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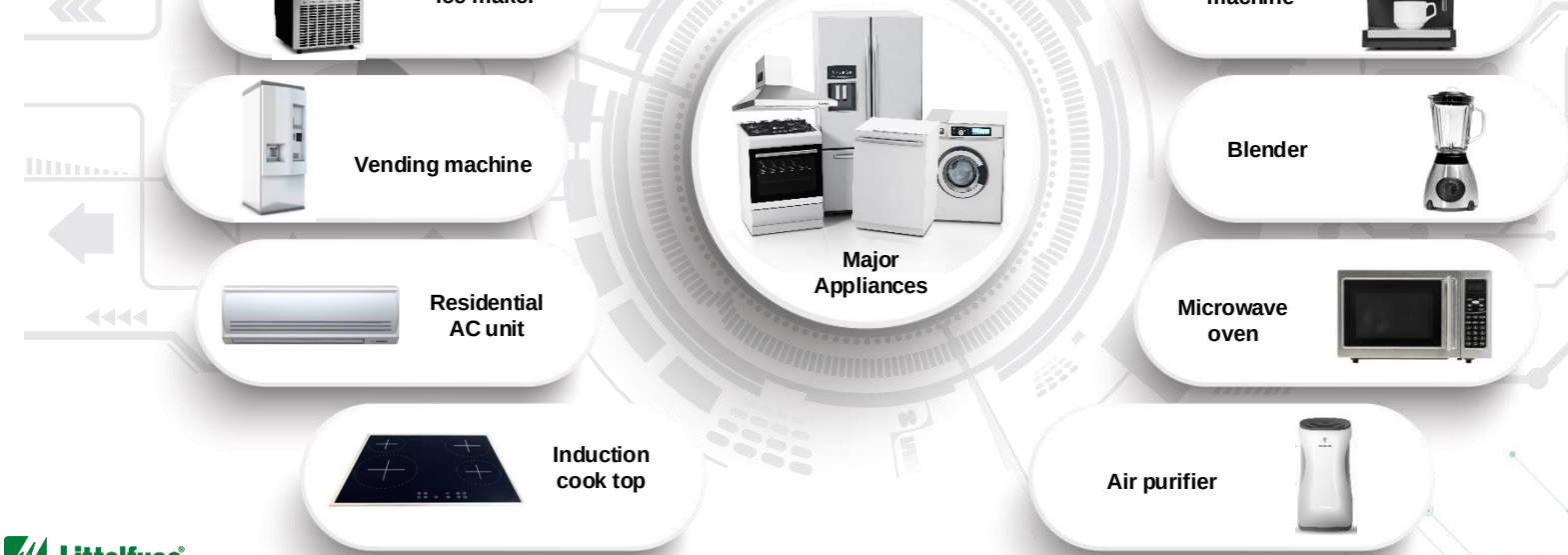
# System Solutions for Major Appliances

Appliances



REV0724

# Common design principles across many types of appliances

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# Major appliance market: ~760M units in 2023

## Market trends and drivers

IoT and smart technologies enable remote control and automation of appliances, which boosts demand for advanced electronics.

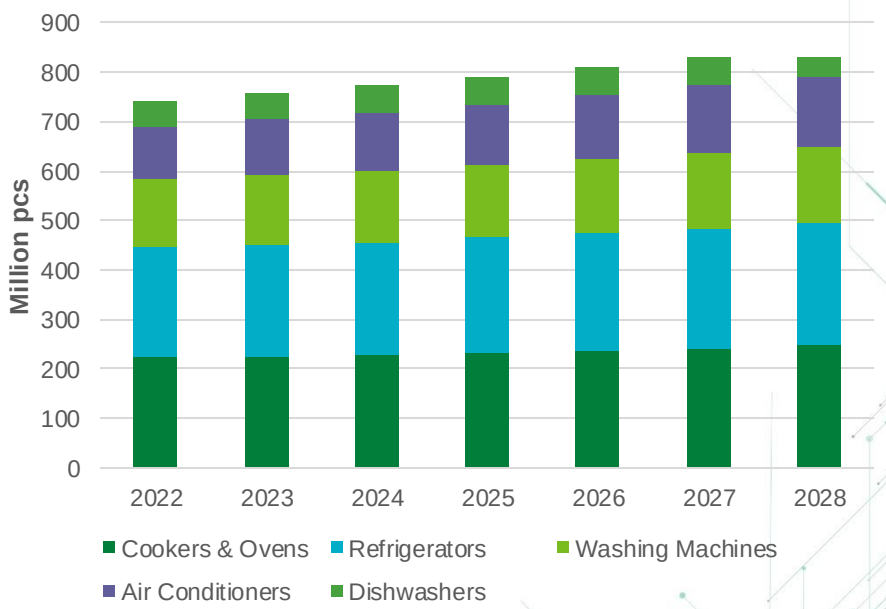
Emphasis on energy-efficient appliances driven by regulations and consumer demand, with technologies such as inverter-driven motors and sensing options.

Enhanced safety features, including advanced circuit protection solutions, help improve appliance reliability and user safety.

Rising incomes in developing regions, especially Asia Pacific, drive growth in appliance sales.

AI, machine learning, and sensor technologies enable new features such as diagnostics and predictive maintenance.

## Projections for major appliances CAGR ~2%




***Sources:*** *Statista Market Insights and Littelfuse estimate*

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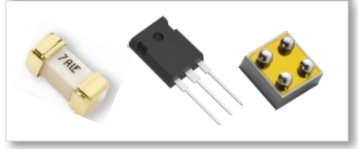
# Littelfuse technologies for appliances

**1 Input protection**
Fuse, MOV

**2 Power supply**
Fuse , TVS Diode, Load Switch



**3 Control Board**
PPTC, Current Sensing Resistor, TRIAC


**4 User interface**
TVS Diode Array, Polymer ESD, Switch

**5 Mechanical subsystems**
TMR Sensor, NTC,
Custom Reed Sensor, Reed Switch

***Acronyms:***
*MOV: Metal Oxide Varistor*
*TVS: Transient Voltage Suppressor*
*PPTC: Polymeric Positive Temperature Coefficient*
*TRIAC: Triode For Alternating Current*
*ESD: Electrostatic Discharge*
*TMR: Tunnel Magnetoresistance*
*NTC: Negative Temperature Coefficient*

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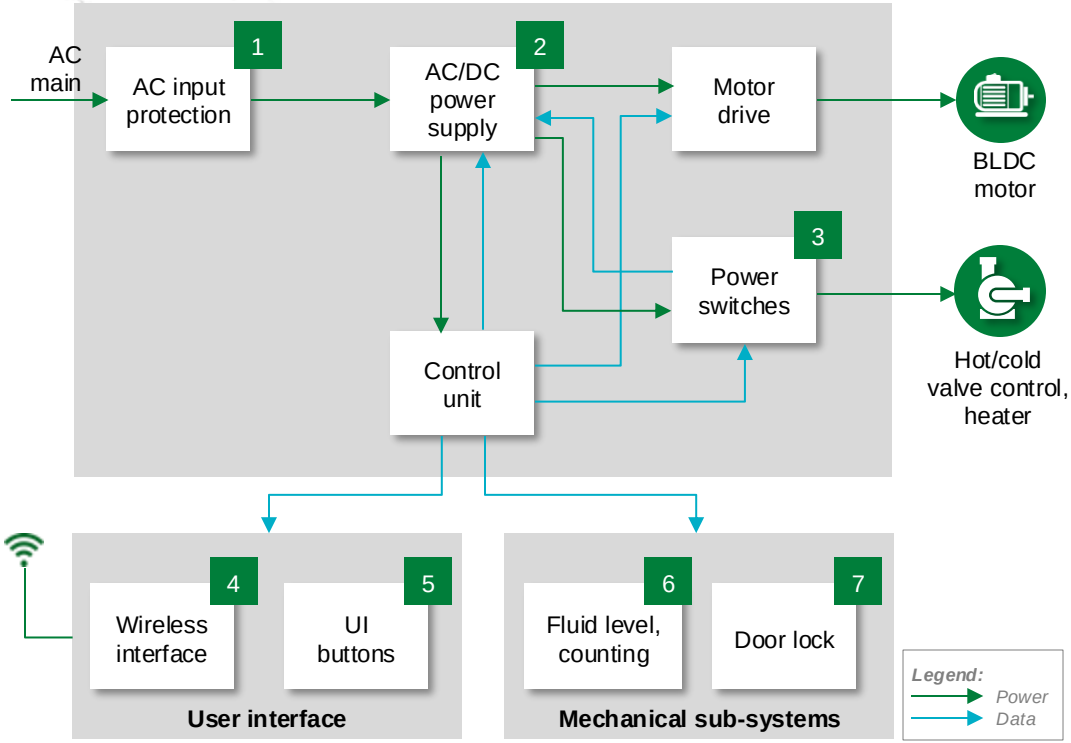
Click the product series in the table below for more info

# Functional block diagram for washing machine




| | Technology | Series |
|---|---|---|
| 1 | Fuse | 5X20mm Fuse |
| | MOV | M3, Xtreme |
| 2 | Fuse | Nano 448 |
| | TVS Diode | SACB, SMAJ |
| | Load Switch | LQ05021QCS4<br>LQ05021RCS4 |
| 3 | PPTC | LVR |
| | Current Sensing Resistor | WPB |
| | TRIAC | QJxx16xHx,<br>QS8004xHx |
| 4 | TVS Diode Array | SP3423, SP1064 |
| | Polymer ESD | PESD |
| 5 | Switch | PTS |
| 6 | TMR Sensor | 54140 |
| | NTC | USP12755 |
| | Reed Sensor | Reed switch PCB, customized |
| 7 | Reed Switch | HA15-2 |

*Acronyms:*
*AC: Alternate Current*
*DC: Direct Current*
*UI: User Interface*
*BLDC: Brushless Direct Current*
*IC: Integrated Circuit*

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Click 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 | Fuses | Protects the power stage from overcurrent | 5X20mm Fuse | Reduces design qualification time by complying with third-party safety standards such as UL/IEC | Third-party compliance with UL/IEC; low internal resistance; shock-safe; vibration resistant |
| | MOV | Protects power unit from voltage surges. Supports UL/IEC requirements. | M3, Xtreme | Reduces design qualification time by complying with third-party safety standards such as UL/IEC | Peak current up to 15000 A; maximum operating temperature of 125 °C |
| 2 | Fuse | Overcurrent protection for auxiliary power supply | Nano 448 | Helps solve the problem of nuisance “opening” | Wide range of current rating available (0.375A to 12A), has enhanced inrush withstand characteristics, |
| | TVS Diode | Protects sensitive circuits by clamping excessive transient voltages | SACB, SMAJ | Improves system reliability by clamping the voltage at safe levels during transients | Excellent clamping capability |
| | Load Switch | Controls the flow of power to subsystems | LQ05021QCS4 LQ05021RCS4 | Slew rate control; integrated output discharge switch, and internal EN pull-down resistor | Ultra-low $I_Q$: 7 nA Typ @ 5.5 $V_{IN}$; low $R_{ON}$ = 31 mΩ Typ @ 5.5 $V_{IN}$ |
| 3 | PPTC | Resets itself after clearing a fault | LVR | Fast time to trip; saves board space; reduces design qualification time by complying with UL/IEC | Line voltage ratings of 120 VAC and 240 VAC; low resistance; holds current up to 2 A; compact size |
| | Current Sensing Resistor | Part of current measurement circuitry | WPB | Cost-effective solution compared to competing technologies; low profile | Tolerance down to 0.5%; power rating up to 3 W |
| | TRIAC | AC switching for heater or motor control loads | QJxx16xHx | Enables easier thermal management and higher surge handing capability | High TJ of 150 °C; surge capability of 200 A at 60 Hz half cycle |
| | TRIAC | Switching for valve control | QS8004xHx | High voltage clamping function to ensure ability to withstand high over-voltage events | Surge capability up to 55 A; requires only a short gate activation pulse in each half-cycle |
| 4 | TVS Diode Array | Protect sensitive chipsets from ESD while maintaining signal integrity | SP3423, SP1064 | Small, space-saving design; low capacitance to prevent signal disruption | µDFN-2 (0201) footprint; ±30 kV ESD withstand voltage |
| | Polymer ESD | | PESD | Ultra-low leakage current; available in many form factors | <0.01 µA leakage current; 0.25 pF capacitance |
| 5 | Switch | Various user interface functions: cycle control, timing etc. | PTS | Provides tactile feedback; enhances user interface experience | Sealed construction for protection against dust and moisture |
| 6 | TMR Sensor | Position detection or water level detection | 54140 | Ultra-low power consumption at 1.5 uA; longevity of up to 20 billion operations | IP67 rated; 17 Gauss sensitivity |
| | NTC | Measures water/liquid temperature | USP12755 | Customized probes and assemblies to meet individual customer requirements | Wide range of requirements for customer-specific applications; various precision levels available |
| | Reed Sensor | Magnetic level or position detection | Reed switch PCB, customized | Highly reliable; long operational life | Simple mechanical design; capable of switching in high humidity environments; custom design available |
| 7 | Reed Switch | Magnetic position detection for door lock | HA15-2 | Durable; no power required for operation | Can be used in harsh environments; high current switching |

# Custom magnetic sensors

## Sensor modeling

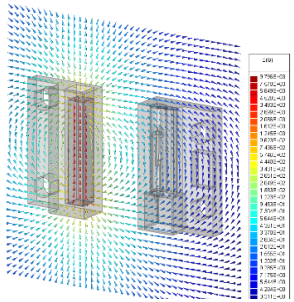
- Reduce cost and increase reliability
- Tolerance variation analysis
- Rapid prototyping with 3D printing

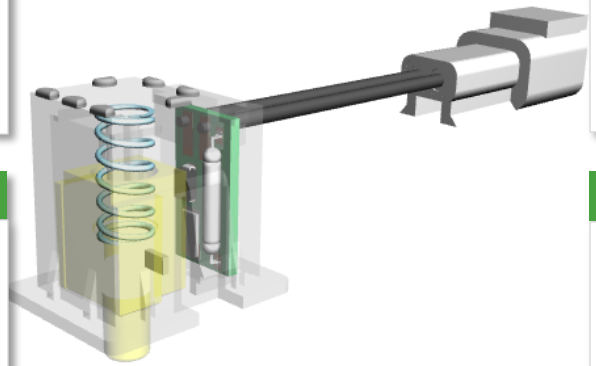
## Encapsulation and sealing

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

## Sensor 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

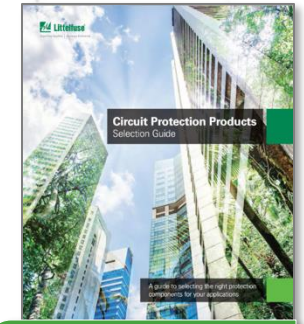
- Injection or insert molding
- Automated cut, strip, and crimp
- Connector type flexibility

## Performance and reliability test

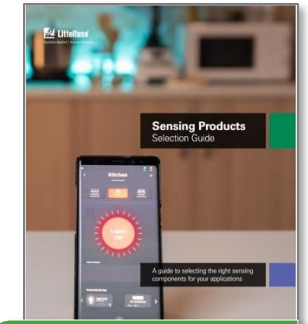
- Validation testing
- 100% automatic end-line testing
- Actuation and contact resistance
- Long-term reliability testing

# Additional information can be found on Littelfuse.com

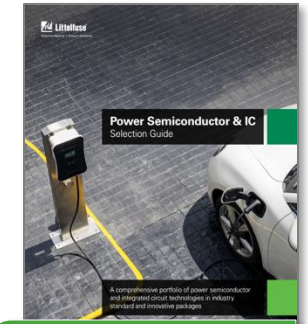
Explore the world of Littelfuse with the electronics eCatalogs (ecatalogs.littelfuse.com)



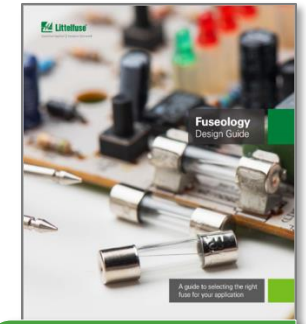

Circuit Protection Selection Guide




Sensor Selection Guide




Power Semiconductor Catalog




Fuseology Selection Guide


C&K Switches Selection Guide

Click on images for more information


ESD Protection Design Guide


ESD Suppression Design Guide


Small Appliances Spotlight Presentation

Scan the code to learn more!

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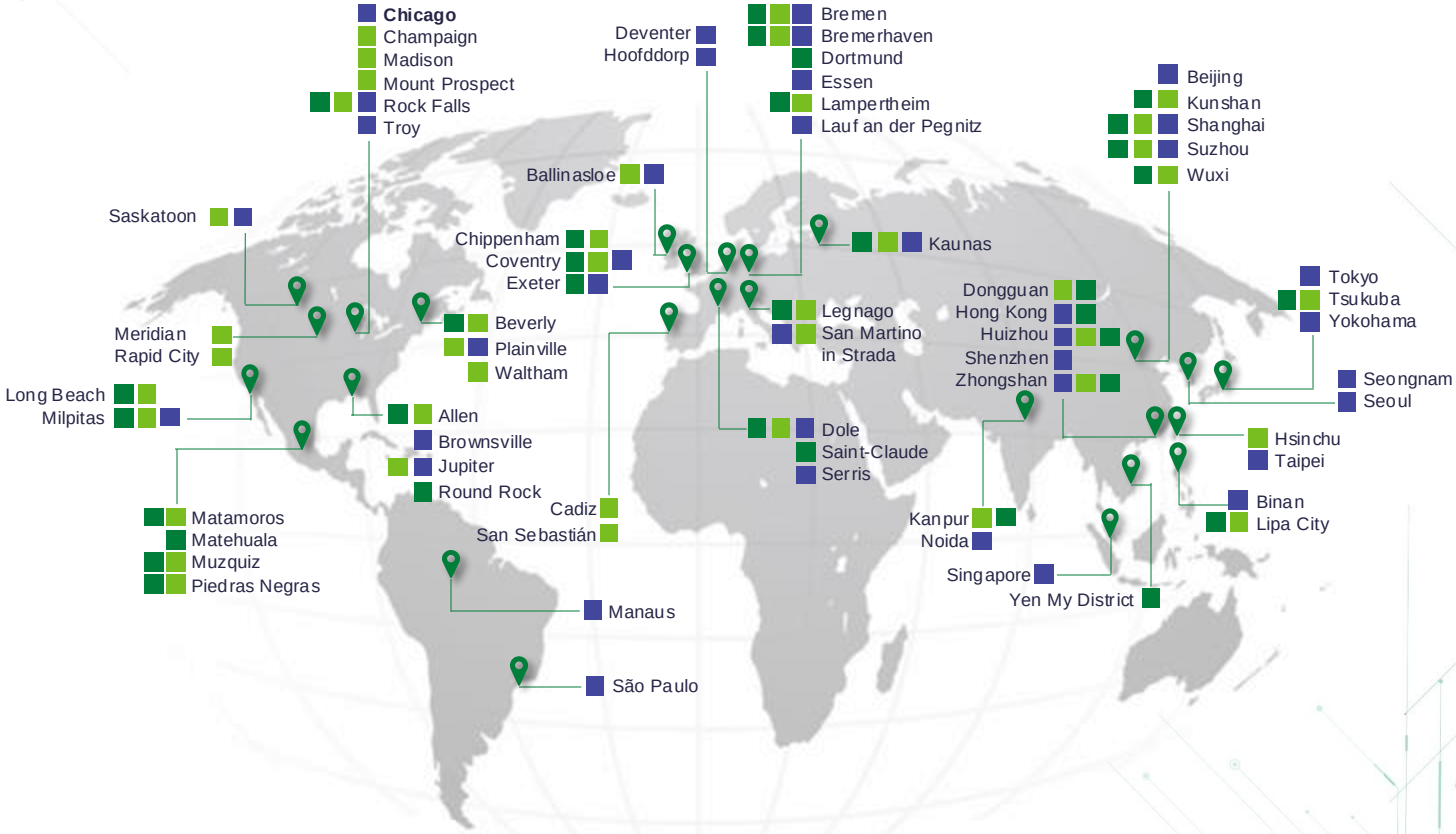
# Local resources supporting our global customers

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# Partner for tomorrow’s electronic systems

## Broad Product Portfolio

We are an industrial technology manufacturing company empowering a sustainable, connected, safer world.

## Testing Capabilities

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


## Application Expertise

Our engineers partner directly with customers to help accelerate product design and meet their unique needs.

## Compliance and Regulatory

We help customers in the design process to account for requirements set by global regulatory authorities.

## Global Customer Service

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

## Global Manufacturing

Our high-volume manufacturing is committed to the highest quality standards.

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