APPLICATION NOTE

Power and Control Applications for Medical Refrigeration

Biomanufacturing

Are you looking for power and control solutions to safeguard the reliability and security of your medical refrigerators?

ABB offers solutions to help improve the performance and dependability of medical refrigerators, leading to the safe storage of temperature-sensitive medical supplies.

What is medical refrigeration?
Medical refrigeration involves advanced cooling systems designed to store sensitive medical products, like vaccines and blood. These refrigeration units are designed to maintain precise and stable temperatures to ensure the safety and effectiveness of the stored medical products.

Why is power and control important for medical refrigeration?
Power and control systems are crucial for medical refrigeration. Reliable power protection and performance helps ensure continuous operation while providing energy efficiency. Therefore, preventing temperature fluctuations that could compromise sensitive items like vaccines or blood. Control systems, including monitoring and alarms, are essential for detecting and addressing any deviations immediately, safeguarding the integrity of the stored materials. In medical settings, even brief power or control failures can lead to significant losses and pose risks to patient health, making robust power and control solutions vital.

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 with our AF coil technology, reducing energy consumption, dissipating less heat, and decreasing temperature rise while increasing panel density.

Compact design
Save space with narrower designs in 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.

Medical refrigeration overview

Medical refrigeration is a crucial component of the healthcare industry, directly impacting patient safety and the effectiveness of medical treatments. It is utilized in various healthcare facilities, including hospitals, blood banks, pharmacies, and laboratories, where maintaining precise temperature conditions for medical supplies is essential to preserve their potency and prevent spoilage, ensuring their viability for use.

Medical refrigeration ensures the efficacy, integrity, storage, and safety of a wide range of medical products, such as blood products, pharmaceuticals, vaccines, biological samples, and chemicals. Preventing the degradation of these items and ensuring their continued viability is paramount.

By design, medical refrigerators are engineered to maintain consistent low temperatures with minimal fluctuations, offering robust construction and rapid temperature recovery.

ABB’s components can be instrumental in facilitating the development of medical refrigerators by offering a range of electrical components that can be integrated into refrigeration systems and help provide precise temperature control, energy efficiency, and reliable operation. By leveraging ABB's products, OEMs can enhance the performance and reliability of medical refrigerators, ultimately contributing to the safe storage of temperature-sensitive medical supplies in healthcare facilities.

Medical refrigerators can be broadly classified into three categories:

Medium temperature refrigeration/Medical refrigerators – operating at temperatures between 2°C and 8°C (36°and 46°F)

Low-temperature refrigeration/Medical freezers – operating at a temperature range of -50°C and -15°C (-58°F and +5°F)

Ultra low-temperature refrigeration/Ultra cold freezers – operating at a temperature range of -90°C and -60°C (-130°F and -76°F)

Types	Specific storage uses
Lab Refrigerators	Specimens, reagents, and laboratory samples such as enzymes, cell cultures, or blood products, stored typically between 2°C and 8°C
Lab Freezers	Specimens, reagents, and laboratory samples such as enzymes, cell cultures, or blood products, stored between -40°C and -20°C for long term storage
Plasma Freezers	Plasma for treatments such as transfusions and other therapeutic applications, stored between -40° C and -30°C
Blood Bank Refrigerators	Blood and blood products (blood cells, plasma, or platelets) at very controlled temperatures between 1°C and 6°C for proper preservation
Ultra Low Temperature Freezers	DNA, RNA, proteins, cell cultures, and vaccines, stored between –86°C and -80°C for long term storage
Shock Freezers	Biological samples, useful in biobanking and cryopreservation applications, swiftly lowered to temperatures between -90°C and -60°C

Medical refrigeration parameters[1]

Temperature stability
Maintains excellent temperature stability by minimizing deviations from the set point and preventing rapid and significant temperature changes.

Temperature uniformity
Ensures rigid temperature uniformity, eliminating hot and cold spots, and maintains temperatures within +/-1°C, regardless of the storage application.

Temperature recovery
Ensures fast recovery time to return to their set point after frequent or prolonged door-opening. Faster recovery ensures contents remain at the correct temperature during regular use.

Temperature monitoring
Uses microprocessor temperature controllers and digital displays for precise temperature regulation.

Essential alarms
Loud and visual alarms are used to alert staff of high or low temperatures or if the door isn't fully closed.

Security & access control
Key locks and electronic access controls are used to restrict access to authorized users, ensuring the security of sensitive clinical samples and medications.

Customization & configurations
Several sizes and configurations are used to meet specific needs. Some have adjustable shelving options which allows for flexible storage configurations and efficient utilization of space.

Quality validation certificates
Certificates of calibration from suppliers to confirm that the cold storage unit has been calibrated with a compliance measuring device.

Medical refrigeration cycle

The refrigeration cycle in a medical refrigeration system involves the transfer of heat through a refrigeration medium, usually a refrigerant. This system typically requires four main components:

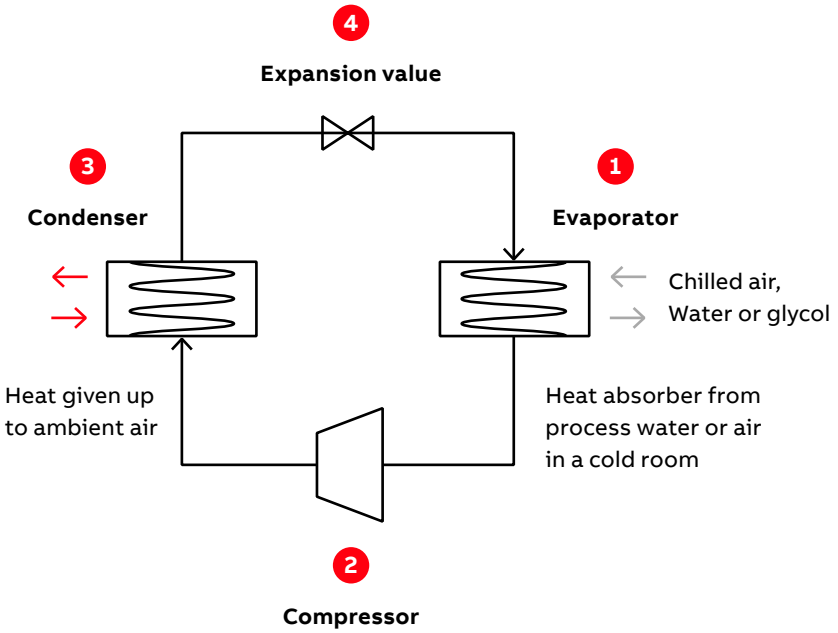
1. **Evaporator:** This is where the refrigerant absorbs heat from the interior of the refrigeration unit. The refrigerant enters the evaporator as a low-pressure, cold liquid. As it flows through the evaporator coils, it absorbs heat from the items stored inside, causing the refrigerant to evaporate and turn into a low-pressure gas. This heat absorption lowers the temperature inside the refrigeration unit.

2. **Compressor:** It is the pump that moves the refrigerant through the system. The vaporized refrigerant is drawn into a compressor. In this phase, the compressor increases the pressure of the refrigerant vapor, raising its temperature. The high-pressure, high-temperature vapor then moves to the condenser.

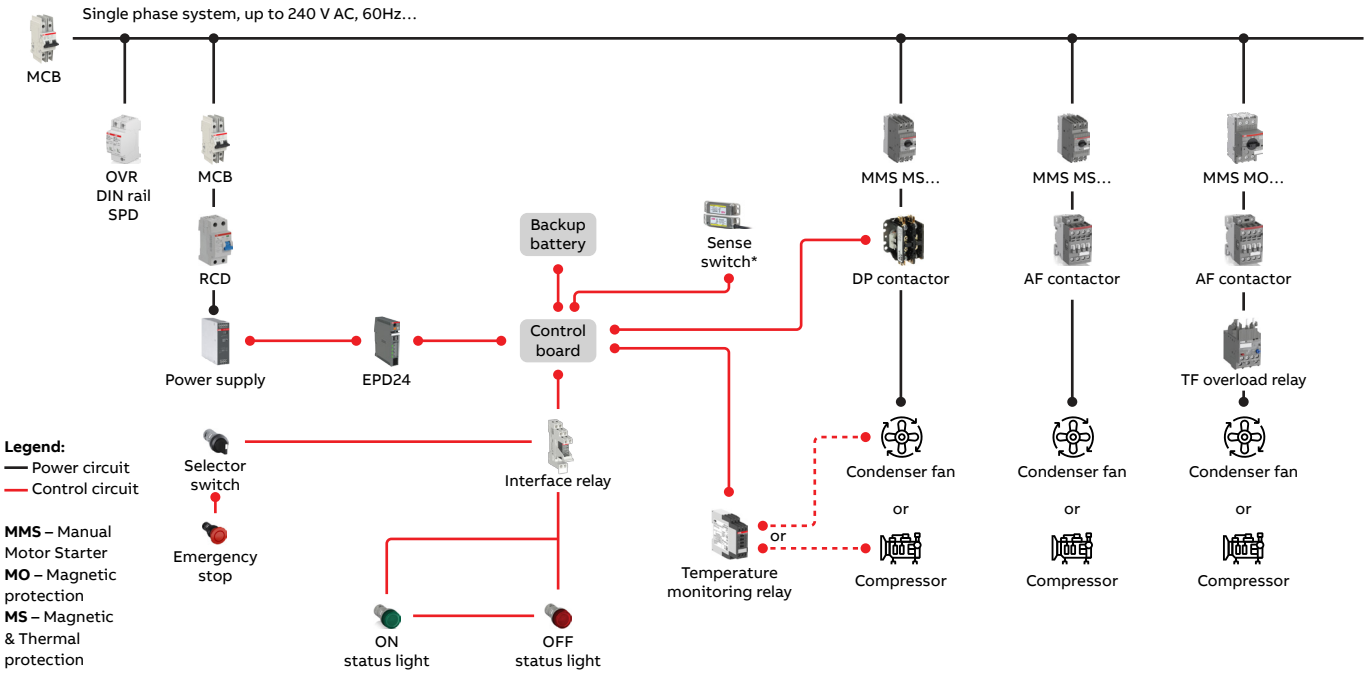
3. **Condenser:** It is the coil allowing the refrigerant to transfer heat to another medium. The gas passes through the condenser, where it gives up its latent heat of evaporation to either air or water and then returns to its liquid state.

4. **Expansion Valve:** It controls the refrigerant flow. The high-pressure liquid refrigerant passes through the expansion valve and experiences a pressure drop. This sudden reduction in pressure cools the refrigerant further, causing it to partially evaporate and cool down before returning to the evaporator to begin another cycle.

Overview of a typical refrigeration cycle



Power and control solutions for Medical refrigeration



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

The table below provides an overview of the difference between the combination of products offered for medical refrigeration.

Product combination	Key differentiator
MMS + DP contactor	For cost and space savings
MMS + AF contactor	For efficiency and space savings
MMS + AF contactor + TF overload relay	For standard offerings

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

- Temperature monitoring to track motor performance to detect overheating and other issues
- Electronic protection device for overload protection

Power and control components and functionalities

Application	Electrical Components	Functional Description
Power circuit	Circuit breaker	Overload and short circuit protection
Power circuit	Surge protection device	Prevent damage from an electrical surge
Power circuit	Residual current device	Ground fault protection
Condenser fan or Compressor	Manual motor starter (MMS)	Isolation, overload, and short circuit protection
Condenser fan or Compressor	Manual motor starter (MMS) Magnetic only (MO)	Isolation and short circuit protection
Condenser fan or Compressor	DP contactor	Remote isolation and control
Condenser fan or Compressor	AF contactor	Remote isolation and control
Condenser fan or Compressor	TF overload relay	Thermal overload protection
Control circuit	Power supply	Converts an electric input to a different current and voltage output
Control circuit	EPD24	Protects and monitors 24VDC circuits against overloads
Control circuit	Temperature monitoring relay	Monitor the temperature of the condenser fan or compressor
Control circuit	Pilot devices	Provide visual status and equipment control
Control circuit	Interface relay	Isolates, connects, and ensures compatibility between components
Control circuit	Sense switch	Monitors equipment door

Product offering

Miniature circuit breakers

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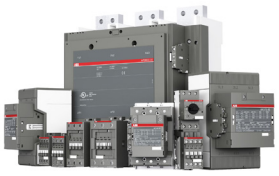
AF contactors



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Residual current devices

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DP contactors

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Surge protection devices

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Manual motor starters

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WEB PAGE

Power supplies

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WEB PAGE

Electronic protection devices

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Sense switches

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Measuring and monitoring relays

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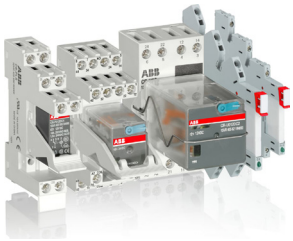
Interface relays and optocouplers



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Assorted pilot devices

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References

[1] United States Pharmacopeia. (2012). Good storage and distribution practices for drug products (Chapter <1079>). United States Pharmacopeia-National Formulary. Retrieved from https://www.drugfuture.com/Pharmacopoeia/usp35/PDF/5656-5663%20%5B1079%5D%20Good%20Storage%20and%20Distribution%20Practices%20for%20Drug%20Products.pdf

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