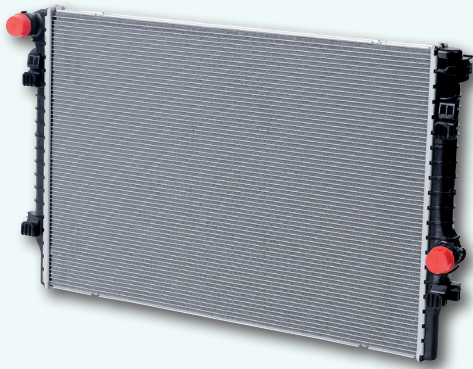


# Radiator



# Charge Air Cooler



## ESTRA Advantage

- Delivers excellent performance and low pressure drop with superior packaging
- Highly diversified portfolio with core depths that can satisfy all engine cooling requirements
- Deep knowledge of vehicle cooling systems to prevent system failures
- Proven product designs meet the most stringent durability requirements
- Capability and willingness to tailor designs for unique requirements

## ESTRA Advantage

- Broad line-up with high heat transfer and low charge air pressure drop
- Variety of center and turbulator geometries enable optimal system sizing
- Extensive manifold and turbulator design experience that best optimize charge air heat transfer and pressure drop
- New mono tube portfolio designed to comply with latest legal emission requirements
- Proven high temperature and high strength materials for all vehicle applications
- High structural and fluid dynamic expertise to customize product

## Features

- Capability of cooling engine and secondary loop systems
- Full face or bed type layout
- Folded tubes or welded tubes layout
- Designs applicable for low and high temperature applications, as well as fuel cell systems
- I Flow, U Flow, and cross counterflow designs available

## Features

- Provides optimal charge air temperatures in all vehicle conditions
- Optimizes charge air pressure drop to ensure smooth engine efficiency and reduce turbo lag
- Full face or bed type layout

## Customer Benefits

- Portfolio covers broad cooling needs for all applications from Internal Combustion Engine, Hybrid and full electric vehicles
- High efficiency radiators enable fan and water pump power reduction
- Compact constructions allow styling flexibility and fuel efficiency
- Tube designs to avoid protective grids

## Customer Benefits

- Charge air cooler portfolio covers all customer applications
- Variety of packaging options for any performance condition
- Improved heat transfer efficiency
- Reduces vehicle emissions and turbo Lag

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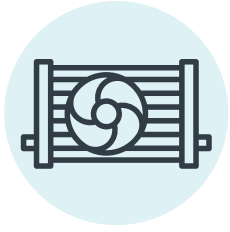
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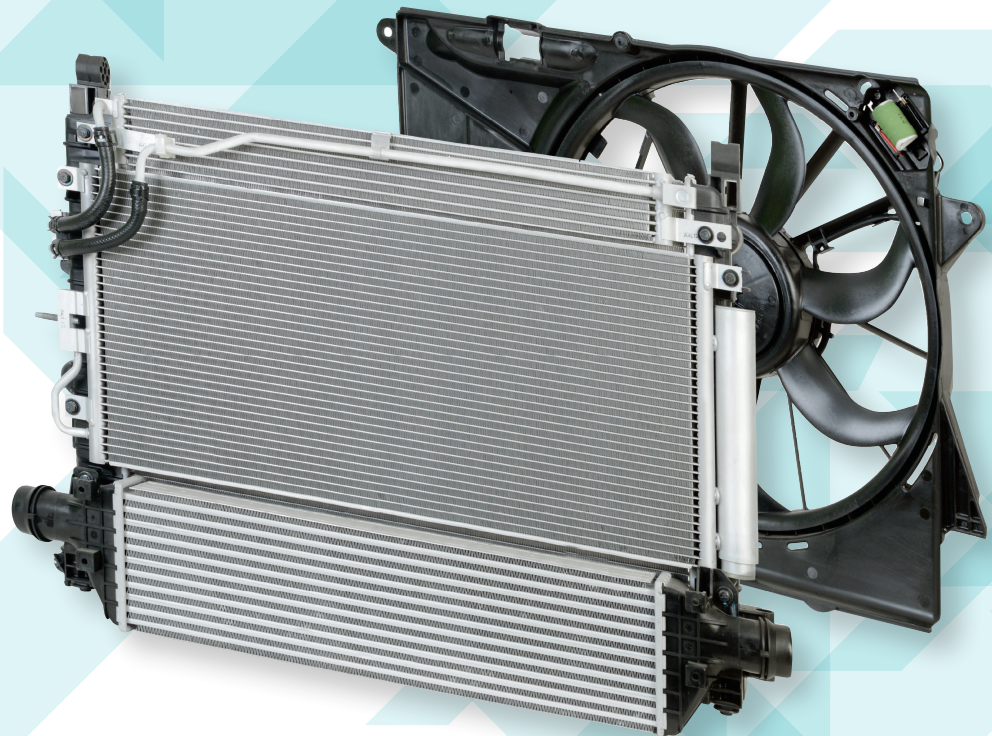
**Be the most preferred partner  
for each of our customers**

*- we do this by continuously  
developing ourselves individually  
and as one family*



# Heat Exchangers

- *Powertrain Cooling Module*
- *Condenser*
- *Radiator*
- *Charge Air Cooler*
- *Motor, Fan & Shroud*
- *Liquid Cooled Chiller*
- *Liquid Cooled Condenser*
- *Battery Cooling Plate*
- *Inner Heat Exchanger*
- *Evaporator & Heater Core*



# Powertrain Cooling Module



## ESTRA Advantage

- Modules customized to deliver superior packaging, performance and mass attributes.
- Strong system development capability to optimize all cooling configurations
- Innovative solutions for mounting and serviceability
- Technical know-how to manage noise and vibration attributes
- Proven solutions to protect against debris impact without the need for grids

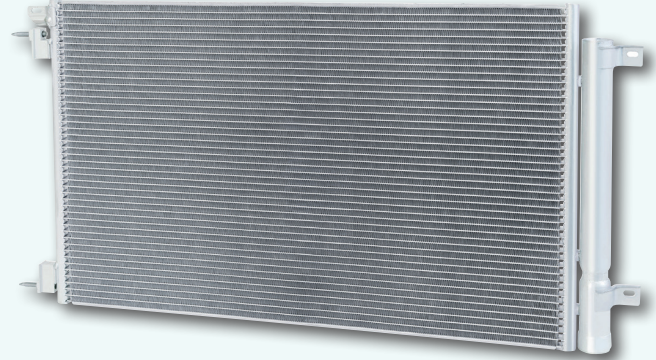
## Features

- Provide adequate airflow and sealing to cool all components in module
- Reduced vibrational loads
- Reduced airborne and transmission noise

## Customer Benefits

- Compact designs deliver high performance, low mass and require less fan power
- Fastener-less designs and proven assembly concepts enable ease of serviceability
- Customized sealing improves module airflow and reduce fan power

# Condenser



## ESTRA Advantage

- Delivers excellent performance and low pressure drop with superior corrosion resistance
- Variety of tube geometries designed to fulfill all vehicle systems and compressor requirements
- Customized air center geometries focused on optimizing heat transfer and pressure drop to fit vehicle air flow
- Innovative design and manufacturing solutions for vehicle integration
- Core bending technology available to enhance compactness
- Folded or extruded tube designs provide impact resistance to road debris without the need for grids

## Features

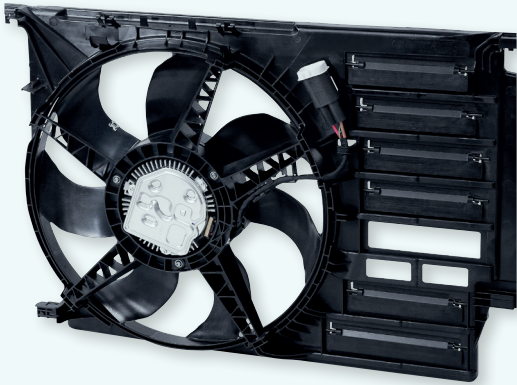
- Integrated receiver dehydrator provides refrigerant sub-cooling for evaporator and removes moisture from system
- Internal flow paths allows proper oil circulation
- Variable design solutions for sub-cooling placement
- Dual filters at receiver dehydration and outlet connection deliver high level technical cleanliness

## Customer Benefits

- Heat exchangers that deliver high performance with low mass
- Reliable material system that provides long life durability
- Flexible design solutions can offset poor vehicle air distribution
- Fastener-less and unique mounting solutions improve the serviceability



## Motor, Fan & Shroud



### ESTRA Advantage

- High level of expertise in development of efficient blades with low noise characteristics
- Strong system integration capability with excellent experience in airflow management for all vehicle architectures
- Highly diverse portfolio of blade geometries to meet all cooling airflow requirements
- Low level of acoustics that extend through entire RPM range

### Features

- Low profile fan and shroud designs available for improved compactness
- Fan geometries include acoustic rings and other noise dampening design features
- Blade geometry customized for system air flow and Low level acoustics

### Customer Benefits

- Optimized fan and shroud design delivers perfect airflow and acoustics level
- Lower power levels as fan and system pressures are equalized
- Low acoustics as system level approach minimizes in vehicle noise levels

## Liquid Cooled Condenser



### ESTRA Advantage

- Deliver excellent performance and low pressure drop in a customizable compact package
- Extensive knowledge in fabrication and brazing technologies
- Comprehensive understanding of material system requirements
- Diverse portfolio of heat transfer surfaces
- Wealth of experience in system integration

### Features

- Provides sub-cooled liquid to the evaporator
- Removes moisture and allows oil circulation in the refrigerant system
- Provides heat source for battery thermal management
- Integrated filters at receiver dehydration and outlet connection deliver high level technical cleanliness

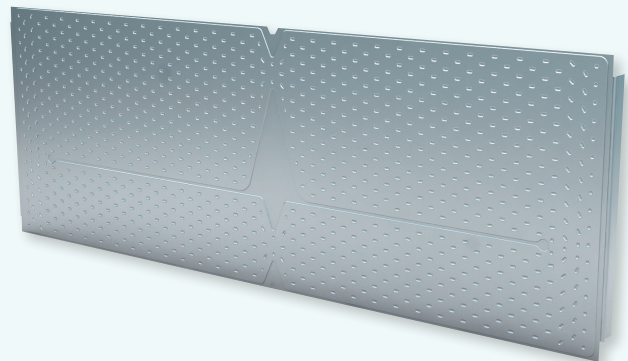
### Customer Benefits

- Lightweight compact designs provide more stable performance
- Enables thinner powertrain cooling module requiring fan power
- Heat source for electric vehicle and hybrid vehicles

# Liquid Cooled Chiller



# Battery Cooling Plate



## ESTRA Advantage

- Delivers excellent performance and coolant pressure drop with superior corrosion resistance
- Extensive knowledge in fabrication and brazing technologies
- Comprehensive understanding of material system requirements
- Diverse portfolio of heat transfer surfaces
- Strong system integration experience

## ESTRA Advantage

- Deliver a uniform temperature for maintaining better temperature in all environments
- Vast manufacturing knowledge in sampling, forming and brazing/welding
- Cooling plates capable of maintaining uniform surface temperature  $< 1$  K across entire plate surface
- Systems design that can deliver  $< 3$  K temperature spread over entire system
- High corrosion resistance and low conductive material suitable for battery cooling applications
- Flexible designs solutions for low pressure drop in all packaging

## Features

- Provides heating and cooling source for both battery cooling and heat pump systems
- Chiller portfolio includes both plate-plate and plate and fin technologies.
- Various refrigeration controls and connections available such as eTXV, EXV, etc.
- 3 way valve and/or reversing valves available

## Features

- Maintain a uniform surface temperature to prolong battery life
- Dissipate high heat loads to enable fast charging
- Maintain low pressure drop system for reduced power consumption

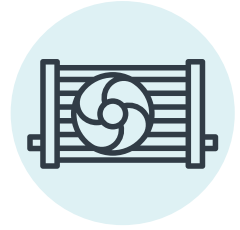
## Customer Benefits

- Lightweight compact designs provide more stable performance
- Enables thinner powertrain cooling module requiring lower fan power
- Integrated refrigerant controls for efficient thermal management

## Customer Benefits

- Uniform temperature at battery contact surface
- Customized plate designs to accommodate any stack configuration
- Wide range of mounting and connecting solutions

# Inner Heat Exchanger



## ESTRA Advantage

- Design uses tube and center technology for applications in heat pump system
- Robust designs capable of operating in low and high pressure systems
- Balanced material system provides superior corrosion protection
- Technical know how to develop water shedding and drainage features into the designs to enhance evaporator performance
- Proven folded tube technology offers high performance and greater durability eliminating the need for coatings
- Optimized designs maintain a uniform temperature in all environments and under all load conditions

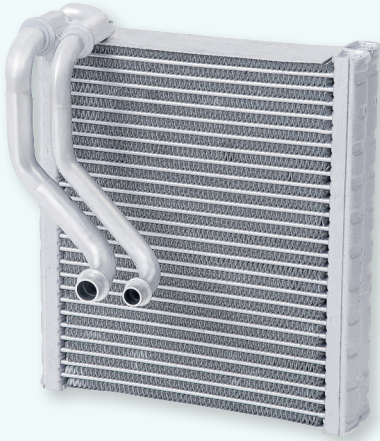
## Features

- Superior performance and temperature uniformity
- Reduced odor and emissions

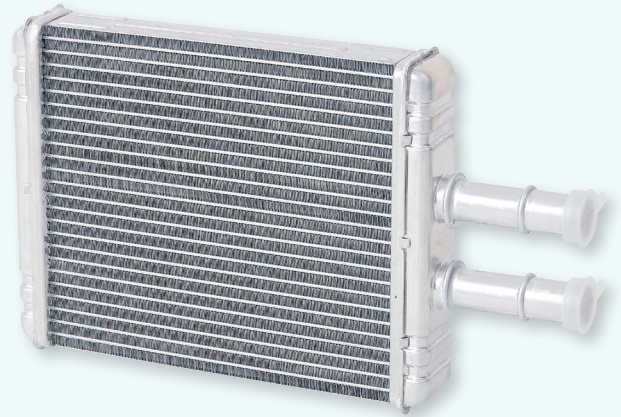
## Customer Benefits

- Acts as cabin condenser for heating and as evaporator for cooling
- Delivers more heating capacity than traditional cabin condenser
- Packaging is interchangeable in existing HVAC modules

# Evaporator



# Heater Core



## ESTRA Advantage

- Delivers better performance and lower mass with less packaging space required as compared to plate type evaporators
- Unique material system provides superior corrosion protection
- Technical know-how to develop water shedding and drainage features into the designs to enhance evaporator performance
- Proven folded tube technology offers high performance and greater durability without the need for coatings
- Effective solutions for managing temperature stratification

## ESTRA Advantage

- Provides excellent performance and lower mass with packaging solutions for all HVAC module architectures
- Variety of tube geometries designed to fit all vehicle systems and heating requirements
- Customized tank geometries enable flexible module designs
- Multi-pass heater design ensures uniform temperature distribution for all module architectures

## Features

- Delivers conditioned air with good stratification
- Reduced odor
- Plate type or tube & center design
- Enhanced hydrophilic coating available for superior corrosion and anti-microbial protection

## Features

- Delivers conditioned air with superior performance and good temperature uniformity
- U flow, cross counter or single-pass layouts

## Customer Benefits

- Compact designs deliver high performance and high efficiency with low mass
- Scalable designs offer flexible packaging to meet various architecture requirements
- Maintains uniform temperature distribution at all load conditions and with all vehicle architectures

## Customer Benefits

- Compact designs deliver high performance and low pressure with low mass
- Scalable designs offer flexible packaging to meet various customer architectures
- Maintains uniform temperature distribution at all load conditions and with all vehicle architectures