

APPLICATION NOTE

Power and Control Applications for Autoclave Sterilization

Biomanufacturing



Are you involved in medical equipment manufacturing?

ABB offers solutions to help improve the performance, energy consumption, and reduce design time for autoclave sterilization equipment.

What is sterilization?

Sterilization is the process of making a material free from all microorganisms. The most common techniques are autoclave sterilization, vaporized hydrogen peroxide, ethylene oxide, and nitrogen dioxide.

What is autoclave sterilization?

Autoclave sterilization is a method used to eliminate microorganisms using saturated steam under pressure. Autoclave sterilization is a common and dependable sterilization technique in the field of biomanufacturing because of its availability, speed, economic benefit, and reliability.

Why is power and control important for autoclave sterilization?

Power and control are essential for autoclave sterilization because effective sterilization requires maintaining specific temperatures and pressures, which can be achieved with adequate power and control systems. Autoclave sterilization follows programmed cycles involving opening and closing valves, which need proper control. Well designed power and control systems are necessary for the safety of the machines and operators because high temperatures and pressure pose significant risks to the sterilizer operators.

Main benefits



Continuous operation

Help ensure optimal uptime with reliable connections and coordinated products that provide robust switching and motor control, as well as protection against overloads and short circuits.



Energy efficiency

Boost control panel energy efficiency and sustainability with our AF coil technology, which reduces energy consumption and dissipates less heat, leading to a reduction in temperature rise and increasing panel density.



Compact design

Save space in the control panel with narrower designs in mini circuit breakers, and contactors that easily fit your application, helping to reduce the control panel dimensions and costs.



Easy to install

Reduce control panel assembly time and simplify installation with our starter connection kits, push-in spring terminals, and snap-in accessories.

Sterilization process

Sterilization is the most effective method for controlling microorganisms as it removes all microbial life. Cleaning, disinfection, and sterilization are often used interchangeably but do not mean the same thing.

- Cleaning removes dirt, debris, and other contaminants from a surface.
- Disinfection involves using chemicals to eliminate most germs and microbes using chemical agents.
- Sterilization removes all microorganisms, including non-harmful microorganisms.

The selection of the appropriate sterilization technique depends on the material's intended use, the type of material, and other factors. Effective sterilization requires thorough preparation and packaging, correct selection of cycle type, exposure and dry time, and correct loading and unloading of the sterilizer. Regular sterilizer maintenance, proper construction, and sterilant delivery system maintenance are also important for effective sterilization.

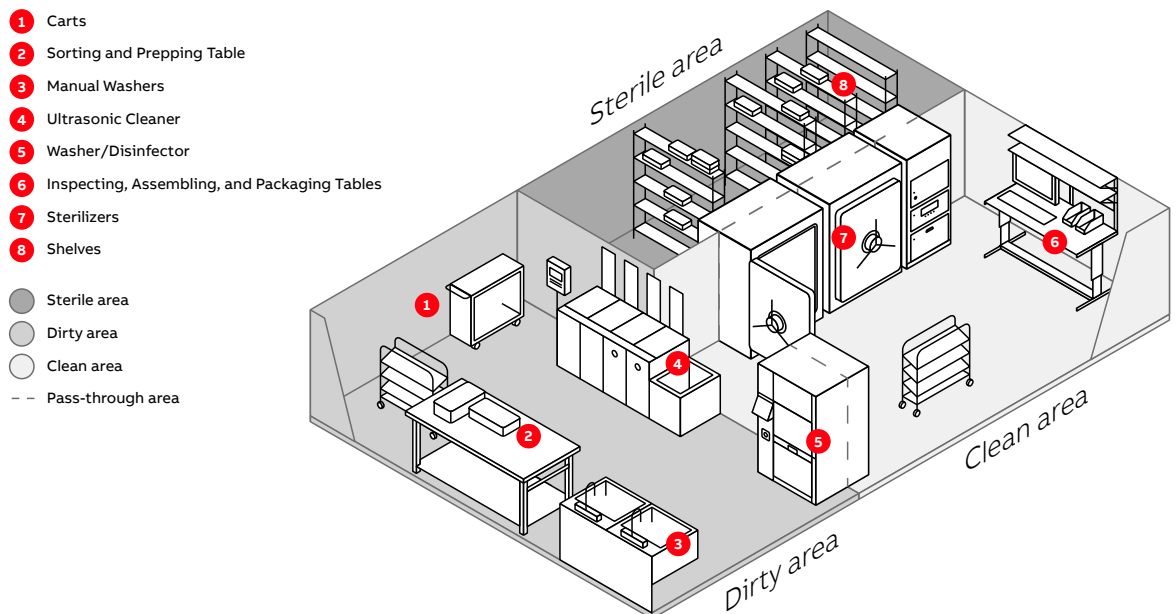


Sterilization process flow in a medical facility

The process flow for sterilization in a medical facility depends on the sterilizer type, unit design, decontamination, disassembling of the device, loading the sterilizer, monitoring, the sterilant quality and quantity, the appropriateness of the cycle for the load contents, and providing optimal conditions.

Sterilization involves the following processes:

Order	Area	Process	Description of process
1.	Dirty area	Sorting and preparation	Within the dirty area, instruments are sorted based on the materials and are prepared for cleaning
		Cleaning and decontamination	Then, the contaminants are removed from the instruments using a utensil washer-sanitizer, ultrasonic cleaner, washer-sterilizer, dishwasher, washer-disinfector, and washer decontaminators
2.	Clean area	Inspection	Next, the instruments are reorganized into correct trays
		Assembly and/or packaging	Additionally, the instruments are arranged to ensure all surfaces are directly exposed to the sterilizing agent. Clean (but not sterile) instruments are also wrapped for future use
		Sterilization	Lastly, the removal of microorganisms on the surface of the instrument using the sterilizers. The sterilized instruments are then cooled and dried
3.	Sterile area	Storage and distribution	The instruments are then kept and preserved for future use



Autoclave sterilization application

The autoclave, or “steam sterilizer”, is a sealed device that purifies materials with saturated steam under pressure. The sterilization process removes microbial organisms, such as fungi and bacteria from a surface or contained in a fluid to prevent disease transmission. Steam, pressure, temperature, and time are the four parameters for steam sterilization.

The steps involved in the autoclave sterilization process can be categorized into five broad themes listed below:

1. Steam quality, delivery, and after design

a) Moisture content: A recommendation of 97% steam (water gas) and 3% moisture (water liquid) has been identified for a successful heat transfer.

b) Boiler assessment: The boiler influences the steam quality and ensures adequate pressure. A pressure reducer valve may be installed near the sterilizer to reduce and supply the optimum steam pressure to the sterilizer.

c) Piping assessment: The steam pipe must be designed appropriately with sufficient insulation and traps to remove the condensate from the steam lines.

2. The autoclave sterilizer: Discussed in detail on the next page.

3. Sterilizer loading and unloading: While loading the sterilizer, there should be adequate room between the sets to facilitate air removal, steam penetration, and improved drying.

4. Sterilization process monitoring: Routine monitoring of every load and package, routine sterilizer efficacy monitoring, qualification testing, and product quality assurance testing are necessary.

5. Routine load and package monitoring: Each package in the load is given a lot number, which identifies the sterilizer, the date, and the cycle run and provides product traceability.



Autoclave sterilization application

Autoclave sterilization involves the following phases:

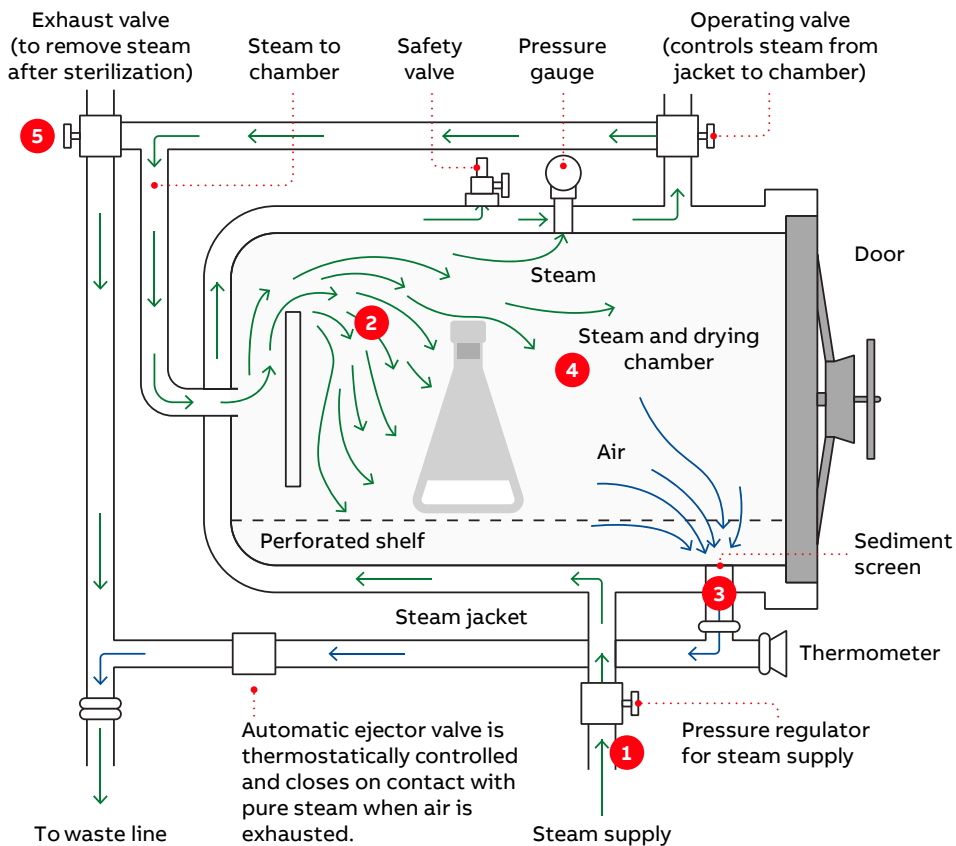
- 1. Pre-conditioning and heating:** The high pressure increases the boiling point of water and helps achieve a higher temperature for sterilization
- 2. Exposure:** When this steam interacts with the surface, it ensures the killing of the microbes

3. Pressure release: The pressure in the cabinet is released

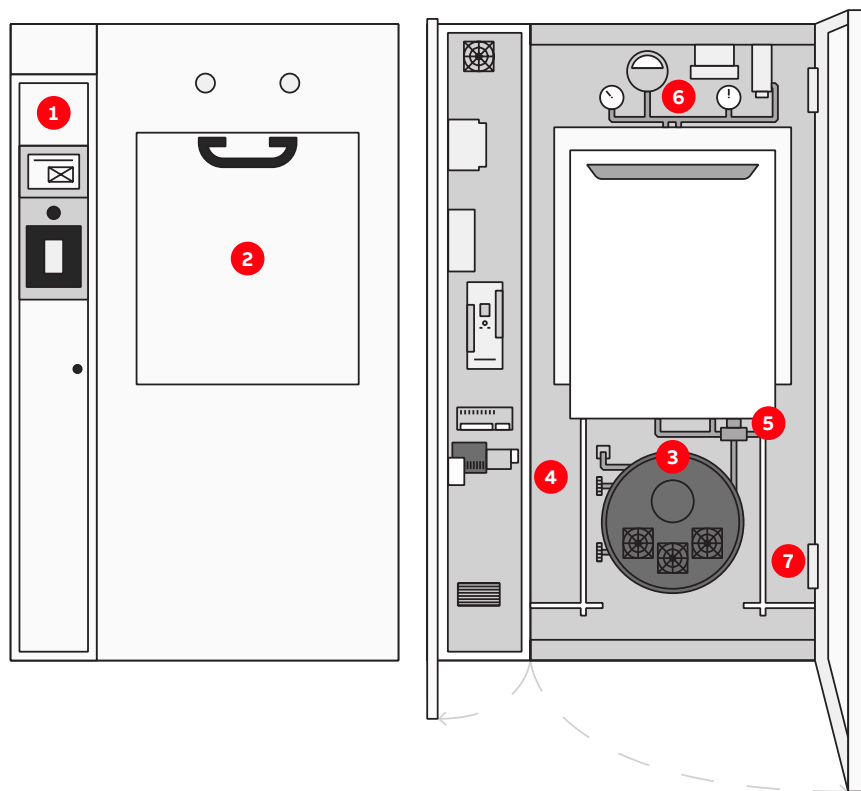
4. Drying: The load is dried to prevent recontamination through the wicking of microorganisms

5. Exhaust phase: The steam is removed from the chamber, and the pressure inside the chamber is released

The working principle of a gravity displacement autoclave



Critical components of an autoclave sterilizer



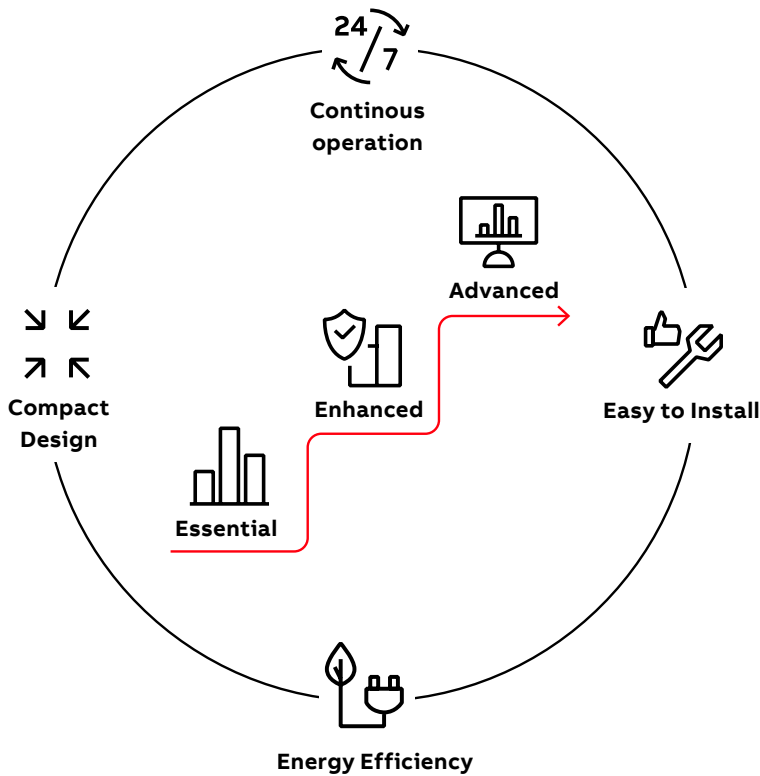
Functions:

- 1. Control system:** It controls the pressure and temperature inside the vessel and turns valves and components on and off in a specific order. This is the main electrical system of the autoclave.
- 2. High-pressure vessel with attached cover (safe):** It is the autoclave's casing, consisting of an inner chamber and an outer jacket. It helps to trap and release the heat and pressure inside the vessel and helps in creating the environment to perform sterilization.
- 3. Steam generator:** This boiler has electric heating elements to heat the water and generate steam.
- 4. Vacuum system:** It is used to force air out of the chamber using a vacuum before a cycle (pre-vacuum) and remove vapors to dry the material in the chamber (post-vacuum).
- 5. Thermostatic trap (steam trap):** It is designed to allow water and air (condensation) to escape from the safe while preventing the passage of dry steam.
- 6. Safety valve:** It helps to avoid an accident when the pressure inside the vessel is exceptionally high. It is the last fail-safe device for the pressure vessel in case all electronic controls fail.
- 7. Wastewater cooling mechanism:** It is used to cool down water before it enters the drain pipes.

Other components that may be available in some other designs are the pressure gauge, pressure control valve, whistle, electric heater, thermometer, sterilization box, water releasing valve, and water level indicator.

Power and control applications for autoclave sterilization

Discover our power and control solutions designed for autoclave sterilization. These solutions help to maintain optimal temperatures, ensuring efficient and reliable performance.



Essential Solution

Get the essentials right with fast and reliable installations

The Essential Solution helps to ensure that combinations of core power devices function in a coordinated way, thereby enabling continuous operation and ease of installation. In addition, the Essential Solution typically covers the requirements of stand-alone machinery like heating elements and valves.

Enhanced Solution

Get going with our robust protection offering featuring enhanced safety, control, and monitoring functions

The Enhanced Solution provides enhanced control, safety, and monitoring functions for applications in the discrete automation field. The Enhanced Solution for autoclave sterilization includes additional protection functions such as voltage monitoring relays, safety relays, and more. We can address any other requirements to suit end-user requests.

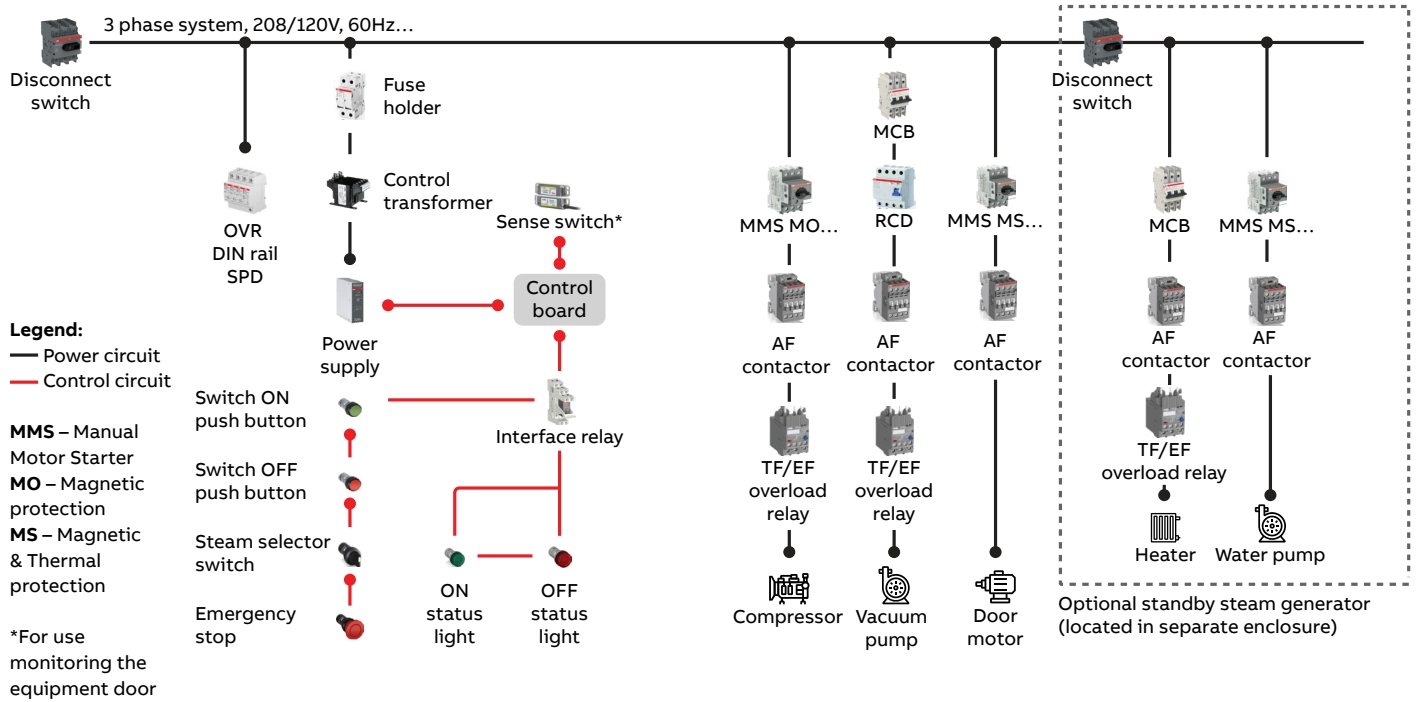
Advanced Solution

Get ahead with smart data and predictive applications to keep your autoclave sterilization systems running

The Advanced Solution for autoclave sterilization includes integrated and future-ready motor protection, fault diagnostics, maintenance schedules, and supports all major communication protocols.

Solution level	Basic protection functions	Monitoring of additional protection functions	Digital connectivity and cloud monitoring
Essential	●		
Enhanced	●	●	
Advanced	●	●	●

ABB's Essential Solution

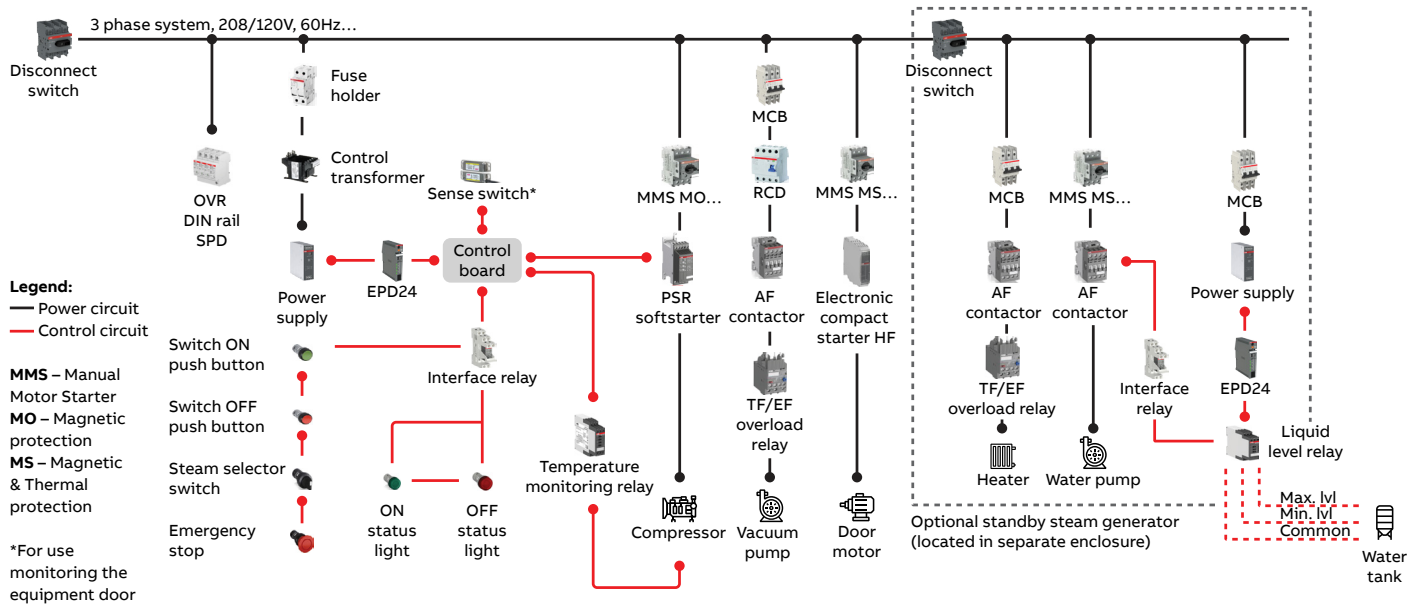


NOTE: THIS CONFIGURATION IS FOR A GENERIC SYSTEM AND IS NOT REPRESENTATIVE OF EXISTING MANUFACTURERS.

The table below provides an overview of the options for product combinations offered in the Essential Solution for autoclave sterilization.

Product combination	Key Differentiator
MMS/MCB + AF contactor + TF/EF overload relay	For standard offerings
MMS + AF contactor	For efficiency and space savings
MCB + RCD + AF contactor + TF/EF overload relay	For additional ground fault protection

ABB's Enhanced Solution

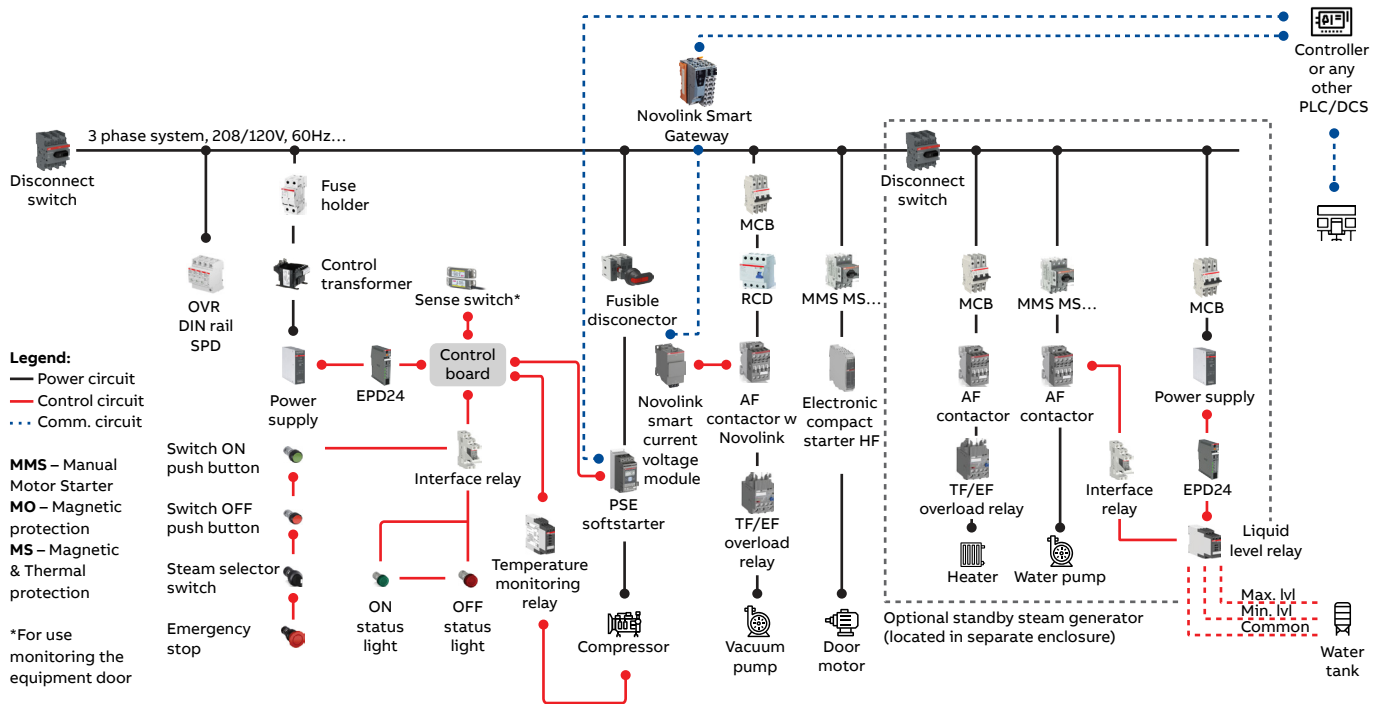


NOTE: THIS CONFIGURATION IS FOR A GENERIC SYSTEM AND IS NOT REPRESENTATIVE OF EXISTING MANUFACTURERS.

The table below provides an overview of the options for product combinations offered in the Enhanced Solution for autoclave sterilization.

Product combination	Key Differentiator
MMS + PSR (Softstarter)	For smooth start and stop
MCB + RCD + AF contactor + TF/EF overload relay	For additional ground fault protection
MMS + electronic compact starter	For additional motor control functionality, efficiency, and space savings
MCB + AF contactor + TF/EF overload relay	For standard offerings
MMS + AF contactor	For efficiency and space savings

ABB's Advanced Solution



NOTE: THIS CONFIGURATION IS FOR A GENERIC SYSTEM AND IS NOT REPRESENTATIVE OF EXISTING MANUFACTURERS.

The table below provides an overview of the options for product combinations offered in the Advanced Solution for autoclave sterilization.

Product combination	Key Differentiator
OS fusible disconnect + PSE (Softstarter)	For smooth start and stop plus communication
MCB + RCD + AF contactor + TF/EF overload relay	For additional ground fault protection, remote monitoring, and communication
MMS + electronic compact starter	For additional motor control functionality, efficiency, and space savings
MCB + AF contactor + TF/EF overload relay	For standard offerings
MMS + AF contactor	For efficiency and space savings

Main components and functions

Primary Functional Requirements

- Circuit breakers, surge protectors, residual current devices, and fuses to prevent equipment damage or fires
- Machine safety, including safety relays, emergency stops, signaling devices, and door sensors for users and service personnel

Secondary Optional Requirements

- Metering and temperature monitoring to track motor performance to detect overheating and other issues
- Digital capabilities offer remote and condition monitoring to allow for troubleshooting and maintenance
- Electronic protection device for overload protection

Power and control components and functionalities

Application	Electrical Components	Functional Description
Power circuit	OT non-fusible disconnect switch	Equipment isolation
Power circuit	Surge protection device	Prevent damage from an electrical surge
Power circuit	Fuse holder	Short circuit protection
Motor load	Manual motor starter (MMS)	Isolation, overload, and short circuit protection
Motor load	Manual motor starter (MMS) Magnetic only (MO)	Isolation and short circuit protection
Motor load	Softstarter	Ramp up speed to control startup torque
Motor load	AF contactor	Remote isolation and control
Motor load	Electronic compact starter	Hybrid starter with direct-on-line and reverse starting
Motor load	TF/EF overload relay	Thermal and electronic overload protection
Motor load	OS fusible disconnect switch	Short circuit protection
Motor load	Miniature circuit breaker	Overload and short circuit protection
Motor load	Residual current device	Ground fault protection
Control circuit	Power supply	Converts an electric input to a different current and voltage output
Control circuit	Control transformer	Reduces voltages from higher to lower
Control circuit	EPD24	Protects and monitors 24 VDC circuits against overloads
Control circuit	Temperature monitoring relay	Monitor the temperature of the condenser fan or compressor
Control circuit	Liquid level relay	Monitor water levels in tank to prevent equipment damage
Control circuit	Interface relay	Isolates, connects, and ensures compatibility between components
Control circuit	Pilot devices	Provide visual status and equipment control
Control circuit	Sense switch	Monitors equipment door

Product offering

Residual current devices



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AF contactors



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Surge protection devices



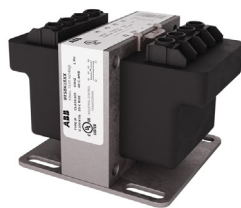
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Fuse holders



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Control transformers



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Miniature circuit breakers



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Disconnect switches



 FUSIBLE
DISCONNECT
SWITCHES
 NON-FUSIBLE
DISCONNECT
SWITCHES
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Measuring and monitoring relays



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Interface relays and optocouplers



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Assorted pilot devices



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Power supplies



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Electronic compact starters



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Sense switches



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Electronic protection devices



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Softstarters



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- [2] J. Fitch, M. Laporte, J. Nussbaum, A. Kern, and S. Barney, "Fact Sheet on Steam Sterilizers at Stanford University," 2013. Available: https://suwater.stanford.edu/sites/g/files/sbiybj19876/files/media/file/sem_steamsterilizers_stanford_2013.pdf



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U.S HQ Office:

ABB
305 Gregson Drive
Cary, NC 27511
United States
Phone: (800) 435-7365

[electrification.us.abb.com](https://www.electrification.us.abb.com)

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