



Expertise Applied | Answers Delivered

System Solutions for Major Appliances



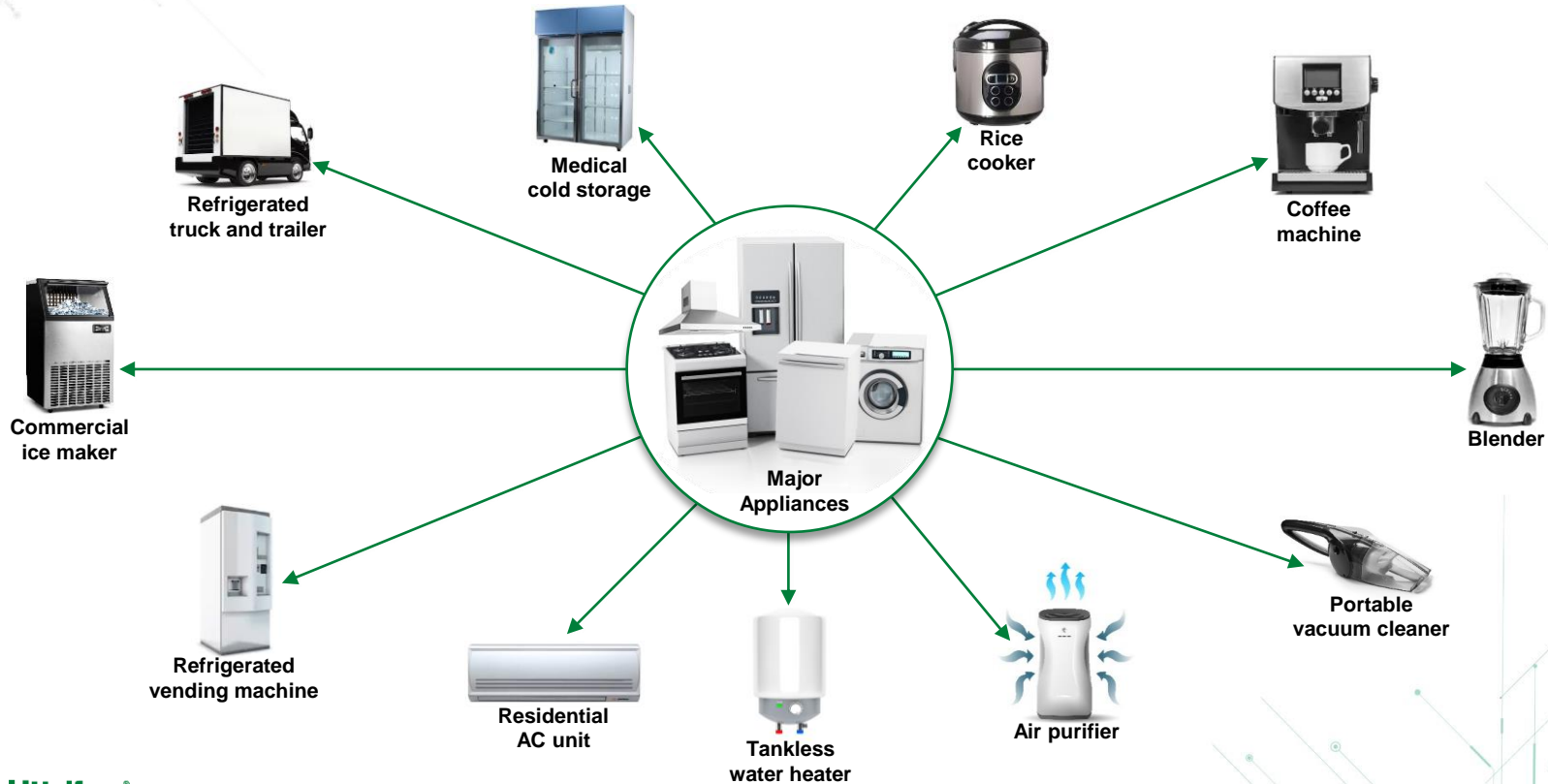
Appliances

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Major appliances share similar architecture with ACs, small appliances, and commercial products



Major appliance market: ~570M units in 2021

Market trends and drivers

Intelligent appliances that provide features such as recommending meals based on refrigeration contents and providing alerts prior to spoilage

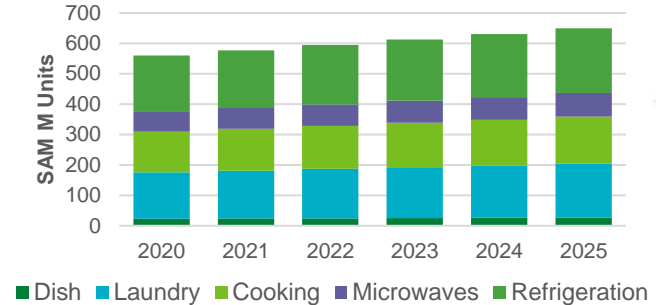
Increased sensors to support intelligence, including humidity, gas (food quality), and gesture control

Sustainability focus with reduction in energy consumption and water usage and the use of recyclable material

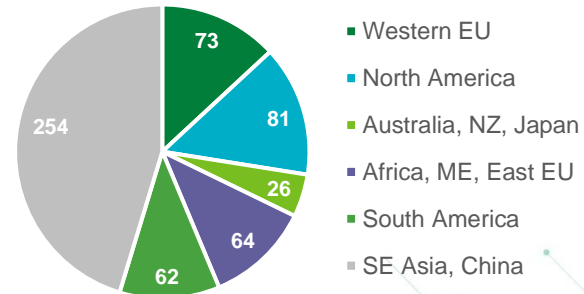
Provide conveniences such as boiling water quicker

Global OEMs have regional assembly for local customization and cost optimization

Sales (units) projections for major appliances



Geographic view (Sales units in millions)



Sources: Passport market reports, OEM annual reports

Littelfuse technologies for appliances

Inside Fan for Air Circulation



- Hall Effect Sensor
- Temperature Sensor Probe

Ice Bucket Module



- Reed Sensor
- Temperature Sensor
- PPTC

Door Assembly



- Reed sensor
- Temperature sensor
- LED protector



Displays and Controls



- TVS Diode Array
- MLV
- Hall Effect Sensor

Control Board



- MOV
- Fuse and Fuse Clip
- TVS Diode
- PPTC

Motor Drive



- TRIAC
- MOSFET
- Temperature Sensor

Acronyms:

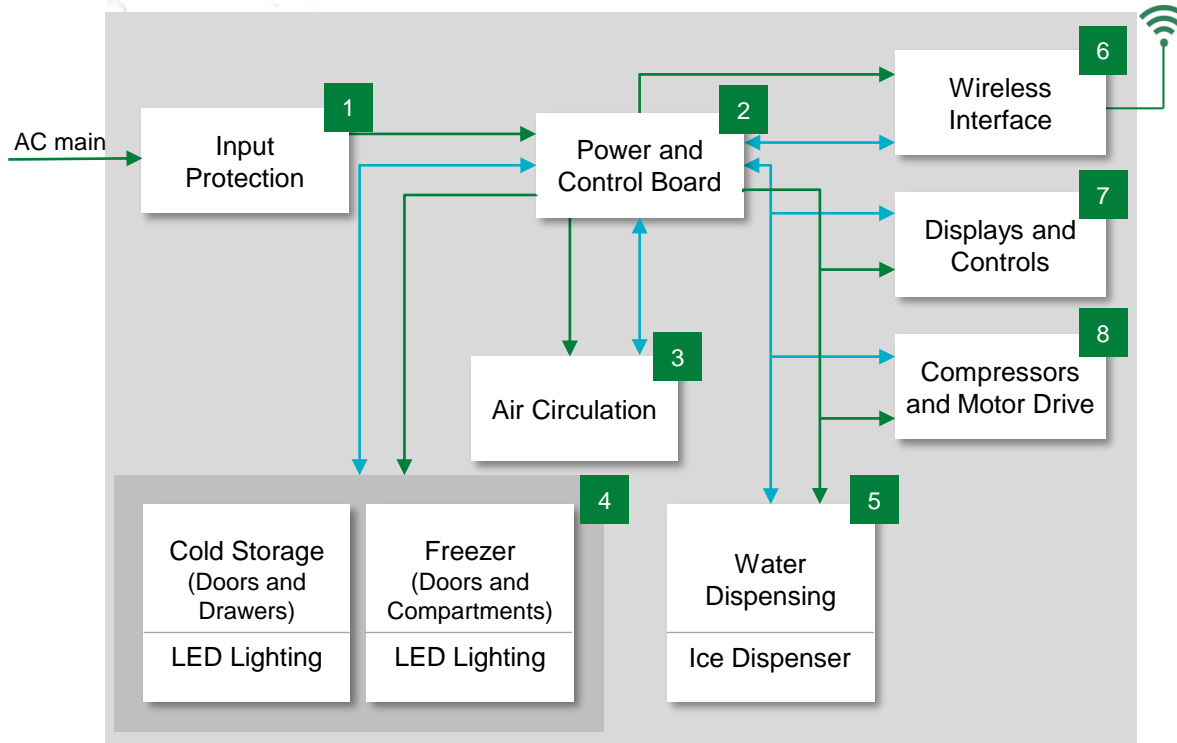
PPTC: Polymeric Positive Temperature Coefficient

TVS: Transient Voltage Suppression

MOV: Metal Oxide Varistors

MLV: Multi-layer Varistors

Block diagram of a typical refrigeration unit



	Technology	Series
1	MOV	TMOV , LA , C-III , UltraMOV
	Fuses and Fuse Clips	3AG , 5x20 mm Fuse , Clips
2	Fuse	TR5 , TE5 , Nano^{2®}
	TVS Diode	P4KE , SMAJ
	TRIAC	Qxx10Hx , QJxx16xHx , L01
	MOSFET	X2-Class
3	Reed or Hall Sensor	59140 , 55100
	Temperature Probe	H3686
4	Reed or Hall Sensor	59140 , 55100
	Temp Probe	H3686 , H6270
	LED Protector	SD
5	Temperature Probe	H2946
6	TVS Diode Array	SP3401
	Polymer ESD	XGD
7	TVS Diode Array	SP1001 , SP1003 , SP1006
	MLV	MLA
	Hall Effect Sensor	55300 , 55250
8	Temperature Probe	H3390
	Reed or Hall Sensor	59140 , 55100

Legend:
 Power
 Data



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

Features and benefits of a typical refrigeration unit

	Technology	Function in application	Product series	Benefits	Features
1	MOV	Helps protect equipment from voltage surges	TMOV , LA , C-III , UltraMOV	Reduces qualification time for compliance with UL/IEC safe standards.	High energy absorption capabilities
	Fuses and Fuse Clips	Helps to protect equipment and users from hazards owing to overcurrent equipment fault	3AG , 5x20 mm Fuse , Clips	Flexibility of package to best meet manufacturing needs	Available in cartridge and axial lead with various forming dimensions
2	Fuse	Fast acting fuse for overcurrent protection	TR5 , TE5 , Nano²⁰	Reduces PCB space requirements	Vibration resistant
	TVS Diode	Voltage transients' protection	P4KE , SMAJ	Improves system reliability by protecting downstream components	Excellent clamping capabilities
	TRIAC	Control of solenoids, motors, and pumps (dishwasher, and so on)	Qxx10Hx , QJxx16xHx , L01	Solid-state switching with no audible noise and no contact bounce during operation; compact design	High voltage withstand capability (1 kA) and high surge current capability (200 A)
	MOSFET	Control of BLDC compressor (refrigeration)	X2-Class	Low gate charge and avalanche rated	Low package inductance
3	Reed or Hall Sensor	Detects if fan stops working	59140 , 55100	Programmable sensitivities for design flexibility	High switching speed up to 12 kHz
	Temperature Probe	Detects fan motor over temperature	H3686	Vinyl probe housing for wide range of temperature sensing applications	Customizable sensing element and wire lengths
4	Reed or Hall Sensor	Detects if doors are open or closed	59140 , 55100	Non-contact and hermetically sealed to operate in contaminated environments	Custom-defined sensitivity options
	Temperature Probe	Detects temperature in different compartments	H3686 , H6270	Snap-in plastic for manufacturability	Customizable size and sensing elements
	LED Protector	Protects LED from overvoltage transients	SD	Reliability against electrostatic discharge	Low clamping voltage
5	Surface Temp Probe	Detects motor over temperature	H2946	Ease of mounting	Customizable sensing element and wire lengths
6	TVS Diode Array	ESD protection of wireless communication	SP3401	Ability to protect high-speed data lines	Low capacitance of .35 pF and low leakage of 1 nA
	Polymer ESD	ESD protection of wireless communication	XGD	Protection without signal distortion	Extremely low capacitance and small size
7	TVS Diode Array	ESD protection of electronics	SP1001 , SP1003 , SP1006	Small form factor for compact designs	High ESD withstand capability
	MLV	ESD protection of electronics	MLA	Increased reliability	Operating temperature range of -40-125 °C
	Hall Effect Sensor	Detects dial position (washing machine)	55300 , 55250	Unaffected by harsh environments or contamination	Analog output
8	Temperature Probe	Detects temperature in freezer	H3390	Ring lug for easy mounting	Sensing element customizable; down to -40 °C
	Reed or Hall Sensor	Signals ice tray is full	59140 , 55100	Non-contact and hermetically sealed to operate in contaminated environments	Custom-defined sensitivity options

Additional information can be found on Littelfuse.com

Explore the world of Littelfuse with the Electronics eCatalogs (<http://electronicscatalogs.littelfuse.com/>)

Circuit Protection
Selection Guide



Sensor Products
Selection Guide



Power Semiconductor
Selection Guide



ESD Protection
Design Guide

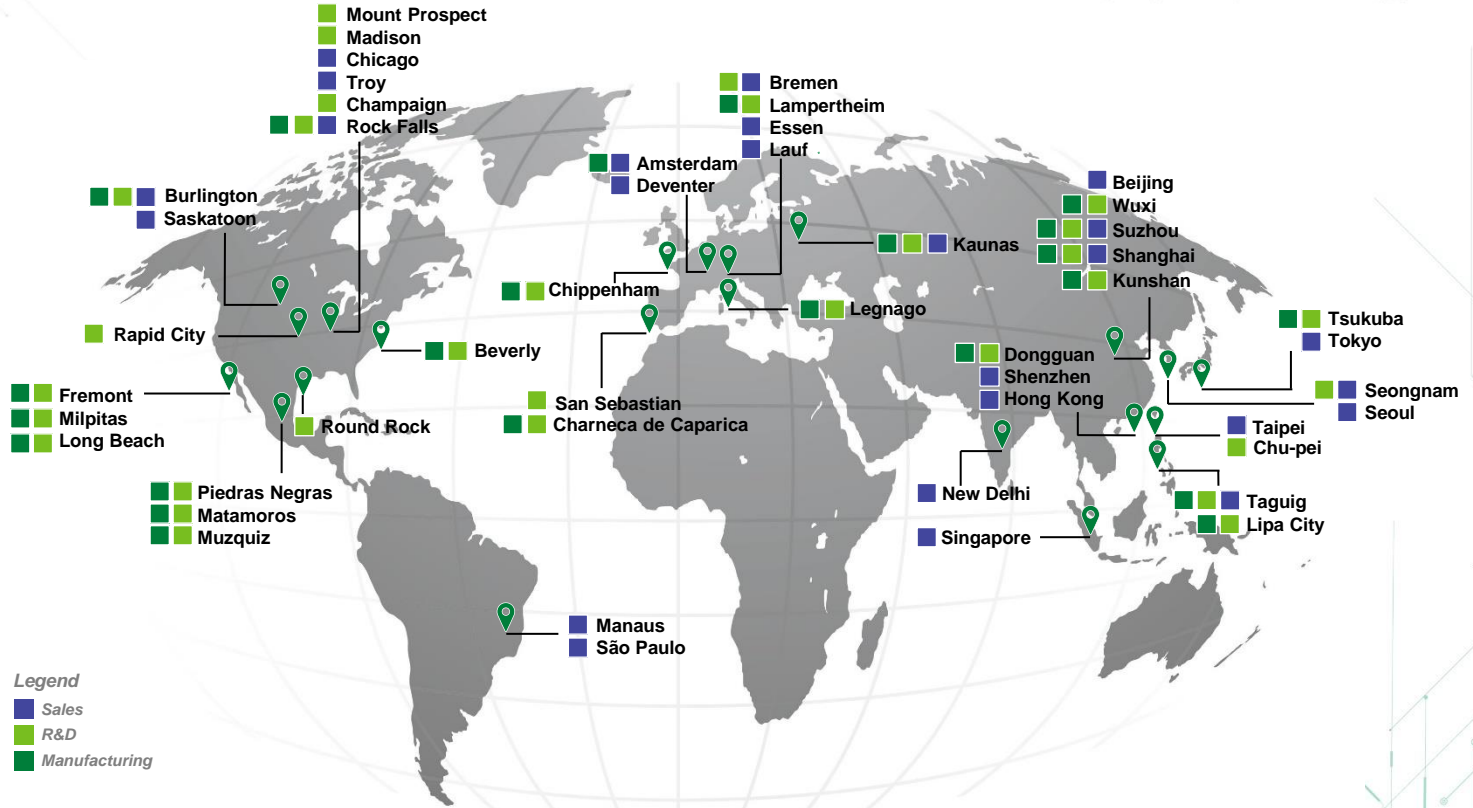


ESD Suppression
Design Guide

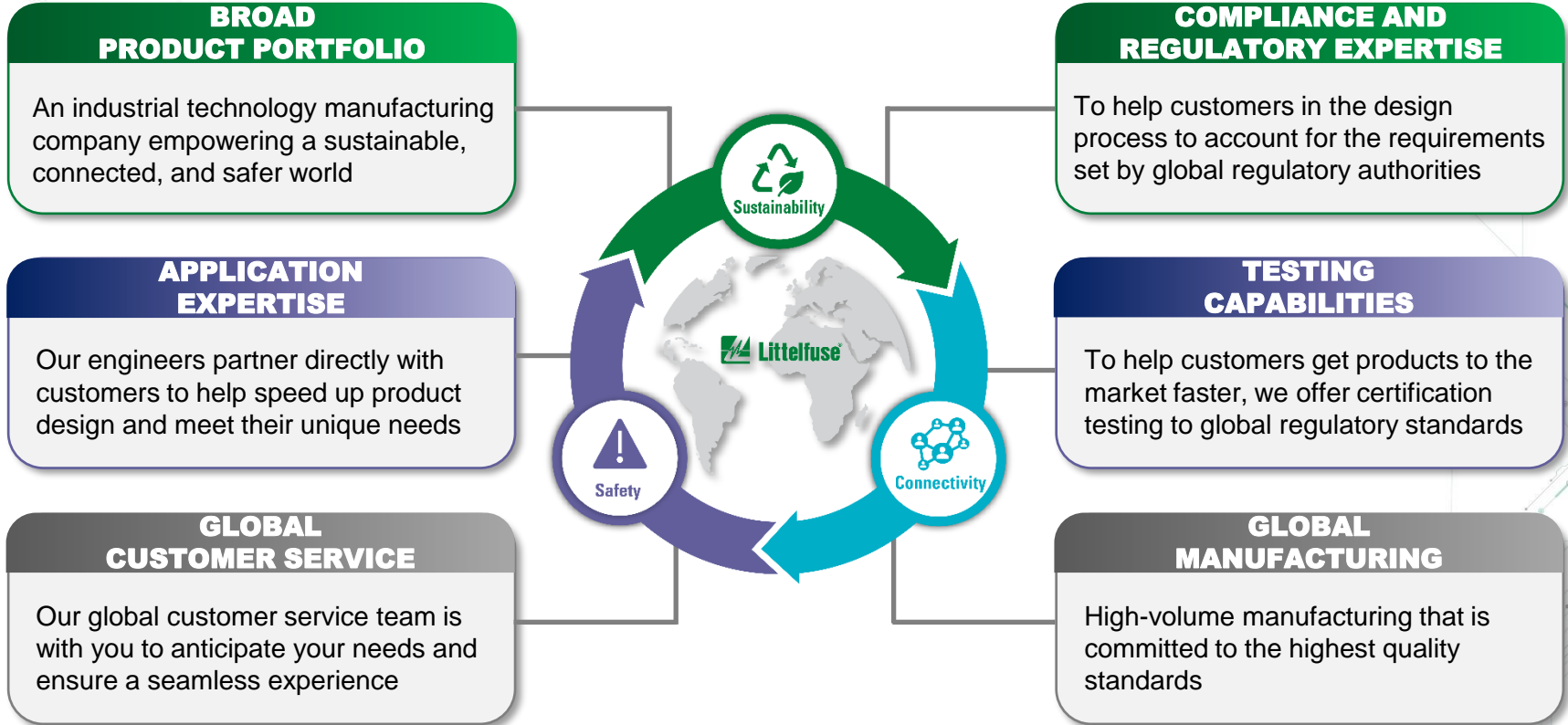


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Sensing solutions for appliances

Sensing solutions for refrigerators

Inside fan for air circulation

- Hall effect speed sensor [55100](#) series, [55140](#) series
- Temperature sensor H3686 series: custom



Ice bucket module

- Reed sensor [59140](#) series
- Surface temperature sensor with lug H3390 series: custom



Door assembly

- Reed sensor [59140](#) series
- Digital Hall effect [55100](#) series



Displays and controls

- Reed switch [59170](#) series, [59166](#) series



Trays and drawers

- Reed sensor/Hall effect [59140](#) series, [55100](#) series
- Temperature sensors H3686 and H6270 series: custom



Compressor and motor drive

- Surface temperature sensor with lug H2946 series: custom



Other Littelfuse solutions

- Overvoltage protection: [MOVs](#), [TVS diodes](#), [TVS diode arrays](#)
- Overcurrent protection: [Fuses](#), [PPTCs](#)
- Power control: [TRIACs](#)

Sensing solutions for dishwashers

Door latch/lock position

- Switch/reed sensor
[59165](#) series, [59140](#) series
- Hall effect sensor
[55100](#) series



Spray arm rotation detection

- Reed sensor
[59140](#) series, [59025](#) series



Water level & plugged drain

- Reed sensor
[59630](#) series, [59140](#) series
- Digital Hall effect
[55100](#) series



Compressor and motor drive

- Surface temperature sensor and lug
Custom H2946 series



Sprayer diverter

- Reed sensor
[59630](#) series, [59165](#) series



Soap & water softener tray level

- Reed sensor
[59630](#) series, [59165](#) series



Other Littelfuse solutions

- Overvoltage protection: [MOVs](#), [TVS diodes](#), [TVS diode arrays](#)
- Overcurrent protection: [Fuses](#), [PPTCs](#)
- Power control: [TRIACs](#)

Sensing solutions for washing machines and dryers

Door latch or lid sensor

- Overmolded reed sensor
[59165](#) series, [59140](#) series
- Digital Hall effect sensor
[55100](#) series



Rotary selector dial/switch

- Analog Hall effect sensor
[55300](#) series, [55250](#) series



Motor

- Temperature sensor
[LC](#) series
[USUR1000](#) series



Drum speed sensor

- Digital hall effect sensor
[55100](#) series



Water/salt level sensor

- [59630](#) sensor
- Custom sensor with reed switch and PCB



Other Littelfuse solutions

- Overvoltage protection: [MOVs](#), [TVS diodes](#), [TVS diode arrays](#)
- Overcurrent protection: [Fuses](#), [PPTCs](#)
- Power control: [TRIACs](#)

Sensing solutions for oven and rangehood

Exhaust fan speed

- Hall effect sensor
[55300](#) series



Door lock

- Reed sensor
[59135](#) series
- Magnetic actuator
[57135](#) series



Door closure

- Reed sensor
[59135](#) series
- Magnetic actuator
[57135](#) series



Oven temperature

- NTC probe
Custom H7235 series



Other Littelfuse solutions

- Overvoltage protection: [MOVs](#), [TVS diodes](#), [TVS diode arrays](#)
- Overcurrent protection: [Fuses](#), [PPTCs](#)
- Power control: [TRIACs](#)

Custom magnetic sensors

Magnetic sensor modeling

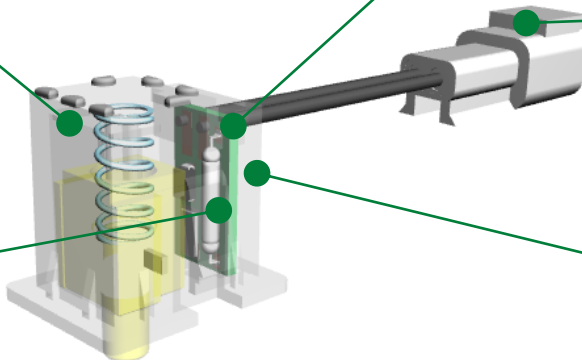
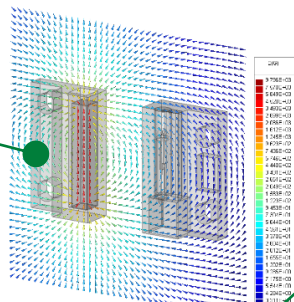
- Reduce cost and increase reliability
- Tolerance variation analysis
- Rapid prototyping with 3D printing

Encapsulation and sealing

- Transfer and low-pressure overmold
- Epoxy or urethane
- Meter or mix dispensing
- Ultrasonic welding or heat staking

Reed and Hall effect assembly

- Automated, cellular, and manual
- Custom reed switch forming
- Integral magnets within sensors



Circuit board assembly

- Vision systems
- SMD—pick and place automation
- In-circuit test

Terminations

- Injection or insert molding
- Automated cut, strip, and crimp
- Connector type flexibility

Performance and reliability test

- Validation testing
- 100% automatic end-line testing
- Actuation and contact resistance
- Long-term reliability testing

Custom temperature sensors

Mechanical fit modeling

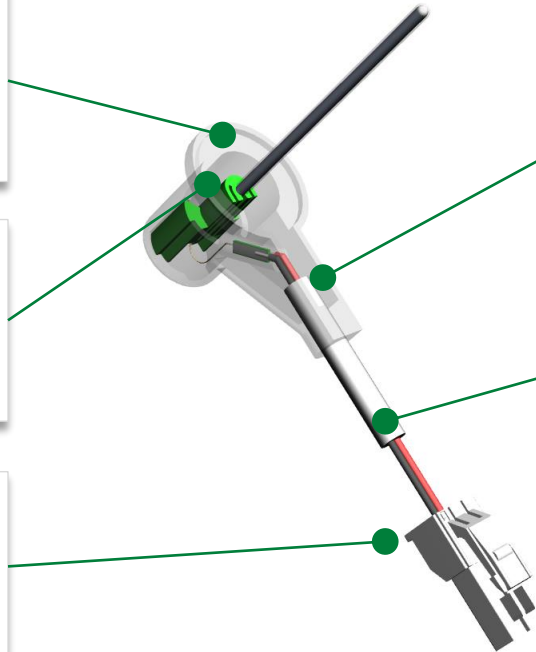
- 3D modeling
- Tolerance variation analysis
- Rapid prototyping with 3D printing

Encapsulation and sealing

- Transfer and low-pressure overmold
- Epoxy or silicone
- Ultrasonic welding
- Moisture protection

Terminations

- Automated cut, strip, and crimp
- Crimp validation
- Connector type flexibility



Sensor fabrication and assembly

- Wire joining for optimal performance
- Precise component placement
- Statistical process control

Performance and reliability test

- Thermal performance confirmation
- 100% automatic end-line testing
- Long term reliability testing

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