

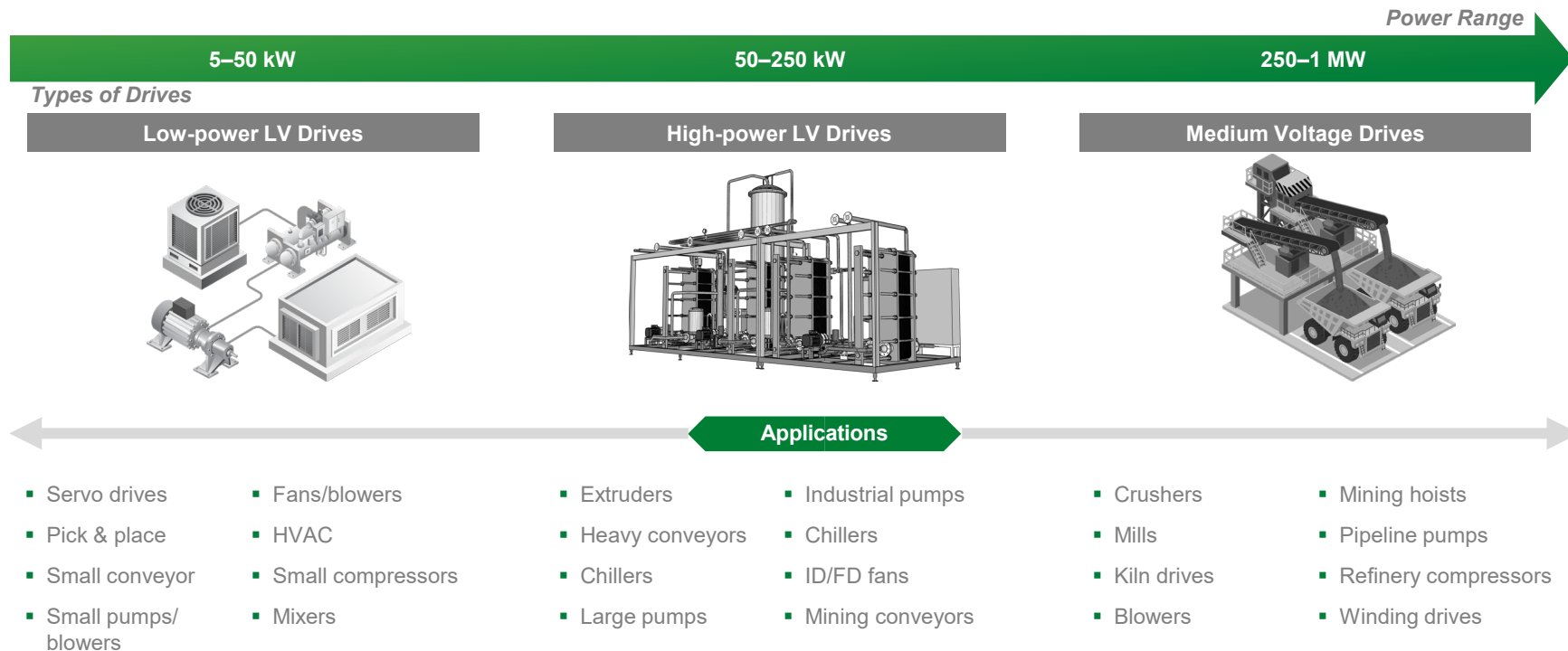
Industrial Motor Drives



Industrial Controls

Industrial Drives Landscape:

From low-voltage servo drives to medium-voltage industrial systems



Littelfuse solutions overview:

Circuit Protection, Power Semiconductor, Switching and Sensing solutions

Power Range

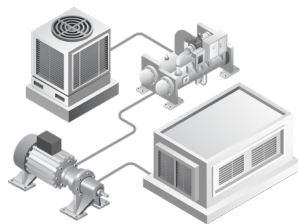
5–50 kW

50–250 kW

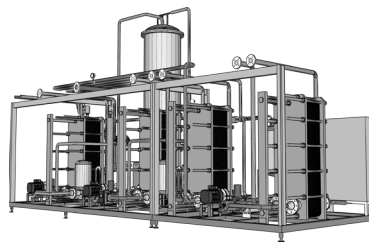
250–1 MW

Types of Drives

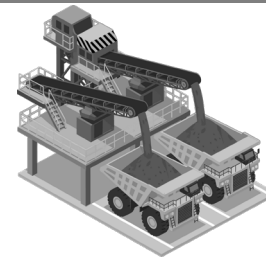
Low-power LV Drives



High-power LV Drives



Medium Voltage Drives



Littelfuse Solutions across LV & MV drives

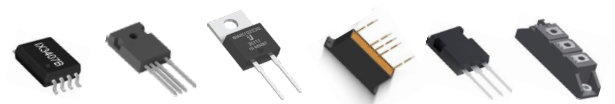
Circuit Protection

Power Semiconductor

Switching & Sensing



UL Class J/T Fuses High Current Fuse UL Class CC Fuses Semiconductor Fuse Fuseholder



Gate Driver 650–1700V SiC MOSFET 650–1200V Si/SiC Diode Rectifier Diode Discrete Thyristor SCR Thyristor Module



DIP Rotary Slide Tactile



MOV

SMD TVS Diode



SMPD

Brake Chopper Module

Phase Control Thyristor

Press Pack IGBT

Stacks & Assemblies



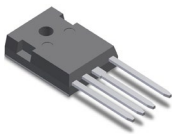
Temperature Sensor

TMR Sensor

Reed Sensor

New and featured products for industrial motor drives

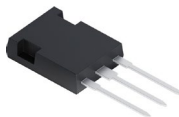
SiC MOSFETs



IXSJ80N1
20R1K IXSJ43N1
20R1K

- 1200 V blocking voltage with low $R_{DS(on)}$ = 18 m Ω & 36 m Ω
- Ultra-fast intrinsic body diode
- ISO247-4L package
- Low conduction losses & reduced heat dissipation
- Low input capacitance
- Improved thermal resistance & power handling capability

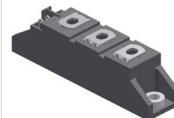
Power Thyristors (SCRs)



CMA160E1600HF

- 1600 V 160 A at $T_c = 80^\circ\text{C}$ in PLUS247 package
- Thermal resistance of $R_{thJC} = 0.15 \text{ kW}$
- Leakage current $I_r < 200 \mu\text{A}$ at $T_c = 25^\circ\text{C}$
- Low off-state losses
- Improved surge robustness
- Increased system efficiency

Thyristor Diode Modules



MCMA140PD1800TB

- 1800 V, 140 A Bipolar Module in TO-240AA package
- Excellent voltage & long-term current stability
- High reliability & robustness
- Higher junction temperature safety margin
- Isolated device with optimized thermal performance

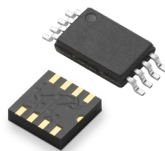
Isolated Gate Drivers



IX3407B

- Capacitive single-channel isolated
- Active Shut Down & Under Voltage Lockout
- Supports a wide range of control logic devices
- No separate galvanic isolation IC needed
- Separate source & sink pin

TMR Angle Sensors



LF53464 LF53466

- Wide range power supply voltage
- TSSOP8 & LGA package
- High accuracy & ultra-low power consumption
- High bandwidth for high-speed applications
- Thermal stability & enhanced reliability

High-Speed Fuses



PSR

- POWR-SPEED® technology
- Extremely current limiting
- Superior cycling capability
- Low watt-loss design
- Fast-acting Class aR performance
- Global certification cURus, CCC, and IEC

VFDs vs. Soft Starters:

Choosing the Right Drive Technology Based on Application Requirements

Variable Frequency Drive (VFD)

Primary Role:

- Variable speed and torque control for performance and efficiency

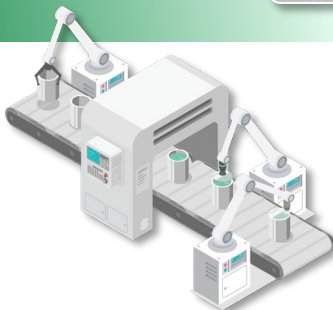


Key characteristics

- Full speed and torque control
- Energy savings for variable load systems
- Supports complex motion and process optimization

Typical applications

- Servo drives
- Pick & place systems
- Conveyors (variable load)
- HVAC systems
- Mixers and extruders
- Crushers and mills



Application-driven choice

Soft Starter

Primary Role:

- Smooth motor start for constant-speed applications

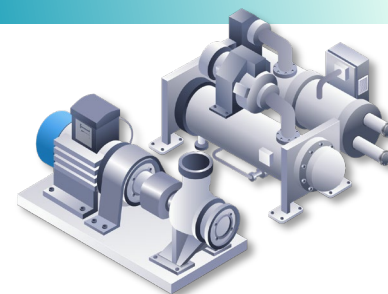


Key characteristics

- Reduces inrush current and mechanical stress
- Lower system cost and complexity
- SCRs bypassed after startup (no harmonics in steady state)

Typical applications

- Pumps (constant speed)
- Fans and blowers
- Compressors
- Large motors with fixed-speed operation
- Conveyors (constant load)



Variable Frequency Drives and Soft Starters: market overview

Market Trends

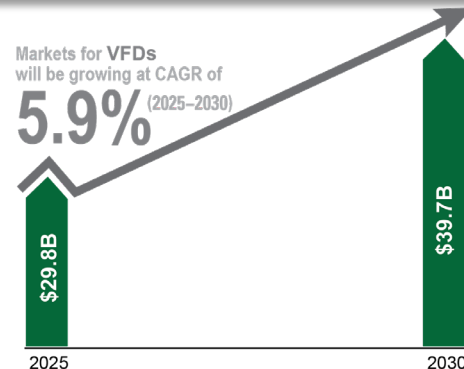
Variable Frequency Drives (VFDs)

- The global VFD market is projected to grow @ 5.6% CAGR between 2025 and 2030; expected to reach \$39.7B by 2030
- APAC accounted for a 34.5% share of the overall market
- By product type, AC drives accounts for 68.9%
- By power range, 6–40 kW segment dominates the market share
- By application, pump segment has the largest share
- A key factor driving growth is the need for higher energy efficiency; energy savings estimated to be over 20%
- Integrating IoT with VFDs for remote monitoring and controlling the devices

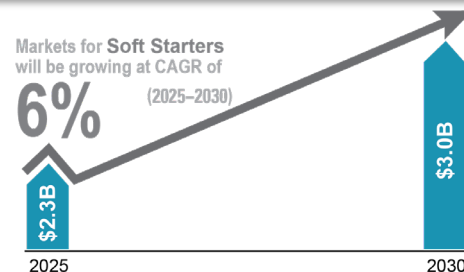
Soft Starters

- The global soft starter market is expected to grow at 6% CAGR between 2025 and 2030
- Market is expected to reach \$3.0B by 2030
- Rising industrial automation, energy efficiency mandates are the primary drivers for the Soft Starter market

VFDs market CAGR 5.9% (2025–2030)



Soft Starters market CAGR 6% (2025–2030)



Sources: Littelfuse Estimates, [GrandViewResearch_VFD](#), [GrandViewResearch_SoftStarter](#)

Variable Frequency Drives (VFDs)



Littelfuse solutions overview for VFD systems



1

Input protection

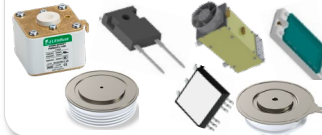
AC Fuse, Fuseholder, MOV



2

Input rectifier and brake

Fuse, SiC/Rectifier Diode, Stack, Power Module, SMPD, Press Pack



3

Inverter

Fuse, IGBT (Discrete/Module), SiC MOSFET, SMPD, Press Pack, Stacks



4

Auxiliary power supply

Si/SiC MOSFET, HV IGBT, Gate Driver, TVS Diode



5

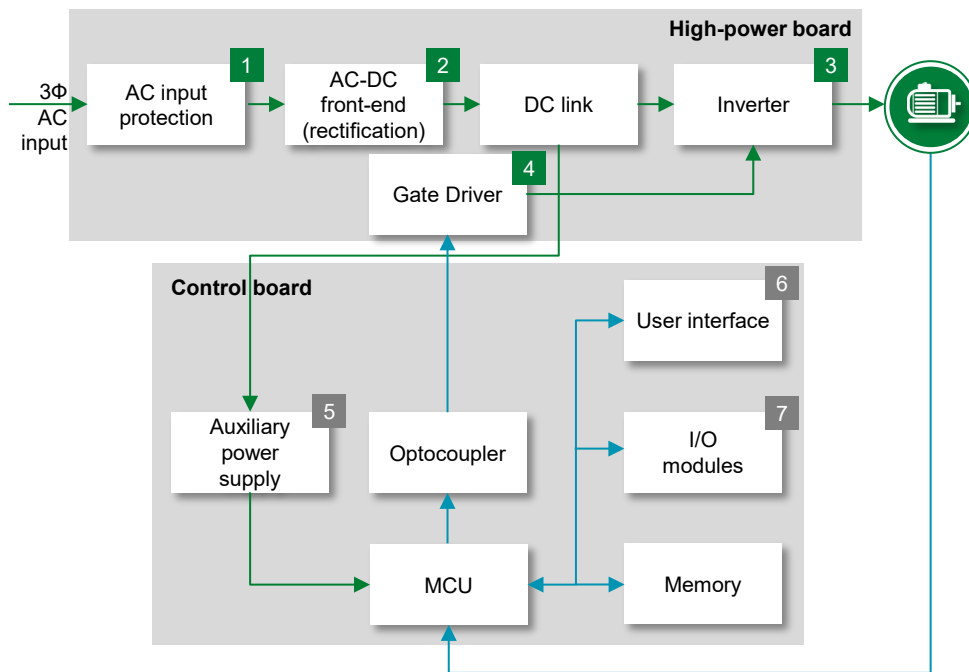
Switches & Sensing

DIP, Rotary, Slide, Tactile, Reed Sensor, TMR Sensor



Littelfuse circuit protection & power semiconductor solutions for VFD systems

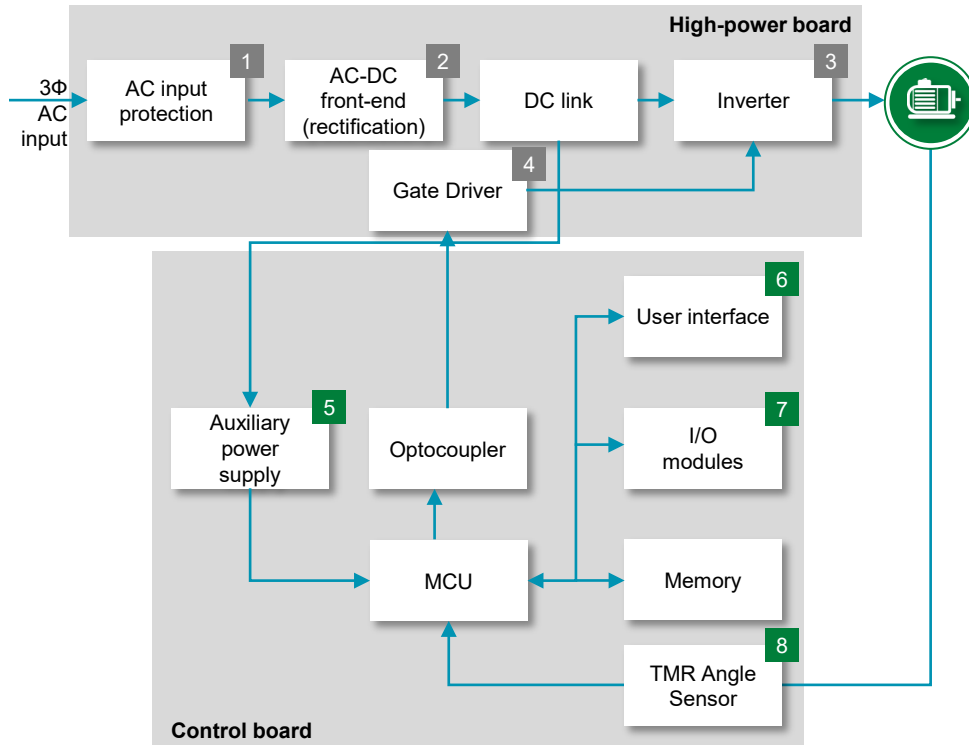
 Click the product series in the table below for more info



	Technology	Function in application	Series
1	Fuse	Protects the equipment from overload and short-circuit	JLS, JLLS, JLLN, LDC, 606, 504, 505, 607
	Fuseholder	Secures mounting of fuses; allows easy fuse replacement	LFT, LFJ
	MOV	Protects against damage due to lightning-induced voltage surges	TMOV, UltraMOV
2	Rectifier Diode OR Si/SiC (650–1200 V)	High current rectification with lower losses; SiC preferred for higher efficiency & reduced EMI	Rectifier Diodes, Si/SiC Diode
	AC Bridge Rectifier	Three-phase AC to unregulated DC for low voltage drives	AC Bridges
	Diode Module (1200–3600 V)	Used in high-power LV drive applications; handles higher RMS current and thermal loads	Dual Modules, 3-Phase Bridge Modules
	SiC MOSFET (650–1200 V)	AFE with reg. DC; low THD, regen capability; high efficiency	SiC MOSFET
	Rectifier Stack	Diode assemblies for medium-voltage drives; high current density & thermal scalability	High Power Stacks
	Brake Chopper (E/E3/SMPD)	Limits the DC bus voltage by switching the braking energy to a resistor	Boost Chopper IGBT Modules
3	SiC MOSFET (650–1700 V)	High-frequency switching; low losses; high power density	SiC MOSFET
	IGBT Module (Up to 1700 V)	2-/3-level inverter circuitry	SMPD Package, CBI Modules
	Press-Pack IGBT/ Stacks	Designed for MV multi-level inverters	Capsule Type IGBT, High Power Stacks
	Semiconductor Fuse	Protection against short circuit at rectifier or inverter stages	PSR, L50QS, L70QS, L60QS
4	Gate Driver	Controls MOSFET/IGBTs	IXD60xx, IX442x, IX434x, IX4310, IX4352, IX3407B

Littelfuse solutions for control board in VFD systems

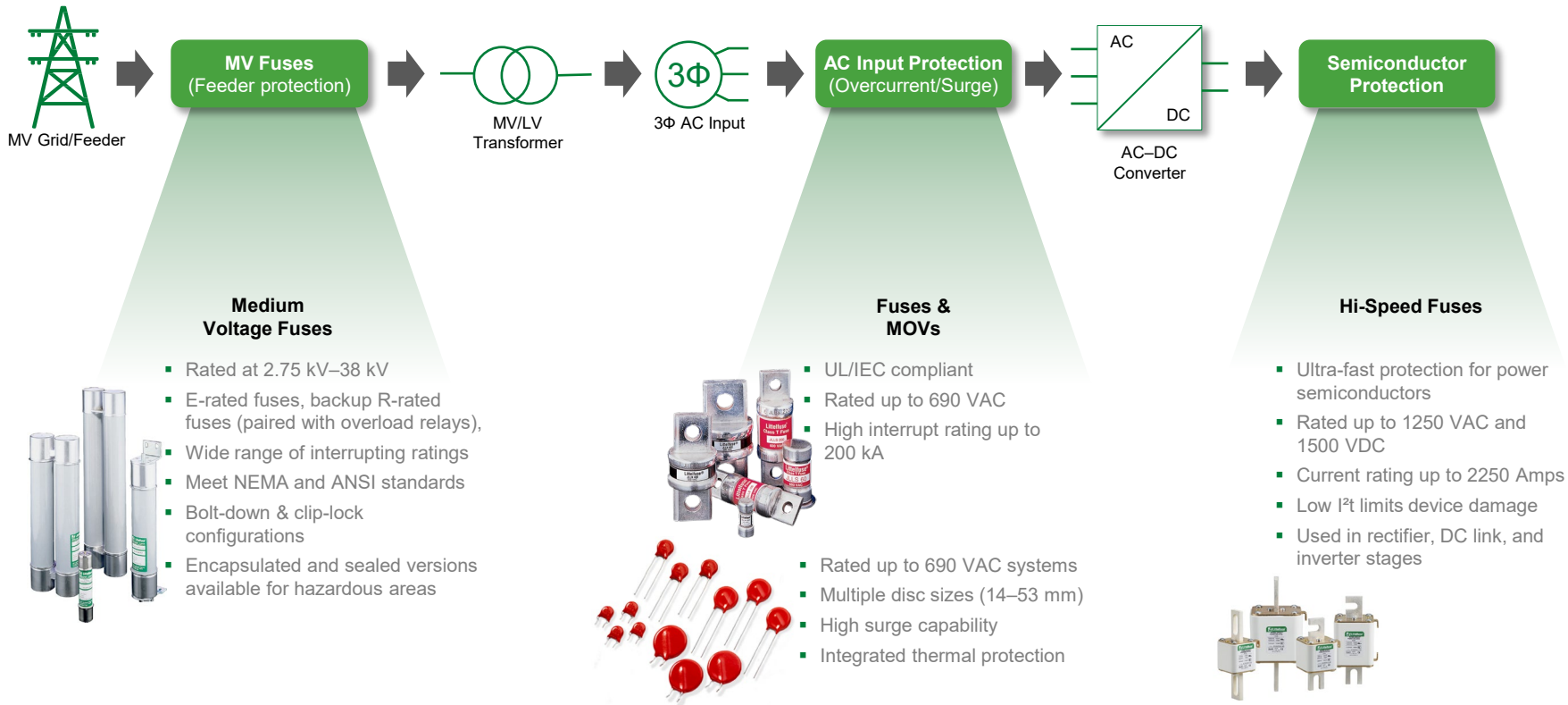
 Click the product series in the table below for more info



	Technology	Function in application	Series
5	Si/SiC MOSFET OR HV IGBT	Semiconductor switch	SiC MOSFET/ 1.5 kV Si MOSFET/ 650V X3 Ultra Junction OR HV IGBT
	Gate Driver	Drives SiC MOSFETs and discrete IGBTs	IXD_609 , IX4310T , IX4352NE
	TVS Diode	Protects semiconductor switches from voltage transient	SMF , SMFA
	Protection IC (eFuse)	Integrated overvoltage & overcurrent protection	LS2604ER
6	Switch	Various functions (drive configuration, on/off, test button, parameter setting, mode selection, input/output selection, etc.)	TDA , RTE , RTA , AYZ , KSC2 , KSC3 , KSC4
7	TVS Diode Array	ESD protection	SP3213 , SP3400
8	TMR Sensor	Electronic commutation; rotor position sensing; mode switching; trigger activation; safety interlocks	LF53464-08TMR , LF53466-08TMR

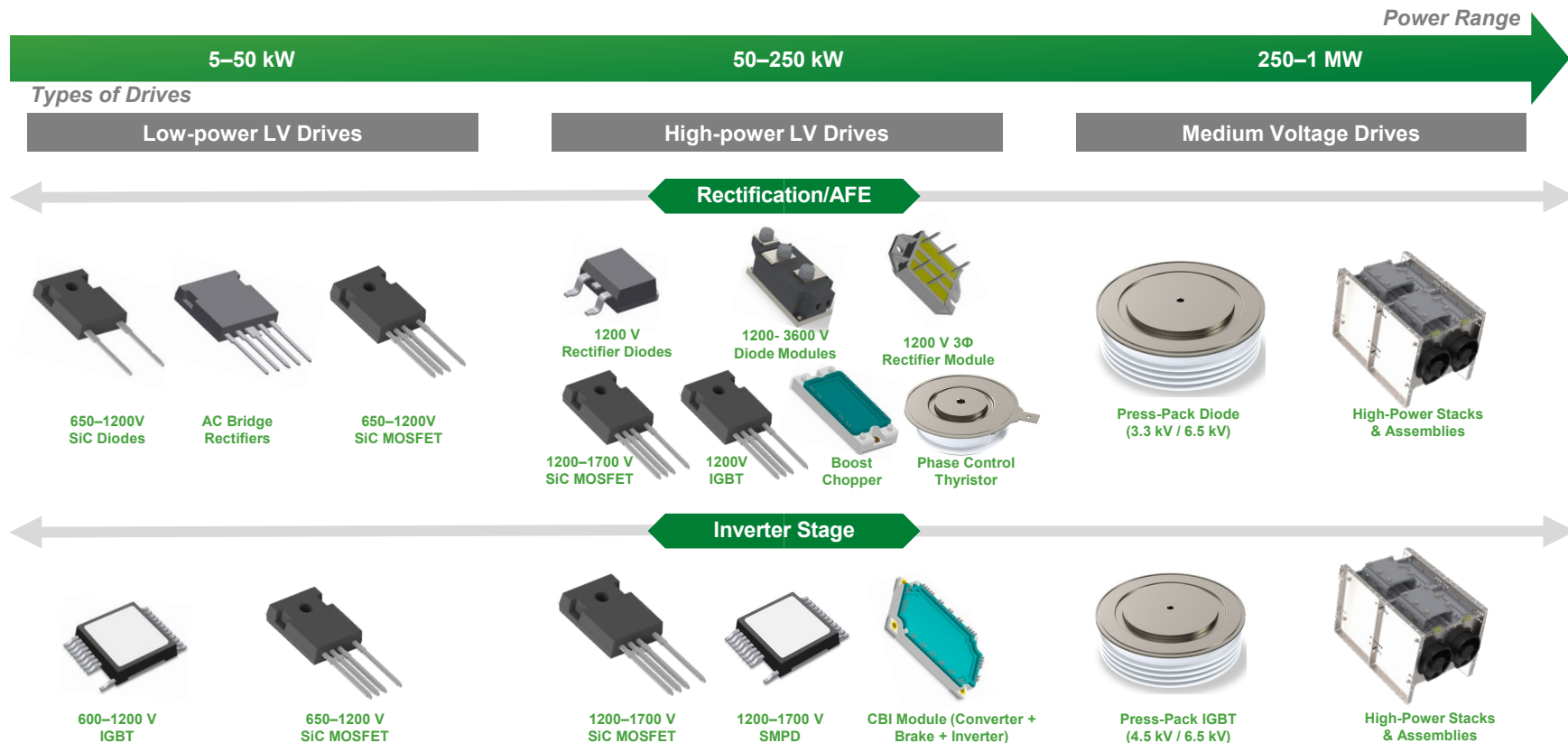
Littelfuse protects drive at three levels:

MV feeder protection, LV AC input protection, and semiconductor protection



Power Semiconductor solutions for industrial drives

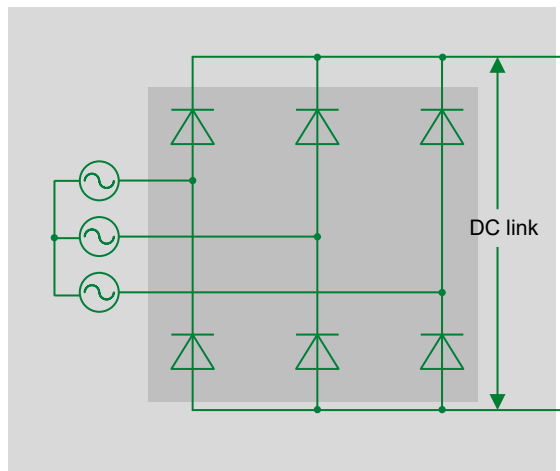
Mapped across drive power and voltage levels



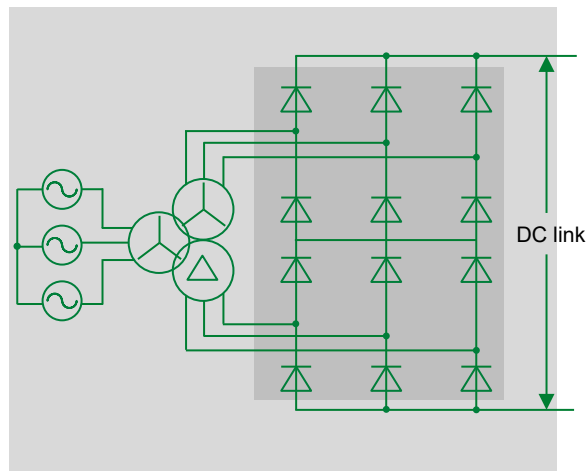
AC → DC rectification commonly used topologies

(6-pulse, 12-pulse, SiC MOSFET AFE)

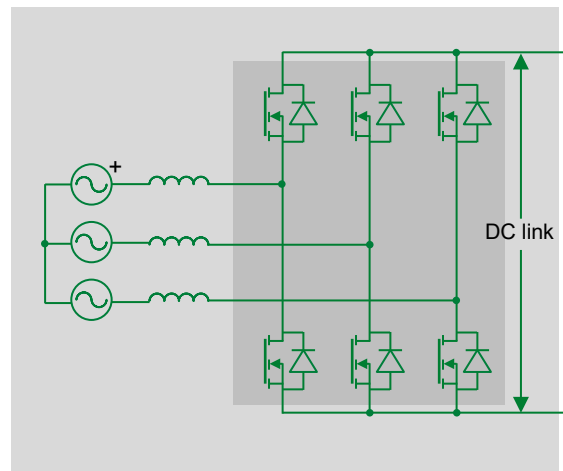
6-pulse



12-pulse



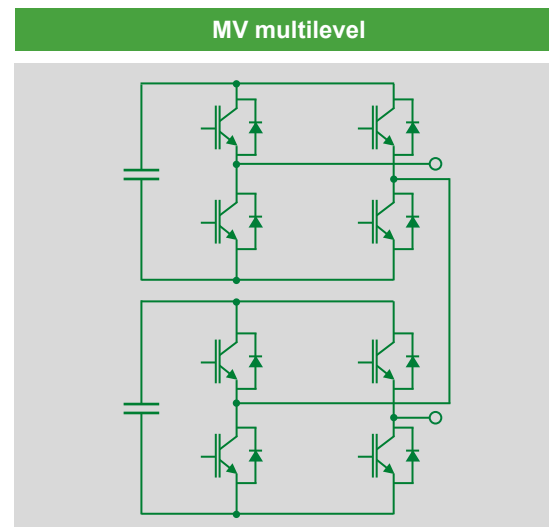
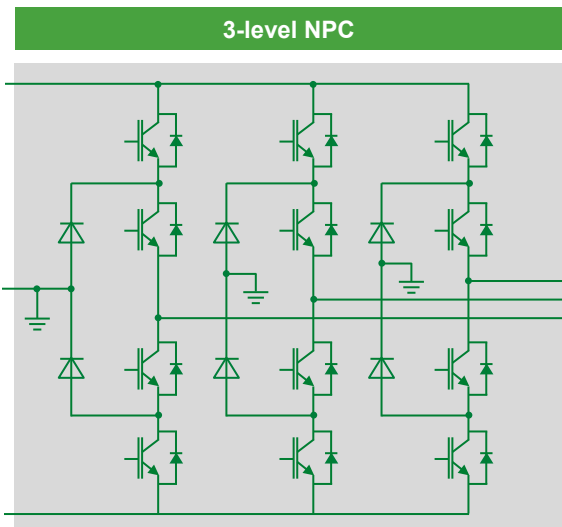
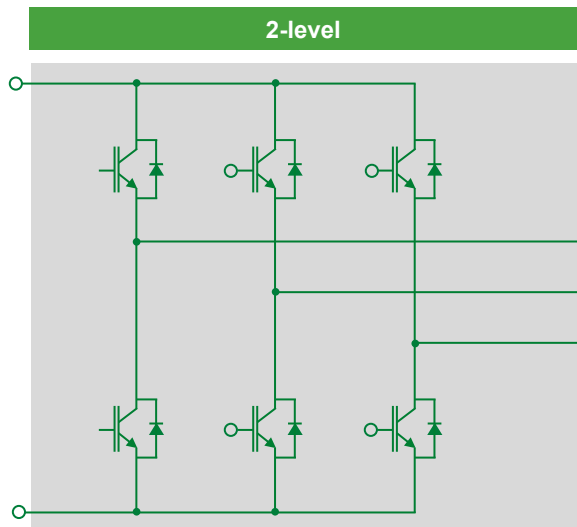
SiC MOSFET for AFE



Topology	6-pulse	12-pulse	SiC MOSFET for AFE (PWM)
Typical use	Standard industrial drives where cost & simplicity matter	Drives needing reduced harmonics without full AFE	High-efficiency, low-THD, regenerative drives
Littelfuse solutions	- Rectifier Diodes (Si/SiC, 650–1200 V) - AC Bridge Rectifiers - Diode Modules (single/dual/3-phase) - Capsule SCRs for MV drives	- Dual Diode Modules 3-Phase Diode Modules - Rectifier Diode Modules - Capsule SCRs for MV drives	- SiC MOSFETs (650–1700 V) - SiC Schottky/Fast Diodes

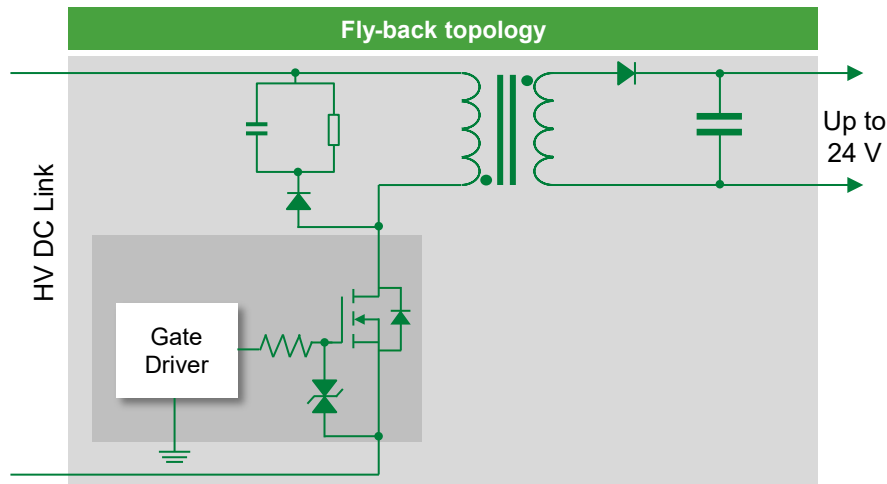
Inverter topologies

(2-level, 3-level NPC, MV multilevel)



Topology	2-level	3-level NPC	MV multilevel
Typical use	General-purpose VFDs, servo drives	High-power LV drives needing lower dv/dt & EMI	Large industrial & utility-scale drives
Key benefits	Simple, cost-effective; high switching speed; compact design	Reduced switching losses; lower motor stress; improved efficiency	Very low dv/dt; scalable to MV levels; high efficiency at high power
Littelfuse solutions	- IGBTs (600–1200 V) - SiC MOSFETs (650–1200 V) - IGBT Modules	- IGBT Modules (1200–1700 V) - SiC MOSFETs (1200–1700 V) - Fast recovery/SiC diodes	- Press-Pack IGBTs (4.5 kV) for applications with low frequency switching (less than 500 Hz) - Press-Pack Diodes

Auxiliary power supply & recommended Littelfuse solutions



Technology	Si/SiC MOSFET/IGBT	Gate Driver	TVS Diode
Function	High-frequency switching	Drives SiC MOSFETs and high-power IGBTs	Protects SiC MOSFET from voltage transient
Key benefits	Higher switching frequency; higher efficiency; increased robustness; smaller die size per voltage/current rating	Eliminates the need for separate negative supply; quick turn-on and turn-off of power switches	Improves system reliability by clamping the voltage at safe levels during transients
Littelfuse solutions	HV MOSFET LSiC1MO/ HV IGBT	IX4310T IX4352NE IX 609	SMF SMFA

Soft Starters



Littelfuse solutions overview for Soft Starters



1

Input protection

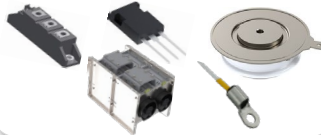
AC Fuse, Fuseholder, MOV



2

Phase control

SCR Module, Discrete SCR,
Phase Control Thyristor, Stack, NTC



3

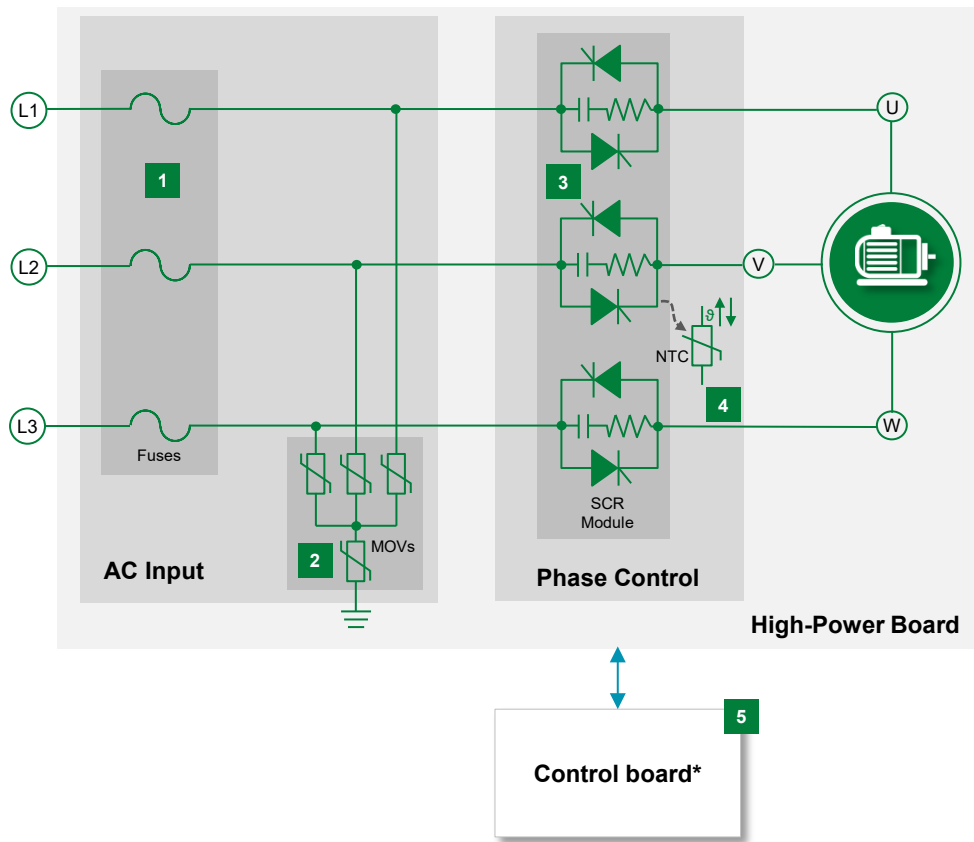
Switches

DIP, Rotary



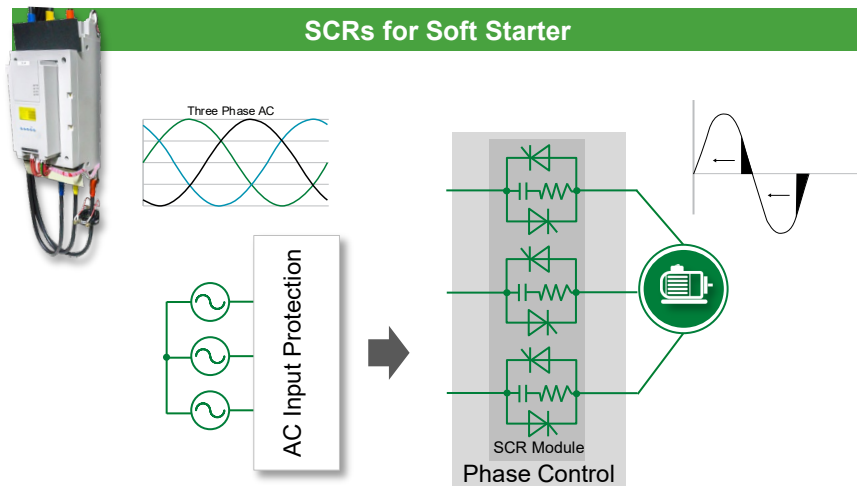
Protection and control components for soft starter topology

 Click the product series in the table below for more info



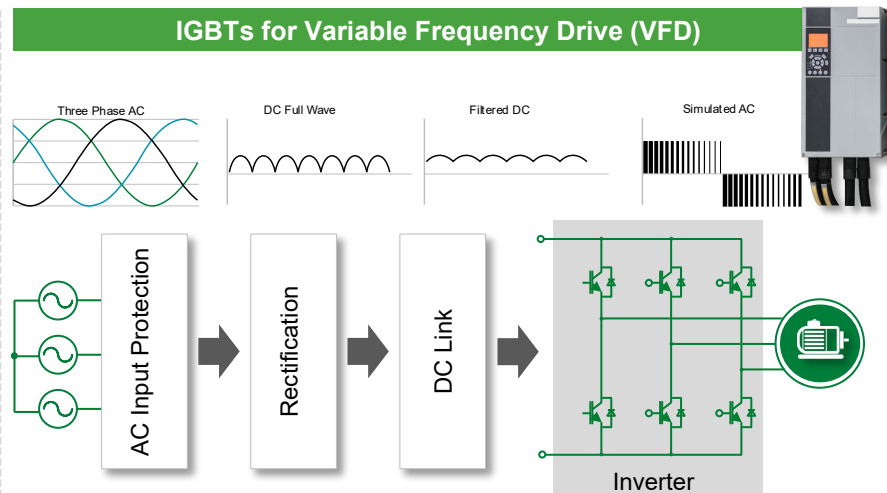
	Technology	Function in application	Series
1	AC Fuse	Protects the equipment from overload and short-circuit	L50QS, L70QS, JLS, JLLS
	Fuseholder	Secures mounting of fuses; allows easy fuse replacement	LSCR, LFT, LFJ
2	MOV	Protects against damage due to lightning-induced voltage surges	TMOV
3	SCR Module	1200–1600 V SCR module/ Discrete SCR targeted for low voltage drives	Dual SCR Modules, Single SCR Module
	Discrete SCR		SCR Thyristors (CMA160E1600HE), Phase Control
	Stack		High Power Stacks
4	NTC	Continuously monitors the temperature of SCRs	USUR1000, SM
5	<i>*Control board solutions are like VFD systems</i>		

Why SCRs are a preferred choice in Soft Starters vs. IGBT for Variable Frequency Drives (VFDs)?



✓ Preferred for motor starting (constant speed)

- **High Ruggedness:** easily handles extreme motor inrush currents during startup
- **Voltage Control:** gradually ramps voltage for smooth, shock-free acceleration
- **Maximum Efficiency:** minimal heat loss and typically bypassed once at full speed

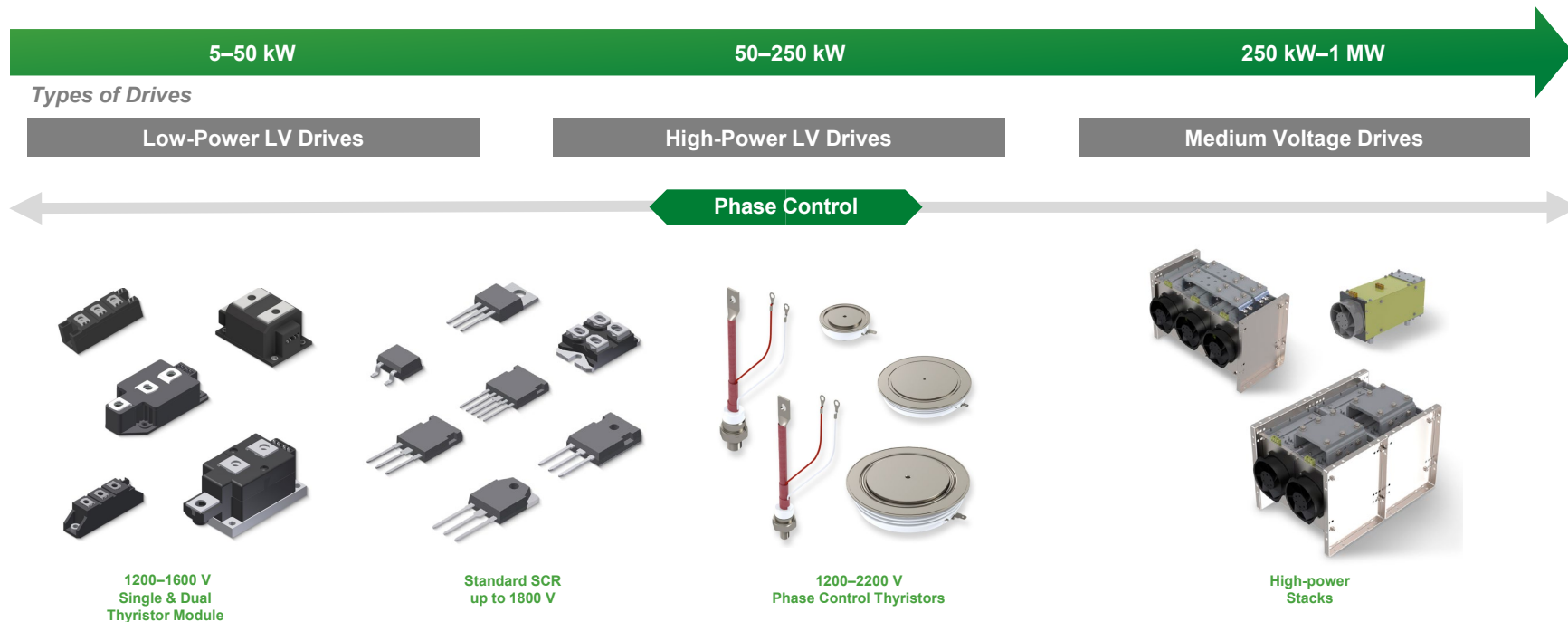


✓ Preferred for variable speed & torque control

- **High-Speed Switching:** enables PWM to precisely control both frequency and voltage
- **Precise Speed Control:** provides smooth, continuous adjustment of motor RPM and torque
- **Advanced Performance:** allows for 4-quadrant operation and regenerative braking

SCR solutions for Soft Starters

Mapped Across Drive Power and Voltage Levels

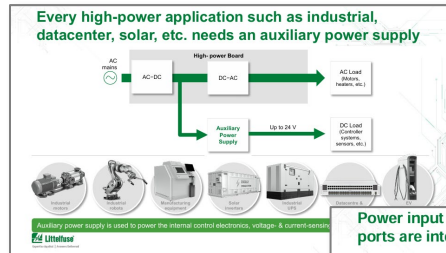


Additional information can be found on [Littelfuse.com](https://www.littelfuse.com)

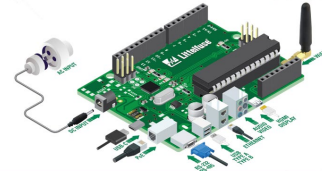
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eCatalogs



Power input and high-speed communication ports are integral parts of every electronics design



Littelfuse solutions for Programmable Logic Controller (PLC)



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