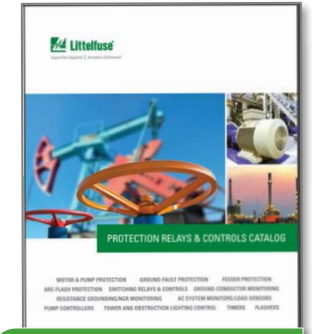


Power Semiconductor Guide

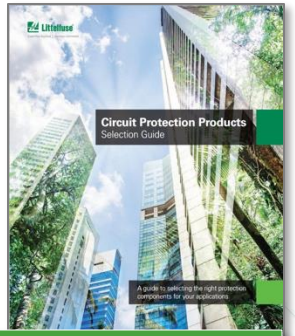
Click on images for more information



Interactive HVAC Guide



Power Relay & Control Catalog



Circuit Protection Selection Guide

Scan the code to learn more!

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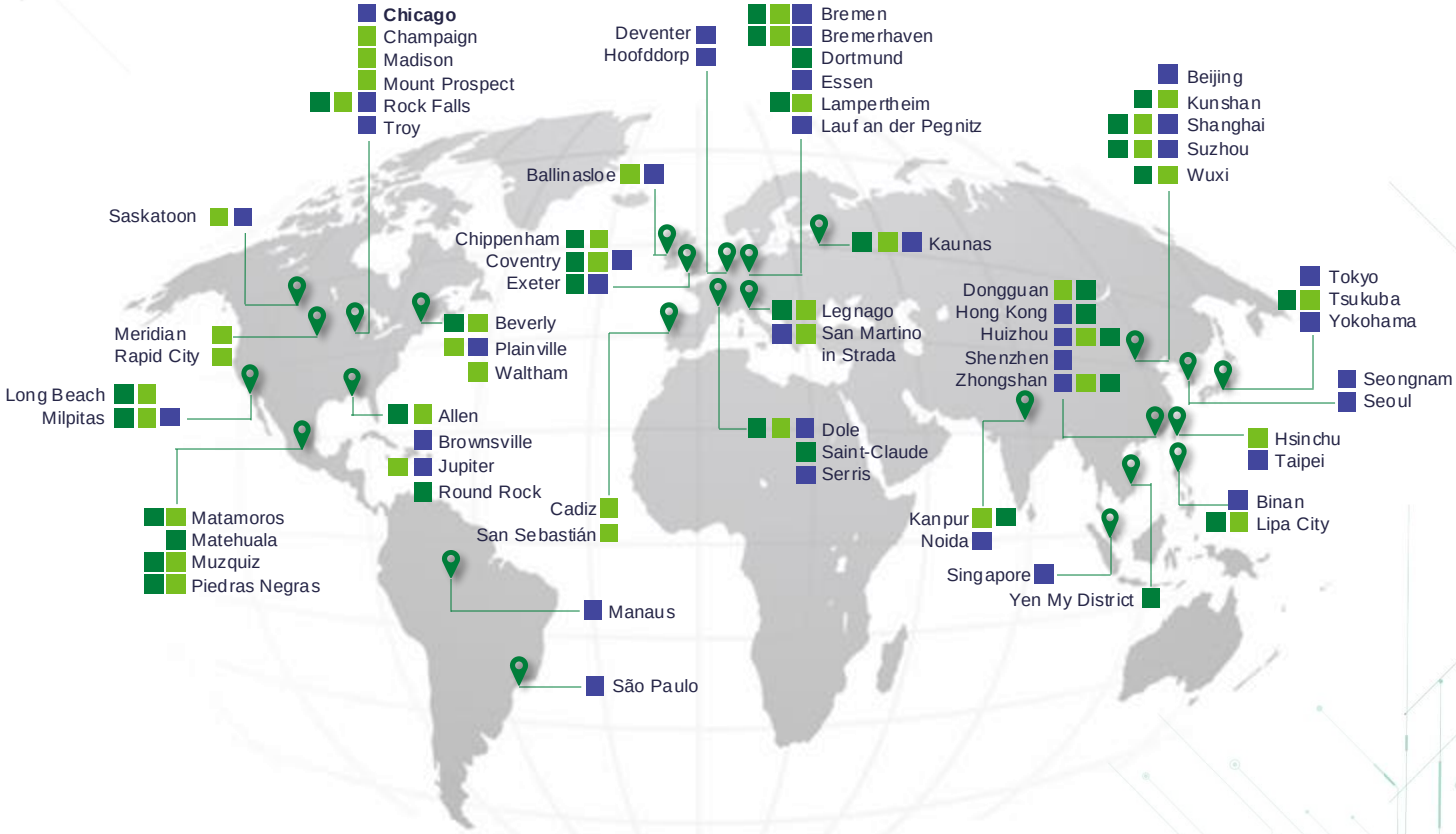
Local resources supporting our global customers



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Broad Product Portfolio

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We help customers get products to market faster, we offer certification testing to global regulatory standards

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