Industrial motor drives and soft starters

Industrial Solutions

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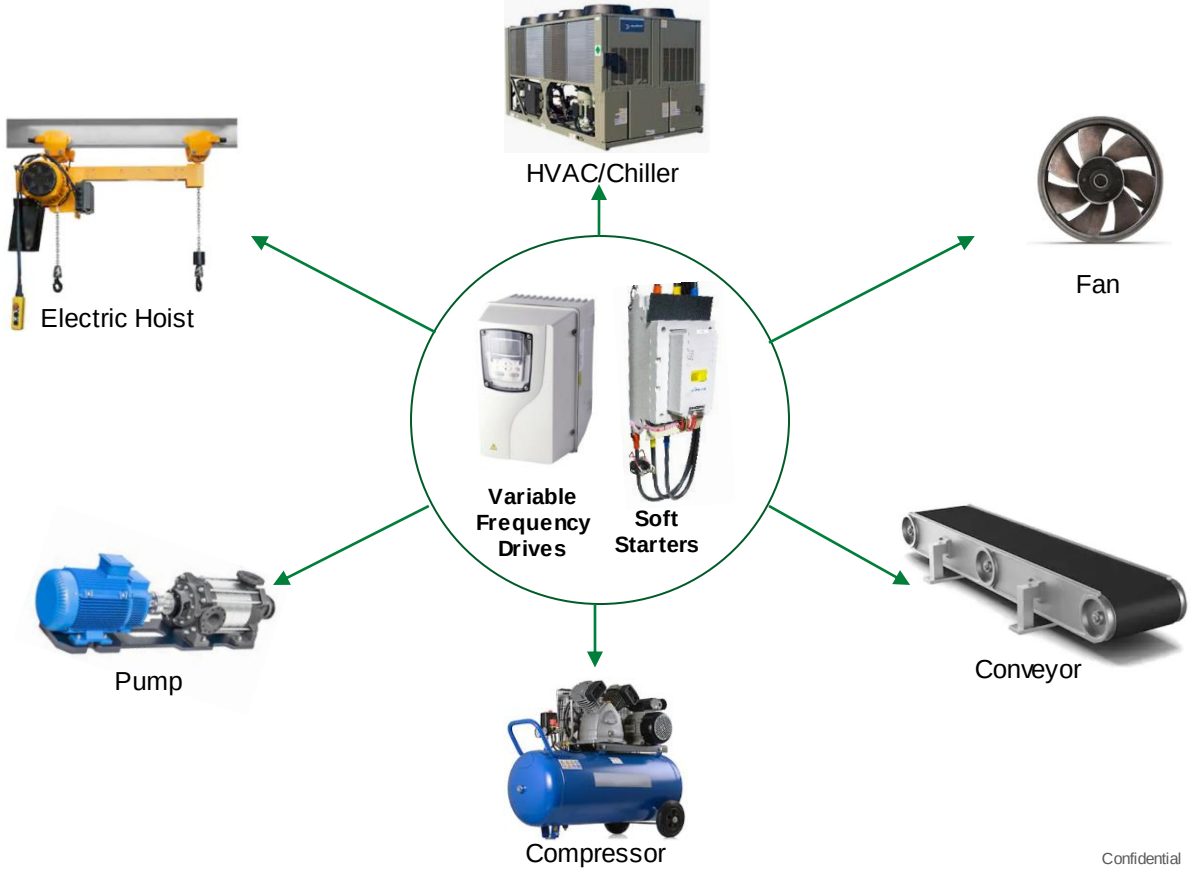
REV0819

Variable frequency drives (VFD) and soft starters in industrial applications: help improve motor life and energy efficiency



VFDs and soft starters work on same principles, but have different architectures and are used in different applications

Variable Frequency Drives

- Controls AC motor speed and torque by varying motor input voltage and frequency
- Can be programmed to vary the speed of the motor based on factors such as flow, pressure, etc.
- Complete control over motor speed can be achieved
- Performance more important than cost and size
- Energy saving is principle advantage
- Examples of applications: elevators, escalators, crushers, mixers, etc.

Soft Starter

- Offers smooth start and stop operation for a motor
- Gets bypassed by a contractor overload circuit as motor reaches its full speed
- Initial cost is lower than a variable frequency drive
- Effectively reduces inrush current during motor start.
- No harmonics are generated
- Examples of applications: conveyors, pumps and other belt-driven applications

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Variable frequency drives and soft starters market overview

Market Trends

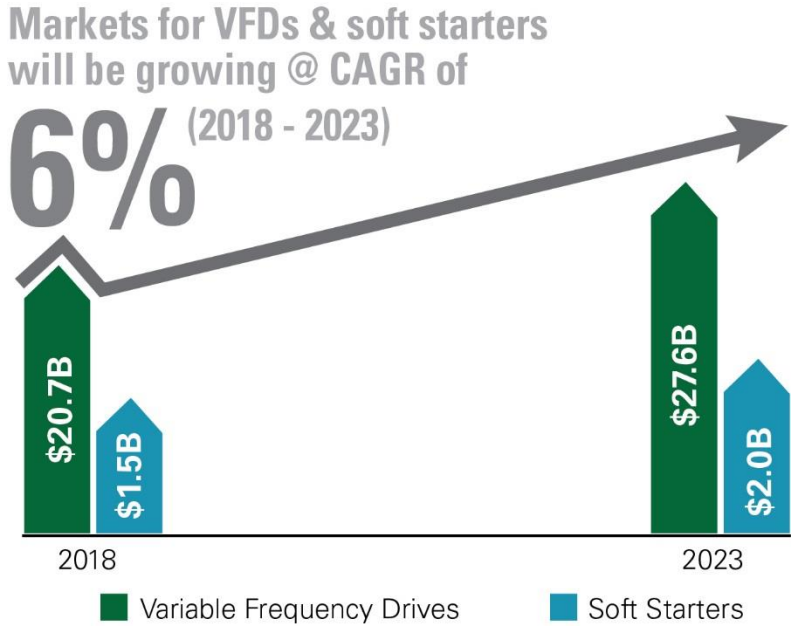
Variable Frequency Drive (VFD):

- The global VFD market is projected to grow @ 6% CAGR between 2018 -2023
- Market is expected to reach $27.6B by 2023
- 35% growth will come from APAC
- A key factor driving the growth is the need for more energy efficiency.
- Energy savings estimated to be over 20%
- Integrating IoT with VFDs for remote monitoring and controlling the devices

Soft Starter:

- The global soft starter market is expected to grow at 6% CAGR between 2018 -2023
- Market is expected to reach $2.0B by 2023
- Increased use of industrial pumps and fans are key driving factors

Market Projections



Source: Marketsandmarkets.com ResearchAndMarkets.com, Technavio.com

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Protection and control solutions used VFD systems

AC Input Protection:

- AC Fuses
- MOVs

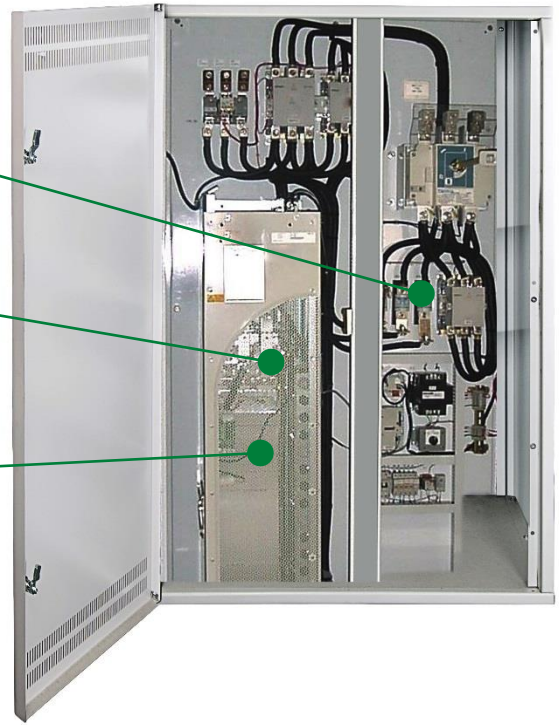
Input Rectifier Circuit:

- Rectifier Module

Inverter:

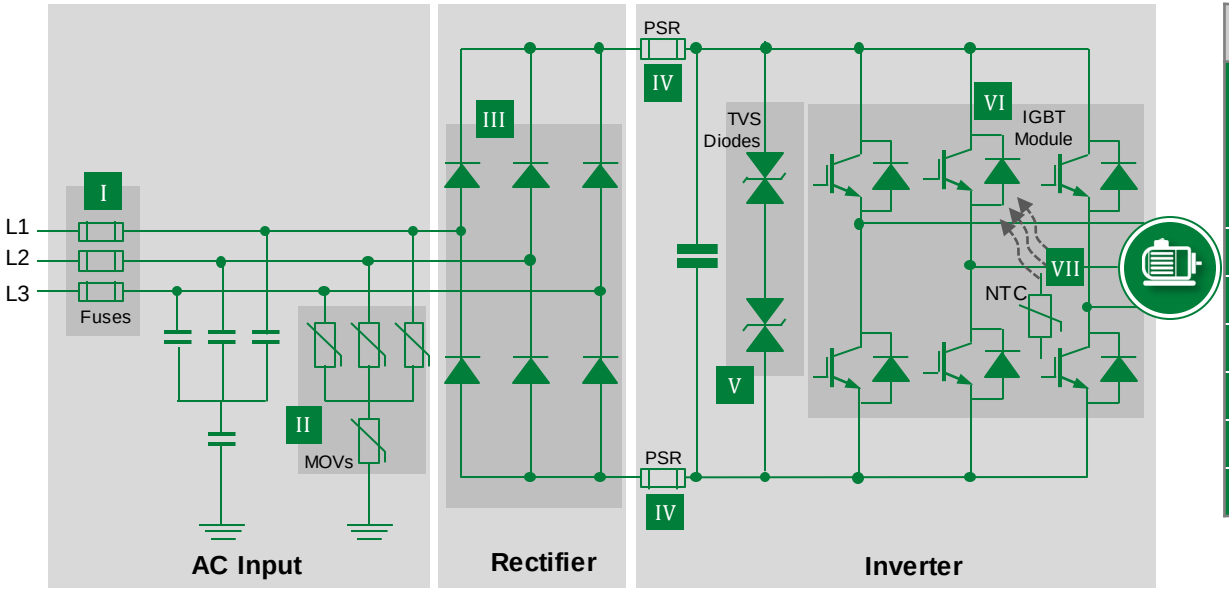
- High speed fuse
- TVS Diode
- IGBT Module
- Temperature sensor

TVS: Transient-Voltage Suppression
MOV: Metal Oxide Varistor
IGBT: Insulated-Gate Bipolar Transistor



Protect Control Sense

Illustration of typical three-phase VFD topology highlighting key protection and control components



	Technology	Product Series
I	AC Fuses for higher interrupt ratings	JLS, JLLS, LDC,L70QS
	AC Fuses	606, 504, 505
	Fuse holder	LFT, LFJ
II	MOV	TMOV
III	Rectifier module	MDD, VUO,VUB
IV	High speed fuse	PSR
V	TVS Diode	AK3-380C
VI	IGBT Module	MIXA, MIXG
VII	NTC	USUR1000, SM

Note: Ground Fault detectors should be used for resistive grounded systems. Suggest: EL731.

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Benefits of Littelfuse components recommended for VFDs

	Technology	Function in Application	Series	Benefits	Features
I	AC Fuse for higher interrupt ratings	AC line fuses for overcurrent or short circuit protection	JLS, JLLS, LDC,L70QS	Reduces damage to equipment caused by heating and magnetic effects of short circuit currents; Compact design	Extremely current-limiting; Small footprint 200kA interrupting rating
	AC Fuses		606, 504, 505		Smallest available package
	Fuse holder	Supports fuse protection	LFT, LFJ	DIN Rail Mountable	Low resistance connection
II	MOV	Protect against damage due to lightning-induced surges or harmonic voltage disruptions from the power line.	TMOV	Integrated thermal disconnect enhances safety by disconnecting during MOV EOL caused by continuous abnormal overvoltage from miss wiring or loss of neutral	TMOVs are UL Recognized Type 4 Surge Protection Devices. Integrated thermal disconnect reduces risk of MOV overheating and catastrophic failures
III	Rectifier module	Converts AC line voltage supplied to the drive to DC.	MDD, VUO,VUB	Compact design, better electrical isolations	Package with DCB ceramic ;Very low forward voltage drop & low leakage current,
IV	High speed fuses	Overcurrent protection	PSR	Best in class DC Performance	Buss Bar Mount
V	TVS Diode	Secondary overvoltage protection especially for high power line voltage applications of 600V or higher	AK3-380C	Offers accurate low voltage clamping capability to provide differential protection to the rectifier diodes, capacitor, and IGBT	Bi-directional, high power TVS Diode rated for 3kA (8/20µs) with a standoff voltage of 380V. Maximum clamping voltage of the two AK3-380C TVS Diodes is only 1040V
VI	IGBT Module	Switching power supplies	MIXA, MIXG	Short circuit rated for 10µsec, low gate charge ,low EMI and competitive low Vce(sat)	Rugged XPT design with thin wafer technology
VII	NTC	Semiconductor Temperature Measurement	USUR1000, SM	Rapid thermal response and long time reliability	USUR is UL Recognized NTC sensor with ring lug mounting; SM NTCs is in hermetically sealed MELF package suitable for operation up to 220°C

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Protection and control solutions for soft starters

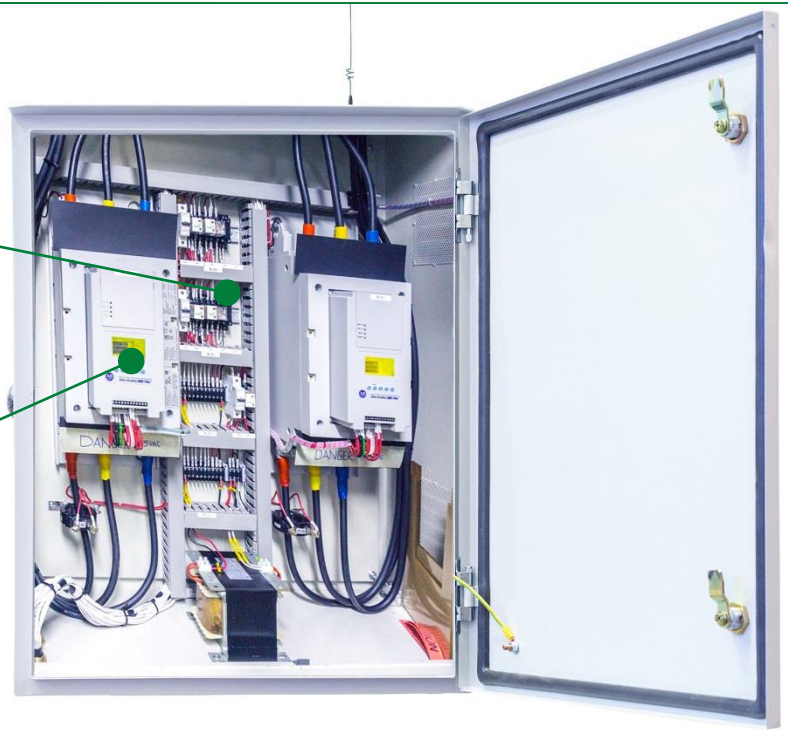
AC input protection:

- AC Fuses
- MOVs

Phase control:

- SCR Modules
- Discrete SCRs
- Temperature Sensors

SCR: Silicon Controlled Rectifier
MOV: Metal Oxide Varistor



Protect Control Sense

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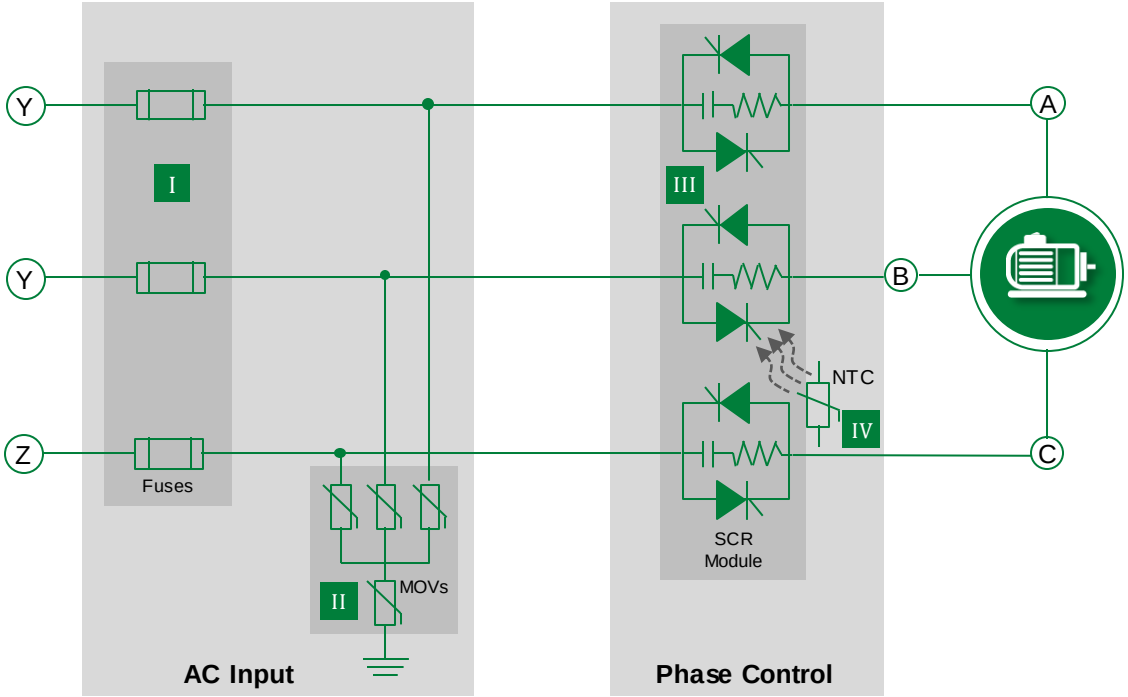
Protection and control components for soft starter topology



	Technology	Product Series
I	AC Fuse	L50QS, L70QS, JLS, JLLS
	Fuse Holders	LSCR, LFT, LFJ
II	MOV	TMOV
III	Dual SCR Module	MCC
	Discrete SCR	N Capsule series
IV	NTC	USUR1000, SM

Benefits of Littelfuse components in soft starters

	Technology	Function in Application	Series	Benefits	Features
I	AC fuses	Designed specifically for supplementary protection of semiconducting devices SCRs, diodes, IGBTs, and so on	L50QS, L70QS, JLS, JLLS	Reliable interruption of all over currents. Less heating and power consumption Help reduce semiconductor failures from over-voltages	Extremely Current Limiting Low Watt Losses Controlled Transient Over-voltages UL Recognized
	Fuse holder	Supports fuse protection	LSCR, LFT, LFJ	DIN Rail Mountable	Low resistance connection
II	MOV	Protect against damage due to lightning-induced surges or harmonic voltage disruptions from the power line.	TMOV	Integrated thermal disconnect enhances safety by disconnecting during MOV EOL caused by continuous abnormal overvoltage from miss wiring or loss of neutral	TMOVs are UL Recognized Type 4 Surge Protection Devices. Integrated thermal disconnect reduces risk of MOV overheating and catastrophic failures
III	Dual SCR Module	To control the application of supply voltage to the motor	MCC	Space and weight savings Simple mounting with two screws Improved temperature and power cycling Reduced protection circuits	International standard package, JEDEC TO-240 AA Isolation voltage 3600 V UL registered
	Discrete SCR		N Capsule series		
IV	NTC	Semiconductor Temperature Measurement	USUR1000, SM	Rapid thermal response and long time reliability	USUR is UL Recognized NTC sensor with ring lug mounting; SM NTCs is in hermetically sealed MELF package suitable for operation up to 220°C

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Safety standards for machinery VFDs and soft starters

Standard	Title	General Scope	Region
IEC 61800-5-2	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional	IEC 61800-5-2 specifies requirements and makes recommendations for the design and development, integration and validation of safety related power drive systems (PDS(SR)) in terms of their functional safety considerations.	Global
IEC 60204-1	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	Covers both electrical safety and functional safety, and in respect of the latter it specifies requirements for electrical control devices, circuits, and functions.	Global
IEC 62061	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	Specifies requirements and makes recommendations for the design, integration and validation of safety-related electrical, electronic and programmable electronic control systems (SRECS) for machines	Global
ISO 13849-1	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	Provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software	Global
IEC 60947-4-2	Low-voltage switchgear and control gear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters	IEC 60947-4-2:2011 applies to AC semiconductor motor controllers and starters, which may include a series mechanical switching device, intended to be connected to circuits, the rated voltage of which does not exceed 1000VAC	Global
UL508/CSA C22.2 No. 14	Standard for Industrial Control Equipment	Cover industrial control devices, and devices accessory thereto, for starting, stopping, regulating, controlling, or protecting electric motors. Devices rated 1500 volts or less	North America
GB14048.6	Low-voltage switchgear and control gear. Part 4-2: Contactors and motor-starters. AC semiconductor motor controllers and starters (including soft starter)	The Chinese GB14048.6-2008 standard is based on the IEC-standard IEC 60947-4-2	China

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Additional information can be found on littelfuse.com

Circuit Protection Solutions:
https://www.littelfuse.com/~/media/electronics/product_catalogs/littelfuse_product_selection_guide.pdf.pdf

Sensor Solutions:
littelfuse.com/selectionguide-sense

Industrial Power Fuses:
https://m.littelfuse.com/~/media/electrical/catalogs/powrgard-electrical-product-catalog.pdf

Power Semiconductor Solutions:
http://www.ixys.com/Documents/Selectorguide.pdf

Ground-Fault Protection with VFDs
https://m.littelfuse.com/~/media/protection-relays/white-papers/littelfuse_white_paper_ground_fault_el731.pdf

TVS Diode Protection for VFDs/IGBT Inverters
https://www.littelfuse.com/~/media/electronics/application_notes/littelfuse_tvs_diode_protection_for_vfds_igbt_inverters.pdf.pdf

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Why choose Littelfuse

- Global leader with broad product portfolio covering every aspect of protection, sensing, and control
- Application expertise combined with product designed guidelines to help you determine best component for your application
- Testing capabilities and assistance to support confirmation of product selection
- Standards compliance expertise including product compliance to many standards and approval support
- High-volume manufacturing, committed to the highest quality standards
- Global company with local support

We are committed to supporting your success

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