MODINE® EVANTAGE™ THERMAL MANAGEMENT SYSTEMS

DRIVE A CLEANER FUTURE

MODINE
Always Innovating. Always Improving.

EVantage™

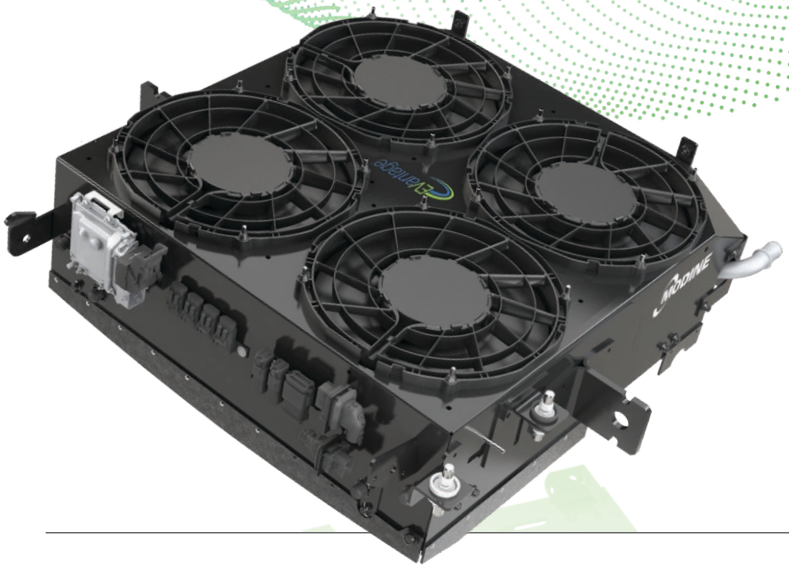
Engineering and support to count on.

As you design the future of clean technology, Modine® is ready to help with proven thermal systems engineered to quickly and seamlessly integrate into your design. The EVantage™ Battery Thermal Management System (BTMS) and EVantage Electronics Cooling Package (ECP) combine state-of-the-art, proprietary Modine heat exchanger technology with tailored smart electronic products to deliver a complete solution, designed to fit any chassis. With the included master thermal controller and Modine-developed firmware, our compact thermal systems are proven to deliver maximum cooling at the lowest power draw.

EVANTAGE™ BATTERY THERMAL MANAGEMENT SYSTEM (BTMS)

CONTROL YOUR BATTERY'S TEMPERATURE IN ALL ENVIRONMENTS

To maximize cell life, battery manufacturers recommend maintaining a battery at an ideal temperature, regardless of ambient temperature or usage. With multi-stage cooling and heating, the EVantage Battery Thermal Management System (BTMS) optimizes the temperature range for an entire bank of batteries with a single unit in all types of environments – from hot summer afternoons to icy winter mornings.



EVANTAGE™ ELECTRONICS COOLING PACKAGE (ECP)

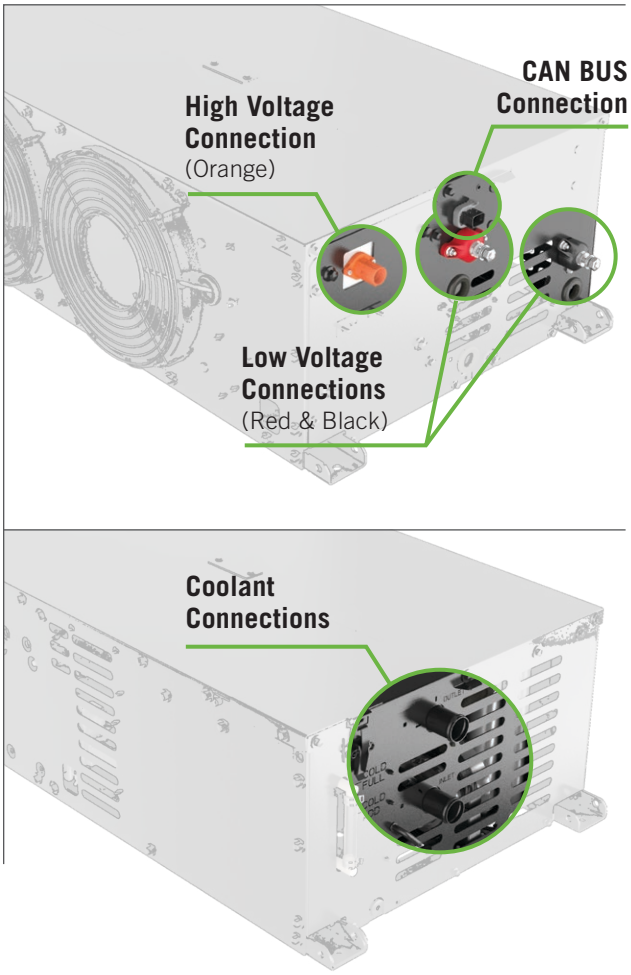
KEEP YOUR ENGINE'S ELECTRONICS COOL FOR ALL LOADS

The EVantage Electronics Cooling Package (ECP) is a complete solution designed to effectively cool down the power electronics on your electric traction engine. With multi-zone cooling, each ECP is designed to your specification with small to large fan arrays that operate only when required, minimizing the power draw.

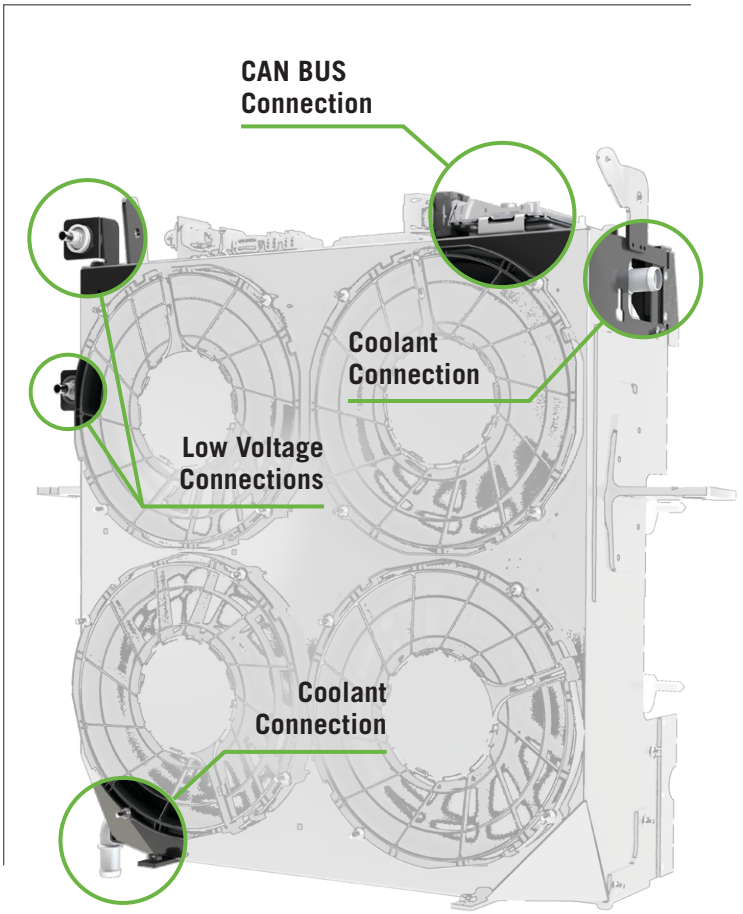
PLUG AND PLAY FOR FAST INTEGRATION

Adding thermal management to your design is easy with EVantage™ systems because they are designed for seamless integration into your chassis. All necessary heat exchangers, smart electric products (pumps, valves, fans, compressors, heaters), wiring and hoses are included, as well as a master controller and tailored firmware to provide complete operation upon delivery. Our team of Modine application engineers will validate one of our standard configuration systems meets your needs or customize a design to fit your application.

BTMS Input/Output



ECP Input/Output



EVANTAGE™ THERMAL SYSTEMS FEATURES

CUSTOMIZABLE
Multiple configurations for different space constraints and cooling capacity needs

FLEXIBLE
Different mounting options available – roof, chassis, body

WEATHER SAFE
Designed for harsh environments – IP67 ingress protection, corrosion resistant materials, fully sealed wiring harness, rigorous validation testing

RELIABLE
Modine patented failsafe system for maximum system reliability

CONVENIENT
Included master thermal controller with Modine-developed firmware and SAEJ1939 CAN communications

EASY MAINTENANCE
Included Maintenance and Diagnostics Software for system monitoring, diagnostics message data logging and preventative maintenance tracking

EVANTAGE™ BATTERY THERMAL MANAGEMENT SYSTEM

TECHNICAL DATA

	Lightweight (24V, 3kW) MOD-24V-24-A-08	**Lightweight** (24V, 10kW) MOD-50-24-A-08	**Heavy Duty** (24V, 10kW) MOD-50-24-P-08	**Heavy Duty** (12V, 10kW) MOD-50-12-P-08
Status	In Production	In Production	In Production	In Production
Active Cooling Circuit	3 kW	10 kW	10 kW	10 kW
Cooling Capacity @				
Outside Temperature	44ºC	44ºC	44ºC	44ºC
Coolant Outlet Temperature	25ºC	35ºC	35ºC	35ºC
Coolant Flow	1,200 l/h	3,600 l/h	3,600 l/h	3,600 l/h
Passive Cooling Circuit	No	No	10 kW	10 kW
Cooling Capacity @				
Outside Temperature	–	–	10ºC	10ºC
Coolant Outlet Temperature	–	–	25ºC	25ºC
Coolant Flow	–	–	3,600 l/h	3,600 l/h
Maximum Power Consumption				
High Voltage (Heating)	8.0 kW	8.0 kW	8.0 kW	8.0 kW
High Voltage (Cooling)	2.0 kW	6.0 kW	6.0 kW	6.0 kW
Low Voltage	1.7 kW	1.7 kW	2.4 kW	2.4 kW
Voltage Inputs				
High Voltage	450 - 750 V	450 - 750V	450 - 750 V	450 - 750 V
Low Voltage	24 V	24 V	24 V	12 V
Heater Capacity	0-8 kW	0-8 kW	0-8 kW	0-8 kW
Weight (Max.) without Coolant	60 kg	62 kg	85 kg	85 kg
Dimensions (L x W x H)	1136 x 664 x 390 mm	1136 x 664 x 390 mm	1093 x 657 x 350 mm	1093 x 657 x 350 mm
Refrigerant	R134a/R1234yf	R134a/R1234yf	R134a/R1234yf	R134a/R1234yf
Additional Features	Surge Tank Aluminum Frame Integrated Pump(s)	Surge Tank Aluminum Frame Integrated Pump(s)	Surge Tank Steel Frame Integrated Pump(s)	Surge Tank Steel Frame Integrated Pump(s)

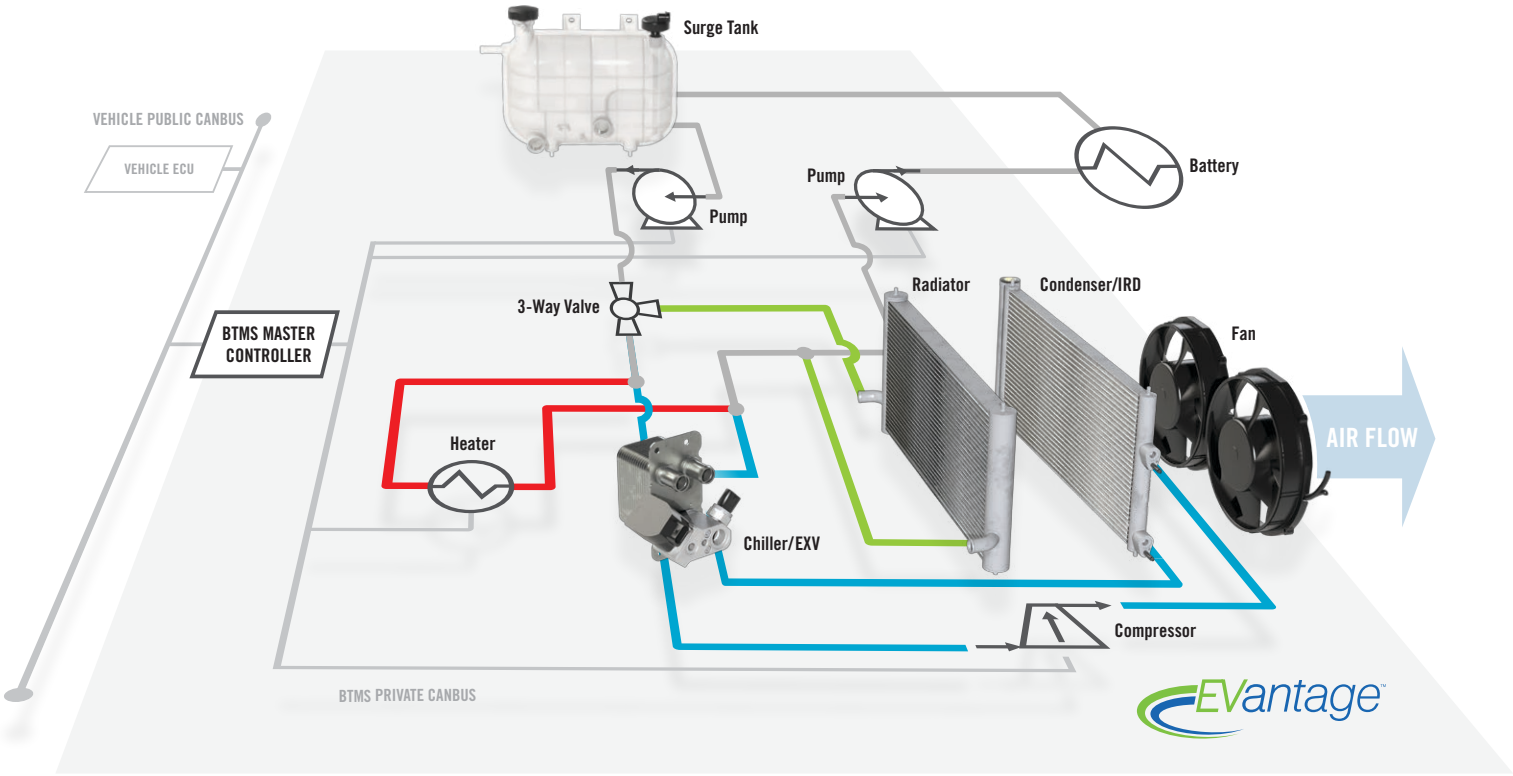
EVANTAGE™ ELECTRONICS COOLING PACKAGE

TECHNICAL DATA

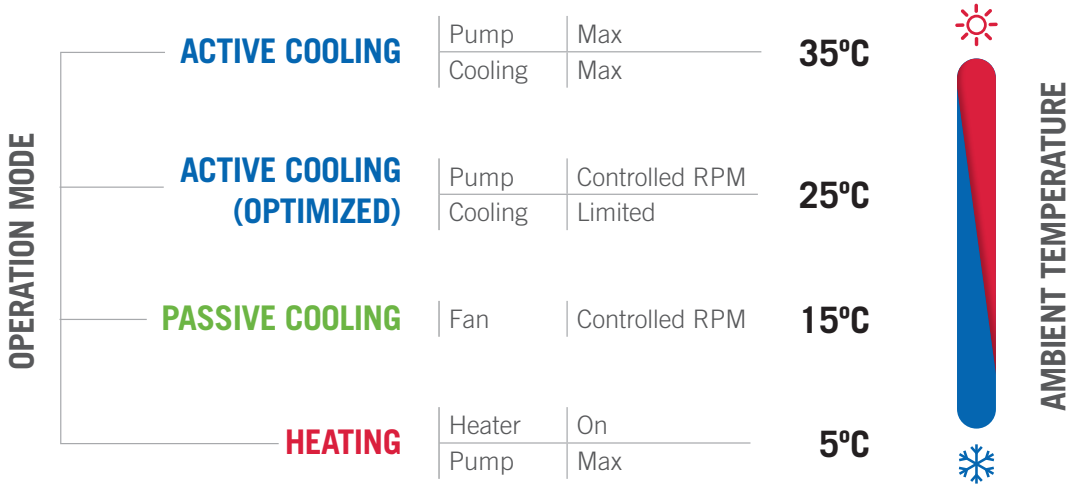
	1-Fan	**2-Fan**	**4-Fan**	**6-Fan**
Status	In Production	In Production	In Production	In Production
Maximum Cooling Capacity	10 kW	20 kW	30 kW	40 kW
Cooling Capacity @				
Outside Temperature	45ºC	45ºC	45ºC	45ºC
Coolant Outlet Temperature	65ºC	65ºC	65ºC	65ºC
Coolant Flow	1,200 l/h	1,800 l/h	2,700 l/h	3,600 l/h
Maximum Power Consumption	0.6 kW	1.2 kW	2.4 kW	3.6 kW
Weight (Max.) without Coolant	10 kg	20 kg	40 kg	60 kg
Dimensions (L x W x H)	580 x 370 x 210 mm	920 x 370 x 210 mm	920 x 860 x 290 mm	1150 x 800 x 320 mm

3-Stage Cooling and Heating for Optimized Operation

EVantage™ Battery Thermal Management System



The smart control system of the BTMS continuously compares the battery coolant temperature to ambient temperature and automatically selects the most efficient mode of operation (active cooling, passive cooling or heating) while minimizing power draw.



DESIGNED FOR HEAVY DUTY OPERATION

Verified to meet the most stringent validation testing, EVantage™ systems have been proven to withstand heavy vibration environments with Modine®-fabricated rugged, anti-corrosive enclosures and flexible, vehicle-grade wiring harnesses and refrigerant hoses.

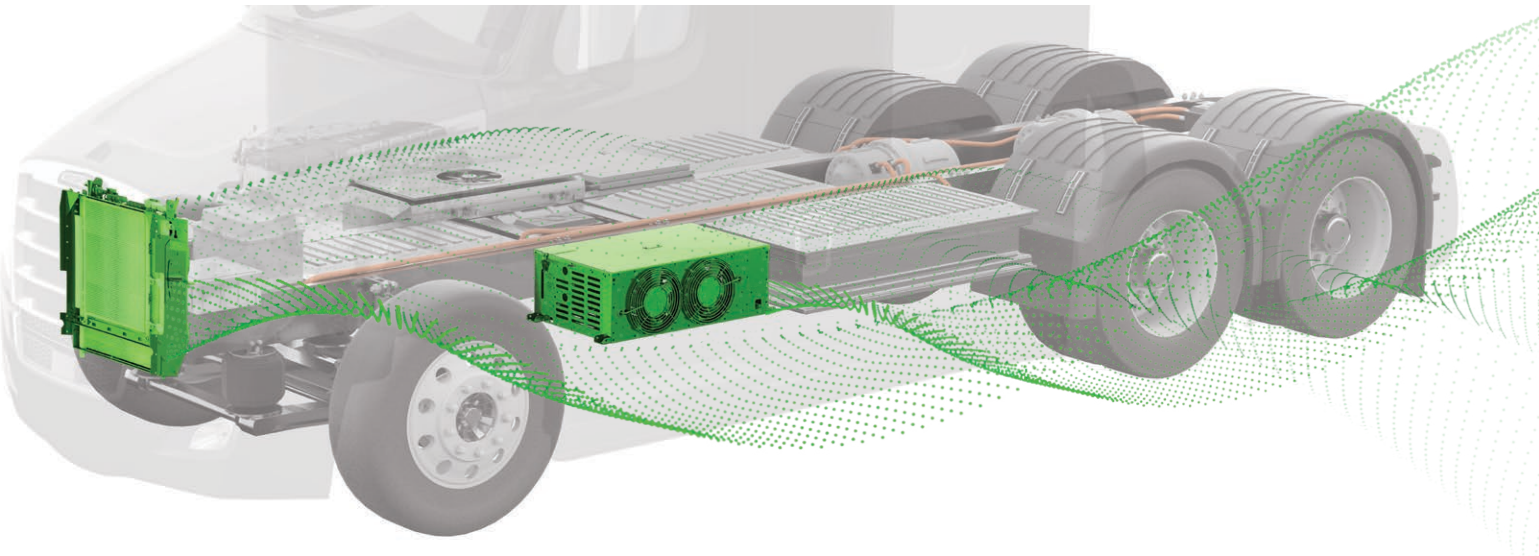
AVOID ROADSIDE BREAKDOWNS WITH FAIL SAFE FEATURES AND PREVENTATIVE MAINTENANCE TOOLS

Each EVantage system is designed with redundancy in critical operations and real-time fail-safe features to minimize field breakdowns. To find and fix issues before they occur in the field, the thermal master controller offers continuous data logging of DM1 & DM2 faults and tracks the accumulated runtime on each component, enabling preventative maintenance. When a repair is needed, the included EVantage Maintenance and Diagnostics software makes it easy to find where the failure occurred and the accessible system design simplifies completing the repair.

CUSTOM DESIGNS AVAILABLE TO FIT ANY CHASSIS

From Delivery Vans to Class 8 Trucks to Buses, commercial electric vehicles come in a range of shapes and sizes. Modine is ready to design a solution to meet the space constraints of any size chassis, from minor modifications of existing configurations to fully custom systems.

Our Wisconsin-based team of engineers has leveraged the knowledge from over 100 years of Modine thermal management expertise to design solutions for over 30 programs currently in testing or full-scale production today.



Design Process

1 STEP ONE

TECHNICAL ASSESSMENT

A Modine Application Engineer (AE) reviews your requirements with standard EVantage™ thermal system configurations and shares assessment with your Customer Design Team.

2 STEP TWO

(IF NEEDED) CUSTOM DESIGN

The Modine AE team creates a custom design and runs a full set of simulations using Modine-proprietary simulation software, built from real-world data, to ensure the design will meet your heat load requirements. An initial CAD model will be shared with the Customer Design Team to finalize space constraint requirements.

3 STEP THREE

FINAL DESIGN AND FIT CHECK

A final CAD drawing is reviewed with the Customer Design Team after all design for manufacturability and reliability (DFM/DFR) adjustments are made. If needed, a finite element analysis (FEA) simulation is run by the Modine AE team to confirm the design will meet the harsh environment requirements of the vehicle and all customer-specified validation tests.

4 STEP FOUR

PROTOTYPE SAMPLES AND CONTROLS FIRMWARE

Modine's inhouse Sample Shop can rapidly build prototypes of our EVantage thermal systems. In parallel, the Modine Controls Team will build the firmware to seamlessly interface the BTMS or ECP with the Customer's vehicle firmware using a library of Modine proprietary and proven controls algorithms for rapid, low risk development.

SAVE TIME WITH VALIDATION TESTING BY MODINE

With a state-of-the-art testing facility in Wisconsin, Modine offers comprehensive validation testing inhouse, from vehicular wind tunnel testing to component-level performance testing. Full vehicle vibration, pressure and thermal life cycle testing can be completed as well. This gives Modine the ability to rapidly perform design and production validation testing on our thermal systems and provides visibility for continuous design improvements. Over the 100 years Modine has been in business, we have developed and perfected tests to verify design and replicate in-field experiences.

MODINE®
HEAT EXCHANGERS

PROUDLY MANUFACTURED IN THE UNITED STATES

Modine's heavy-duty aluminum radiators and condensers use our patented PF® (parallel flow) design for highest performance in a lightweight, compact form factor. Our PF® products can be configured in a variety of sizes and are available with flexible mounting and fluid connection options. Using the proprietary Modine controlled atmosphere brazing (CAB) process, PF® radiators and condensers offer excellent corrosion resistance with low pressure drop. Modine PF® products provide extreme durability for harsh environments without sacrificing performance.

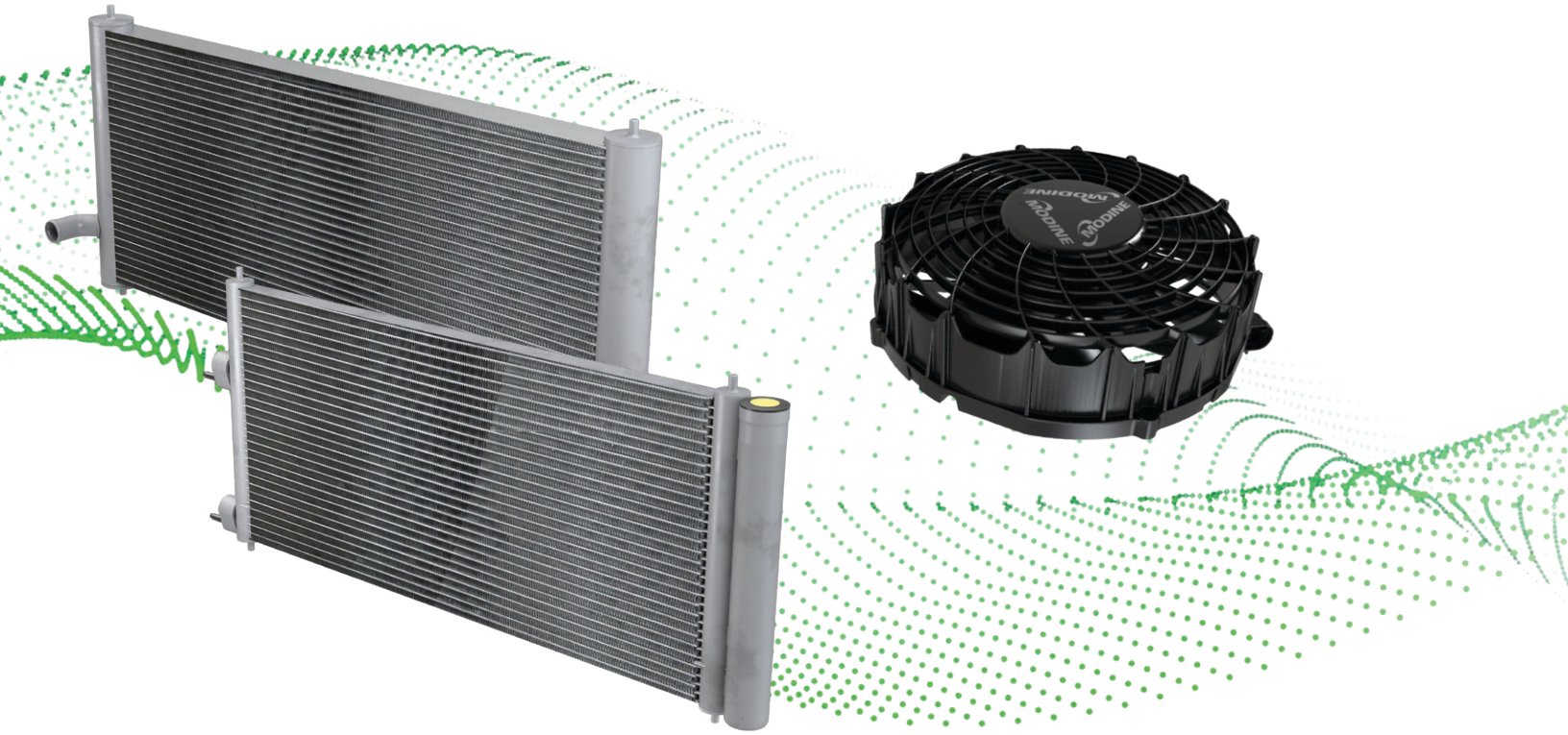
MODINE® SMART
ELECTRIC PRODUCTS

ENGINEERED FOR THE BEST PERFORMANCE

The EVantage™ thermal systems utilize vehicle-grade, ruggedized electric products to ensure a long life in harsh environments. Designed for the demands of commercial vehicles, Modine's proprietary smart electric products minimize power draw and maximize overall system efficiency and uptime. All products offer CAN bus control, at least a 30,000-hour life and are fully sealed to an IP68 rating or higher.

Available Electric Products:

- Variable speed, scroll compressor
- Brushless pumps
- Brushless fans
- Multi-way valves
- Compact heater



INTELLIGENT CONTROL SOFTWARE

MAXIMIZE PERFORMANCE AND MINIMIZE POWER DRAW

Every EVantage™ thermal system includes a master controller and controls firmware to seamlessly integrate the system into the vehicle's control network. Modine® has developed a proven library of control algorithms to enable rapid, low risk development of firmware for a BTMS or ECP unit. The Modine controls firmware supports both fully automatic operation in which all components in the system are set based on readings from temperature and pressure sensors throughout the system, to full manual operation in which the vehicle's control software sets critical parameters such as fan speed, valve settings and more. Each active component (compressor, heater, pump, valve, fan) has independent, variable control to optimize heating/cooling and power draw, whether in AUTO or MANUAL mode. With over 5 years of firmware development, testing and lessons learned, Modine's controls team can expedite your time to market for a wide variety of EV thermal management applications.

MAINTENANCE AND DIAGNOSTICS SOFTWARE

REAL-TIME INFORMATION TO OPTIMIZE PERFORMANCE

Modine's EVantage™ Universal Maintenance and Diagnostic Software provides the ability to download DM1/DM2 Diagnostic Message data logs, monitor status, monitor system response in real time, troubleshoot any potential problems, and offers a manual mode option which allows individual override control of all the major components (fans, pumps, heater, compressor, valve). EVantage Universal Maintenance and Diagnostic Software can be integrated with any telematics solution for monitoring on the road. When a repair is needed, the EVantage software makes it easy to find where the failure occurred.

LEADING THERMAL MANAGEMENT SINCE 1916.

We design, manufacture, and test heat transfer products for a wide variety of applications and markets. We're at work in practically every corner of the world, delivering the solutions our customers need, where they need them.

Since the beginning, Modine has been applying our thermal management expertise to the automotive industry. Every day, our EVantage™ Thermal Systems team is delivering solutions to the critical thermal issues created by the transition to e-Mobility, pushing the boundaries of technology to solve the toughest problems.

Together with our customers, we are committed to driving a cleaner future.

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