HYDAC INTERNATIONAL

Solutions for electrifying mobile machines

EN 10.172.0/12.23

The future of mobility. Experience it today.

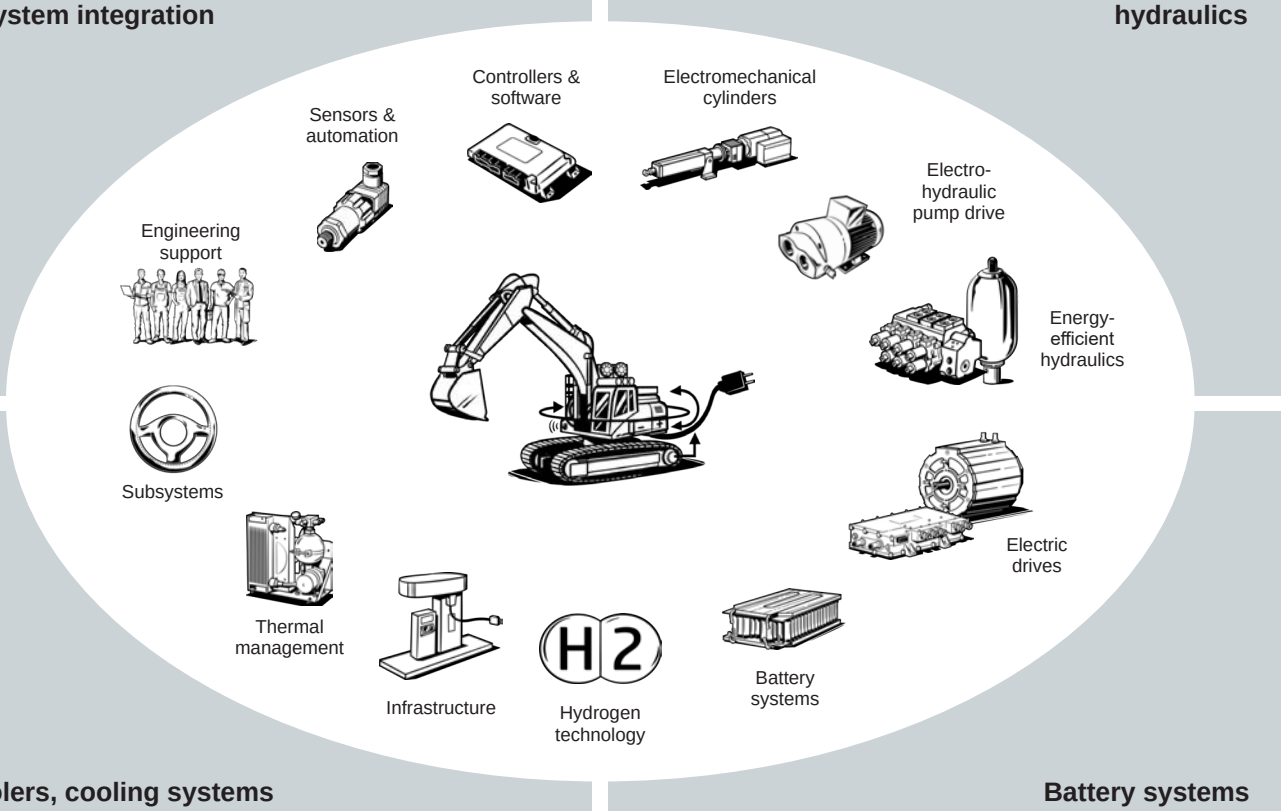
From the component to the system solution: our holistic approach

HYDAC has mastered the system architecture of the electric machine. We are your **capable development partner** thanks to our expertise in all the key fields – from batteries, software and thermal management to electric drives and energy-efficient hydraulics – as well as our product portfolio that has already been proven in use.

We work with you to evaluate your challenges and offer you needs-based solutions that will prove themselves both today and in the future.

Control technology, software & system integration

Energy-efficient hydraulics



Coolers, cooling systems & thermal management

Battery systems & electric drive technology

Save development time!

With HYDAC's pre-validated electrification solutions.

Contact us now!

E-mail: e-mobility@hydac.com

Web: www.hydac.com

Our solutions for electrifying mobile machines

HYDAC offers the best of both worlds. With over 60 years of expertise as a fluid technology, hydraulics and electronics company and the dynamism of a start-up, we devote our energies to the technologies of the future. From hydrogen applications to the electrification of mobile machines – we draw on our decades of experience and comprehensive understanding of machine architectures to create our innovations.

Control technology, software and system integration

Our answer to increasing complexity: standardisation and modularisation.

1

Electric drive technology

Traction drive motor or hydraulic drive set, our solutions have proven their worth in the field for years.

2

Battery systems

Turnkey: we supply your complete battery system for the off-highway sector.

3

Thermal management

Solutions for electric machines – customised to suit your individual requirements.

4

Energy-efficient work functions

Optimise your machine’s efficiency. We know what levers to pull to enhance efficiency.

5

Hydrogen applications

We are by your side as experts in alternative energy sources.

6

1

Control technology, software and system integration

Electrification leads to an additional increase in the complexity of mobile machine system architectures. In particular, the number of communication interfaces between the components poses further challenges. The demands are even higher when it comes to designing or integrating systems. With expertise in the fields of functional and electrical safety, we're your perfect partner for software and systems development. In this respect, we rely on three pillars: control technology, software and system integration.

Control technology made easy

Safety-certified control units

Designed for harsh conditions, the TTControl controller range is suitable for the challenging areas of use encountered in off-highway applications.

- Functional safety according to ISO 26262, EN ISO 13849, ISO 25119, ISO 19014
- Maximum flexibility in machine development
- Support for multitasking and object-oriented programming
- Up to seven CAN bus connections in one controller
- Easy and fast code reusability within all products
- Full product lifecycle support and secure libraries via the MATCH software suite

Get started with the cloud

Connect your machine to the TTConnect Cloud Service platform using our TTConnect Wave IoT gateway.

This allows you to:

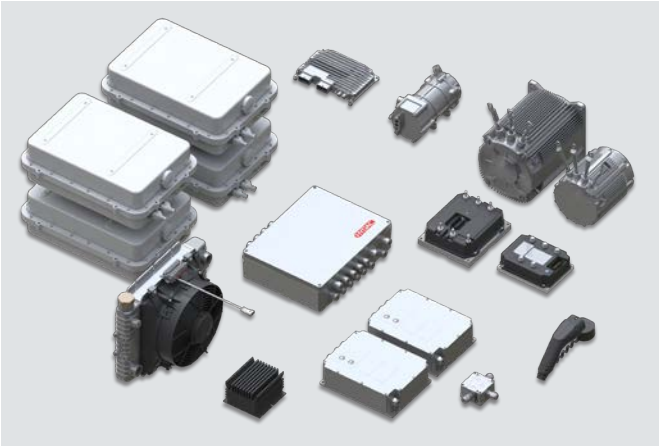
- collect and analyse machine data to enhance efficiency and cut costs
- operate with complete machine management
- configure your dashboard easily and intuitively
- update your fleet with the touch of a button
- customise the portal with your colours and logos to match your corporate identity

Innovative hardware solutions from TTControl

TTControl – a joint venture established by the TTTech Group and HYDAC International – provides control systems and operator interfaces for mobile machinery and off-highway vehicles. Being leaders in functional safety, TTControl's software and hardware platforms enable equipment manufacturers to develop highly reliable electronic control systems quickly and economically.

A holistic approach: HYDAC electrification kits

Save precious time during development with our 48 V standard system



Power distribution unit included

Pre-validated systems reduce complexity – so you save even more time when developing your electrified machine. This is why we offer holistic electrification kits.

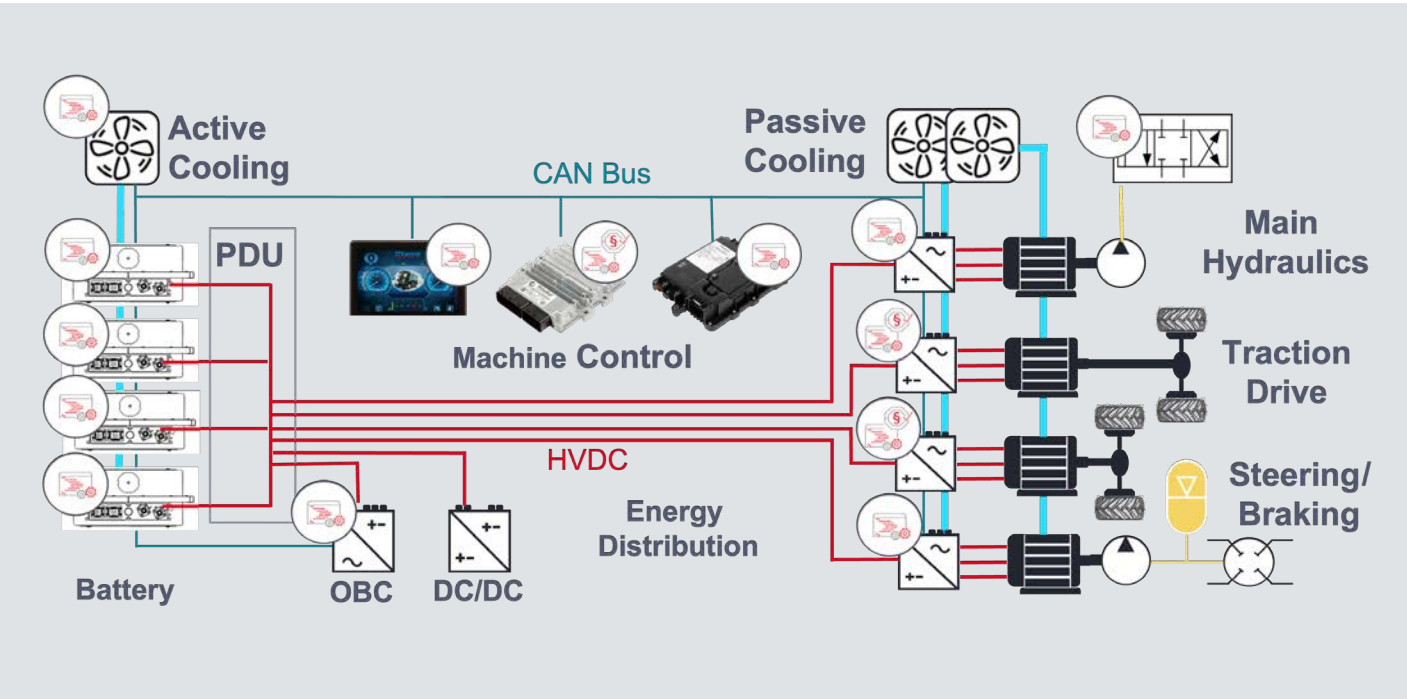
In addition to a uniform diagnostic interface, the overall solution provides all the basic functions.

Scope:

- Modular battery pack up to 25 kWh
- Up to two electric drive sets, e. g. for pump, fan, winch or traction drives
- AC charging up to 7 kW with EVSE functionality
- DC charging up to 12 kW (with off-board charger)
- Power distribution unit
- ECU with energy and power management and diagnostic interface

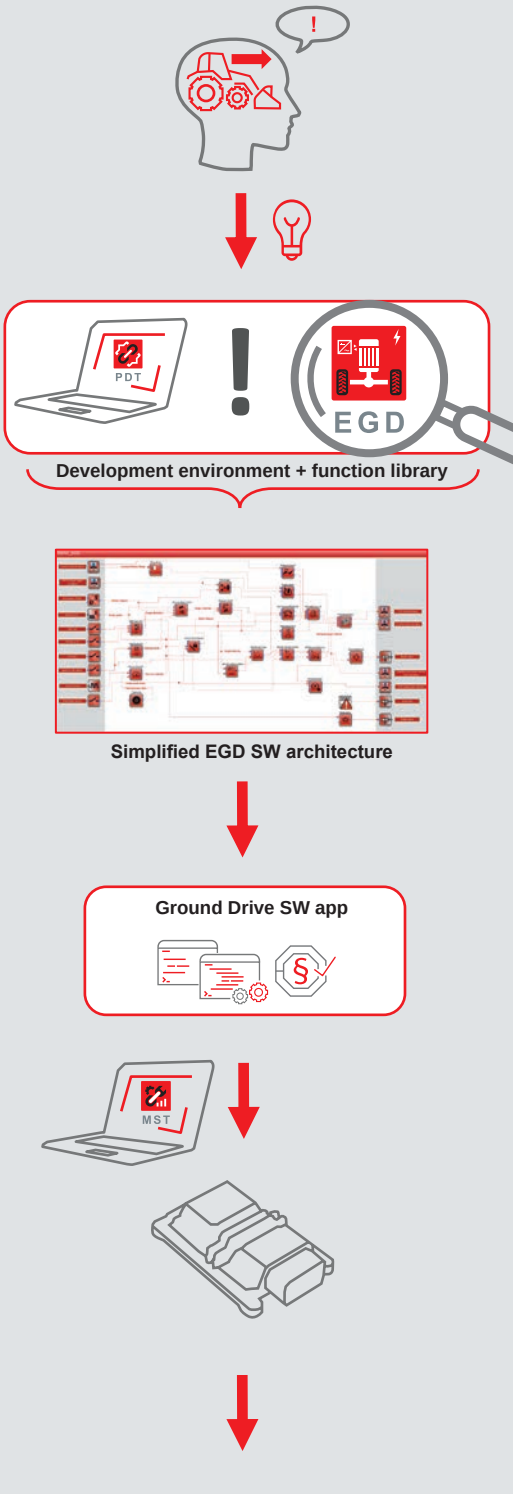
The requirements that complex system architectures are expected to meet are high

The architecture of electrified machines is highly complex. What counts in particular here is all the components and their interfaces interacting in the best possible way. The demands are even higher when it comes to designing or integrating systems.



From the problem to the solution:

Example toolbox workflow using EGD



Overview of the HYDAC toolbox development:

TOOLBOX

Reducing complexity with modular function libraries and component drivers
Would you like to develop your very own software and shorten the development period at the same time? Rely on HYDAC's know-how. Our tested, certified and documented libraries simplify your software development activities.

EGD EVM BTM VTM HGD

In detail: electric traction drive control

Find your ideal solution the quick and easy way with our EGD (electric ground drive) toolbox

Velocity Pedal Scaler and Limiter:
Interpretation of the driver's wishes and mode-dependent scaling or limitation

RekuStager:
Increase or decrease the recuperation rate

AutoParkBrake and HillHold:
Prevents rolling away and makes starting on slopes easier

WheelSlipControl:
Wheel speed monitoring and wheelspin reduction during acceleration and deceleration

InverterDriver:
With our component drivers, the inverter can be controlled within a short space of time

SpeedModeTorque:
Torque limitation depending on the speed, operating mode and drive situation

And many more modular library modules with additional functions for your traction drive control.

2

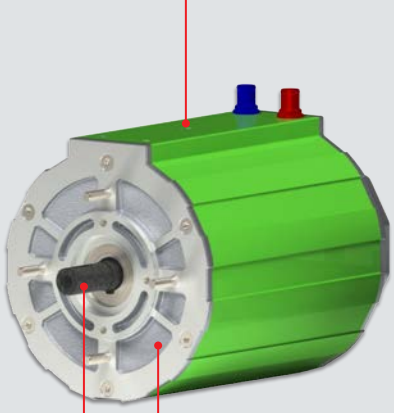
Electric drive technology

HYDAC overcomes your challenges by drawing on its expertise in the best possible system design. Our components have been proving themselves in use since 2018. With several thousand drives in the field, you benefit from our proven application experience, high quality and modular design. In addition to series motors, we also offer complete drive sets consisting of an electric motor, a perfectly matched inverter and a matching cable harness.

Modular drive systems, tailored to your requirements

Proven in use since 2018: our powerful motors

Mobile machines are just as diverse as the requirements they have to meet. That's why we focus on designing our motors to be application-specific and modular – so you use precious energy in the right place.



Cooling jacket
- Air-cooled
- Water-cooled

Winding
- Windings for 48 V, 96 V, 400 V, 800 V
- Variants for different nominal speeds

Mounting flange
- SAE pump flanges in different sizes
- Gearbox flanges

Shaft
- Keyed shaft
- Hollow shaft for SAE pump connection
- Splined shaft

ENGIRO: the HYDAC Group's drive specialist

ENGIRO
HYDAC INTERNATIONAL

Founded in Aachen in 2010 and part of the HYDAC group of companies since January 2022, ENGIRO develops and produces electric drive solutions for mobile applications. The company has a large portfolio of highly efficient electric motors and generators with high power and torque densities and a robust design in the range of 5 – 400 kW drive power in voltage ranges from 48 V to 800 V.

In detail: drive sets

Save precious time and use turnkey sets

We test and parameterise all the sets on our very own test benches and deliver them with a complete parameter set. They are immediately ready for use following installation in the application. Speed and torque ramps can be adapted in this regard to suit customer requirements.

48 V hydraulic set

14 kW drive unit for hydraulic applications

Special features

- PM synchronous motor with integrated magnets
- 48 V frequency inverter or motor control with CAN interface
- Full torque at zero speed
- Air-cooled
- Standardised, but adaptable in a modular manner

800 V hydraulic set

96 kW drive unit for hydraulic applications

Special features

- PM synchronous motor with integrated magnets
- 800 V frequency inverter or motor control with CAN interface
- Water-cooled
- Screw flange on the shaft enables flexible drive adjustment
- Flange adapter for SAE-2, SAE-3 and SAE-4 available
- Double shaft end with screw flange possible

700 V traction set

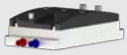
260 kW drive unit for traction applications

Special features

- PM synchronous motor with integrated magnets
- 800 V frequency inverter or motor control with CAN interface
- Water-cooled
- Full torque at zero speed (3650 Nm)
- External splined shaft according to DIN 5480
- Flange prepared for SAE-3 adapter

In addition to these examples, we supply many other turnkey drive sets and motor controller sets. Contact us now to find your custom-fit drive solution.

The right motor / converter combination for your application

			 				 			
	Voltage		**48 V**				**96 V**			
	Length Code	M_{nom} in Nm	P_{nom} in kW				P_{nom} in kW			
			2000 rpm	4000 rpm	6000 rpm	8000 rpm	2000 rpm	4000 rpm	6000 rpm	8000 rpm
159 AH	06	20	4	9	13	13	4	9	13	18
205 A	04	35	7	12	11	6	7	14	18	20
	08	61	13	13	–	–	13	27	28	20
	12	83	14	6	–	–	17	33	26	5
205 W	04	39	8	12	10	6	8	14	19	21
	08	75	15	15	10	–	16	31	31	27
	12	125	–	–	–	–	25	27	16	–
260 W	08	220	–	–	–	–	35	27	5	–

			 				 			
	Voltage		**400 V**				**800 V**			
	Length Code	M_{nom} in Nm	P_{nom} in kW				P_{nom} in kW			
			2000 rpm	4000 rpm	6000 rpm	8000 rpm	2000 rpm	4000 rpm	6000 rpm	8000 rpm
205 W	08	80	16	31	42	52	16	31	50	54
	12	125	26	44	57	64	26	44	57	64
	16	170	40	78	107	133	36	78	110	131
260 W	10	245	58	100	93	–	58	100	125	–
	20	520	–	–	–	–	113	206	253	–
	28	880	–	–	–	–	184	350	408	–

3

Battery systems

The battery is the heart of the electrified machine. The requirements here are particularly high – the contacting and cooling in particular are challenging for manufacturers and developers. But there are innovative solutions. INVENOX battery systems rely on simply clamping the cells between printed circuit boards which means they completely do without costly welded joints. Another advantage is that Fantastium – the special contacting material – dampens vibrations and provides greater stability.

Our patented technology

Benefit from the unique advantages of the INVENOX system

Cylindrical cell in conventional systems		Cylindrical cell in the INVENOX system
Welds as potential weak points	Increased safety level →	Damping of vibrations due to the Fantastium contact material ✓
Effective cooling is challenging	More efficient systems with more power →	Powerful cooling through pole contacts ✓
Welded and bonded cells have "irreversible connections"	Optimised for service, reuse and recycling →	Reversible modular design ✓

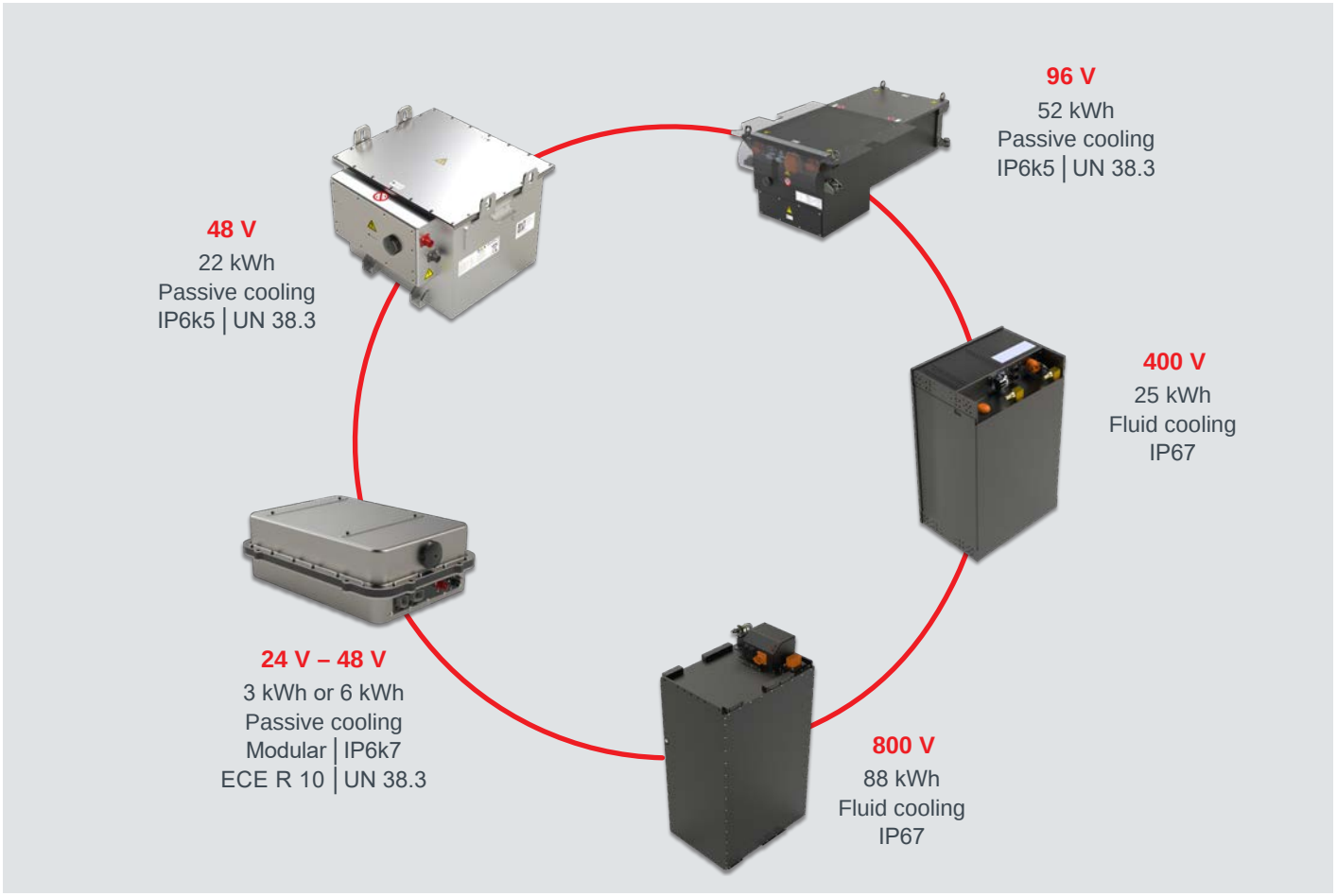
Advanced battery systems as part of the HYDAC Group

INVENOX ADVANCED BATTERIES

Established in 2014, INVENOX develops advanced battery systems. In addition to high-quality lithium-ion energy storage systems, the company provides comprehensive support in both pre-series and series product development, not to mention data management and the associated testing. With their compact design, the systems are ideally suited to mobile machines. With an integrated BMS and PDU, the energy specialist supplies complete turnkey systems.

At a glance:
get to know our portfolio

Modular and versatile: Thanks to the battery modules' modular design, you have access to a wide range of INVENOX systems in different sizes – up to a voltage level of 800 V.



Choose the best for your machine's energy supply with INVENOX

Powerful: Achieve up to 40% more energy per vehicle. Thanks to the modular design, we can find the perfect solution for almost any application.

Robust: Our flexible contacting material ensures that the cells are installed in a vibration-resistant manner. And without sacrificing efficiency. The highly thermally and electrically conductive material enables perfect performance.

Flexible: One design, multiple possibilities – we offer you high-energy or high-performance cells in an ideal design. If required, various cooling options are available for each module. Whether they are air-cooled or fluid-cooled.

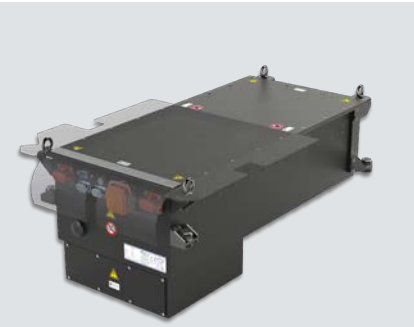
Robust battery systems – perfectly suited to mobile applications

Product range: 24 / 48 / 96 V lithium-ion battery system

24 V / 48 V

Technical details

- Multi-master function
- Voltage range from 18 – 30 V or 35 – 59 V
- Discharge current continuous 120 A
- Discharge current peak 350 A (10 s)
- Charging current up to 80 A
- Integrated electric heating
- Passive cooling via stainless steel housing
- IP 6k7 protection class



96 V

Special features

Benefit from a robust and sealed housing and an integrated BMS. Our patented cell contacting system enables an extremely compact design. Specifically designed for mobile applications, the 24 V, 48 V and 96 V solutions offer high performance and durability combined with easy installation.

400 V lithium-ion standard module

Technical details

- Multi-master function
- Expandable up to 150 kWh with six submodules
- Voltage range from 240 V to 403 V
- Discharge current continuous 100 A
- Discharge current peak 150 A (10 s)
- Charging current up to 25 A
- IP 6k7 protection class
- Integrated PDU with 1x HV intermediate circuit, 2x precharger, 1x post-discharger, current sensor, main fuse, insulation monitor

Special features

With fluid cooling and an integrated power distribution unit. The standardised 400 V battery system benefits from a robust and compact design thanks to our patented cell bonding process. At the same time, the system is easy to install with high performance and durability.

4

Thermal management

Needs-based thermal management forms the foundation of the electrified machine – because intelligent systems offer greater convenience, range and productivity. With a high level of system understanding for your vehicle, HYDAC offers you holistic thermal management solutions for electric drive components – tailored to suit your individual require-ments.

Cooling systems in electric machines are demanding

The interaction between the heat emitted and the heat required in mobile machines is more complex than ever before. An electrified machine's heat balance is fundamentally different from that of an internal combustion engine.

The need for thermal management solutions in electrified machines is increasing

	Diesel engine	Transmission	Working hydraulics	Driver's cab	Battery	E-motor + converter	Onboard charger	Operating temperature
Conventional drive	❄	❄	❄	❄ ♨				~ 105 °C
Electric machine		❄	❄	❄ ♨	❄ ♨	❄	❄	25 – 85 °C

Whether it's summer or winter: thermal management is the key to efficiency in electric machines

A coordinated system ensures maximum efficiency – regardless of the ambient temperature. This is because dissipating heat to protect the components and using it efficiently for air conditioning purposes is an important part of the discipline.

Winter

Passive battery cooling –
energy-saving method

Heating the driver's cab
with waste heat from the hydraulics and the electric drives

Cooling the electric motor and converter
with a speed-controlled air cooler

Summer

Active battery cooling
to keep the temperature in the ideal temperature range

Air conditioning in the driver's cab
with a battery thermal management system

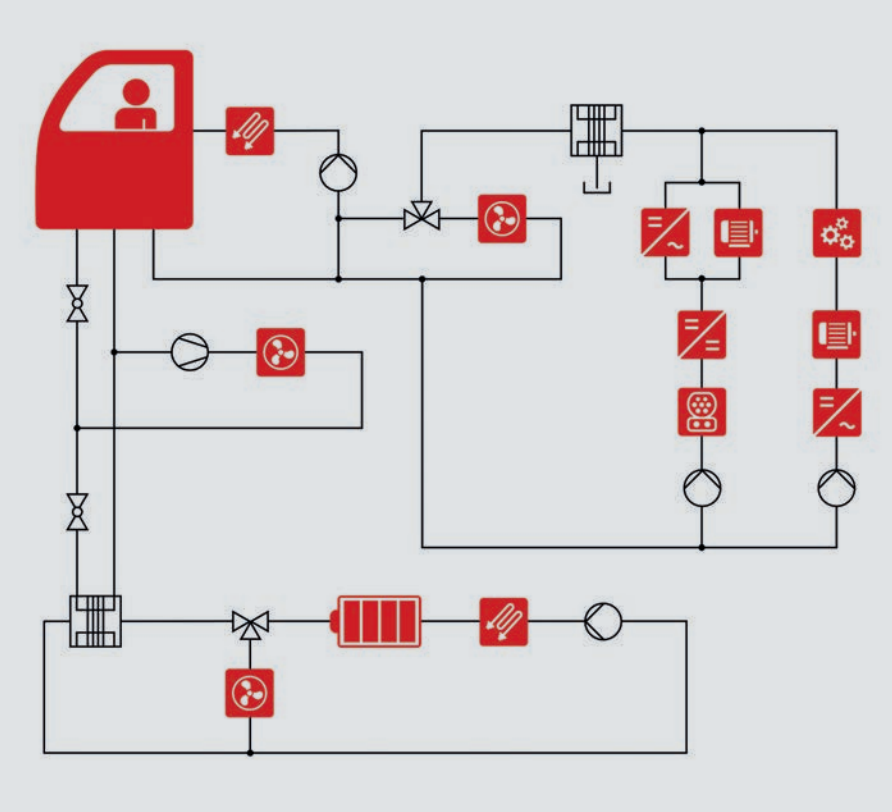
Cooling the electric motor and converter
with a speed-controlled air cooler

Vehicle thermal management system (VTMS): your pre-validated complete solution

Make the design and selection of high-voltage components as cost-effective as possible: Our holistic approach offers a VTMS designed for your machine.

The interaction of cooling and refrigerant circuits coordinates energy storage, power electronics and traction drives and working drives and keeps them within an optimal operating window for your application. The accompanying diagram shows an example of the tasks mentioned.

Compared with conventional combustion technology, the high efficiencies of the high-voltage components don't generate sufficient power losses to heat the machine's cabin. The existing heat flows must therefore be conducted efficiently and supplemented by fast-response components.

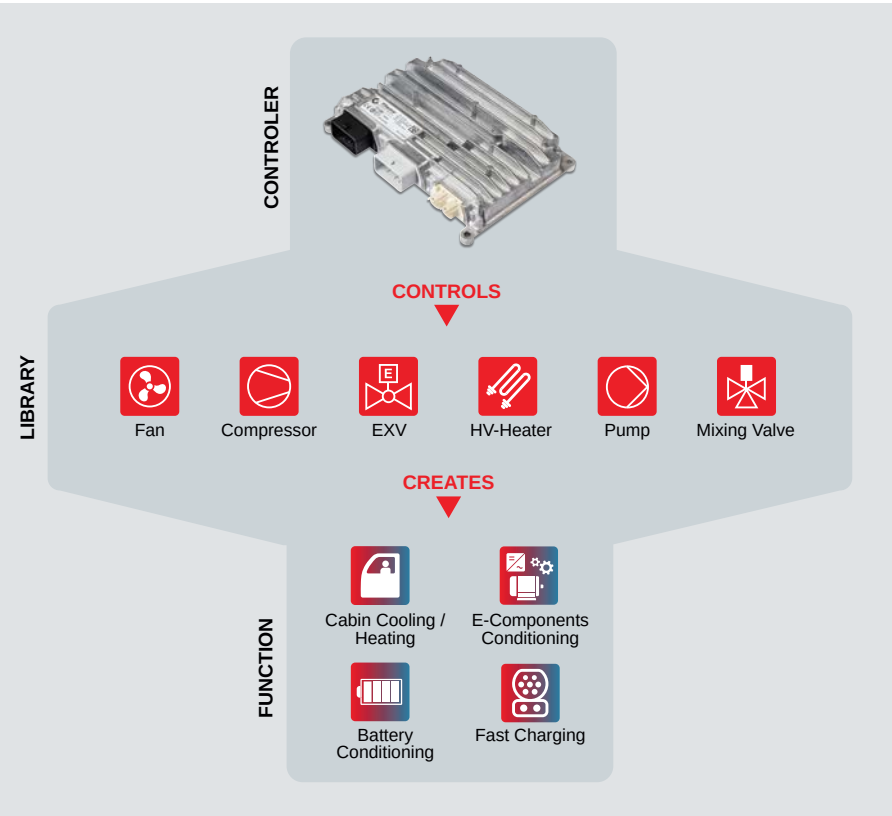


The right cooling strategy for your system

Depending on the particular requirements, the energy storage system can be kept at the right temperature by the refrigerant circuit under ambient conditions or even by passive cooling. We search for and find the cooling strategy that fits your system best and implement it.

Your smart thermal management system

The implementation of the appropriate logic ensures that the cooling and heating system becomes a smart thermal management system. The Electronic Control Unit interacts with the HYDAC Software component library to create the machine-specific TMS functions. By relying on pre-validated components from the MATCH Toolbox, you gain time and save costs.



In detail: robust cooling solutions

Whether it's a cooler, a cooling system or a custom development

BTMS – active battery thermal management system

Shock and vibration-resistant mobile chiller in a compact and highly integrated design

Our system ensures that the temperature of the battery remains in the optimal range. In addition, other functions can be integrated which heat or cool the driver's cab. A compact system for a controlled battery temperature and comfort in the passenger compartment.

- Stable battery performance with the best possible lifespan
- Standardised, but also adaptable and modular
- Validated E/E architecture based on modular software
- Allows fast battery charging

Passive cooling systems for motors, inverters & hydraulics

Mobile air coolers

AC-M series

Specifically designed for mobile applications where high performance is required in combination with a compact design and simple installation.

- DC motor
- Standard cooler
- Lightweight and compact, simple installation

Mobile fluid cooling system

FLKS-SC1

Our versatile fluid cooling systems deliver your cooling fluid at the right temperature and pressure for an efficient result.

- Cooling system
- Lightweight and compact
- Standard cooler

Custom cooler

CFT

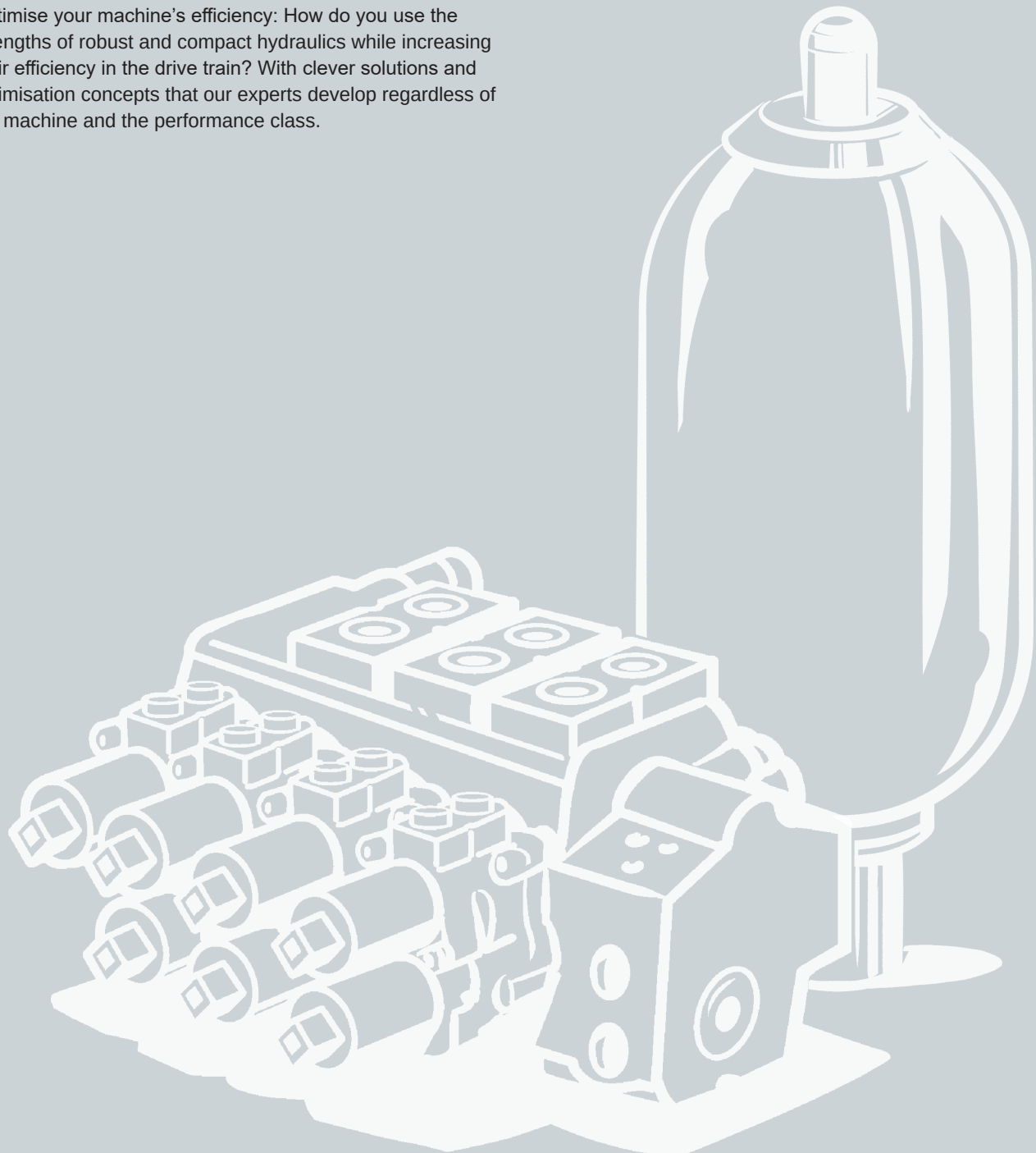
The HYDAC CFT was specially developed to meet the high demands encountered in mobile applications.

- Cooler filter tank
- Many functions integrated
- Weight optimisation and optimised in terms of installation space
- Individually tailored

5

Energy-efficient work functions

Optimise your machine’s efficiency: How do you use the strengths of robust and compact hydraulics while increasing their efficiency in the drive train? With clever solutions and optimisation concepts that our experts develop regardless of the machine and the performance class.



Optimised working hydraulics for greater energy efficiency

Discover the potential savings in your work functions. With decades of experience in component development, system development and application development, HYDAC has established itself as a reliable partner for efficient drive systems. Rely on our tried-and-tested products for your electrified machine – from the supply via adaptive main control and actuators to the complete system view.

Our approach to optimising your hydraulics

At a component level

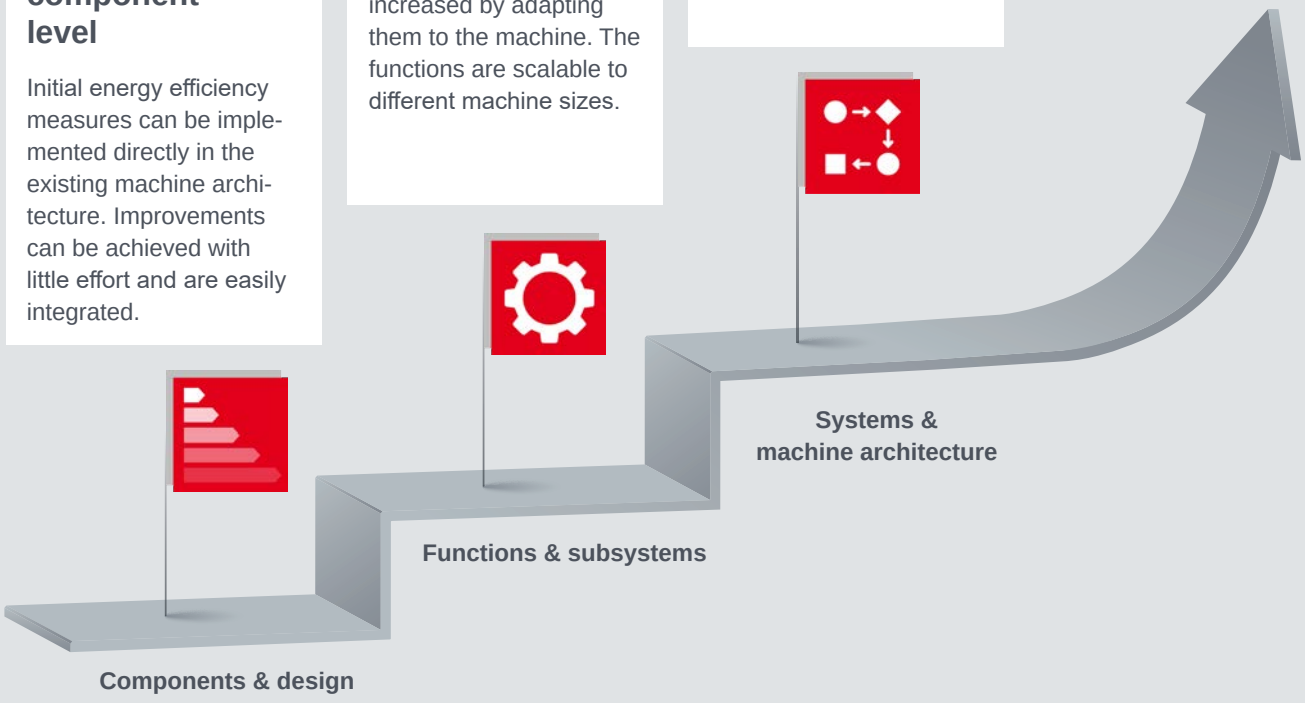
Initial energy efficiency measures can be implemented directly in the existing machine architecture. Improvements can be achieved with little effort and are easily integrated.

At a function level

With our pre-validated function modules, efficiency can be further increased by adapting them to the machine. The functions are scalable to different machine sizes.

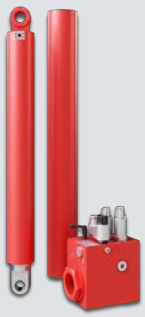
At a system level

Whether it's hydraulics or electromechanics, with our expertise in system architectures we're able to offer you ways to optimise your machine's efficiency.



Harness the potential

For greater energy efficiency in your mobile machine



Load compensation – to minimise dead loads

We offer components and individual solutions to efficiently minimise dead loads in your work functions.

HYDAC load compensation components

- SK series standard piston accumulators
- Customised load compensation cylinders
- Special blocks for individual function adaptation

Electric cylinders – for maximum efficiency

Find the ideal drive solution to meet the highest efficiency and eco footprint requirements in your linear work functions.

HEZ – HYDAC electric cylinders

- High efficiency > 80%
- Powerful up to 250 kN
- Simple commissioning and service (rental fleets)

Gravity – free energy

Find a wide range of electrical load holding valve solutions to lower your loads safely and without energy.

Electrohydraulic load holding blocks

- Standard blocks
- Special blocks for optimum adaptation to the installation situation and functionality
- Benefits of high-precision PWS cartridge technology
- Volume flow rates up to 200 l/min
- Load pressures up to 350 bar

Minimise dead loads

Recuperate energy

Use gravity

Smart complete power unit solutions – for efficient hydraulic circuit supply

We offer you a custom-fit and easy-to-install supply for your working hydraulics to keep potential primary losses as low as possible.
From classic power unit structures to intelligent supply units.

HYDAC standard modular power units

- Can be configured in a modular manner (controller, inverter, motor, pump, control block)
- Highly efficient IPM motor technology in combination with gear pumps (AZP/IZP)
- Pump combinations with a "low noise" and "torque control" option
- Rated power: 3 – 30 kW (other power levels on request)
- Pressure range: up to 250 (320) bar
- Voltage supply: 24 V to 400 V DC

Needs-based supply

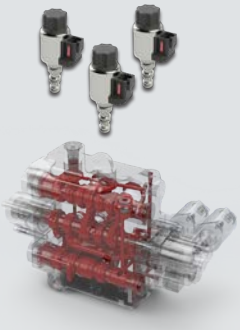
Adaptive pump solutions – to minimise the drive load

With custom adjustment options, we help you to make your drive as compact and efficient as possible.

HYDAC pumps

- Proportional torque adjustment with the PPV100M
- Discrete torque adjustment with the PGE104 (PGI)
- Equalisation (parallel functions) with the Multi PPV100M

Equalise the pressure level



Enhancing efficiency – the quick and easy way

Initial efficiency measures can be implemented directly in the existing machine architecture.

Pressure losses can be minimised with the help of innovative valve solutions and flow simulations and by optimising the design of existing hydraulic solutions.

Reduce pressure losses

LX-6

Load-sensing valves from the LX series – for minimum pressure losses with maximum compactness

With the load-sensing valves from the LX series, pressure losses are reduced by up to 50% compared to comparable valves in the performance class.

- Reduce flow losses in the valve with a uniquely compact design
- High stability and control quality
- Minimum load-sensing control margin as the basis for energy-efficient use
- Additional energy savings potential when using the ICU electromechanical motor control unit

6

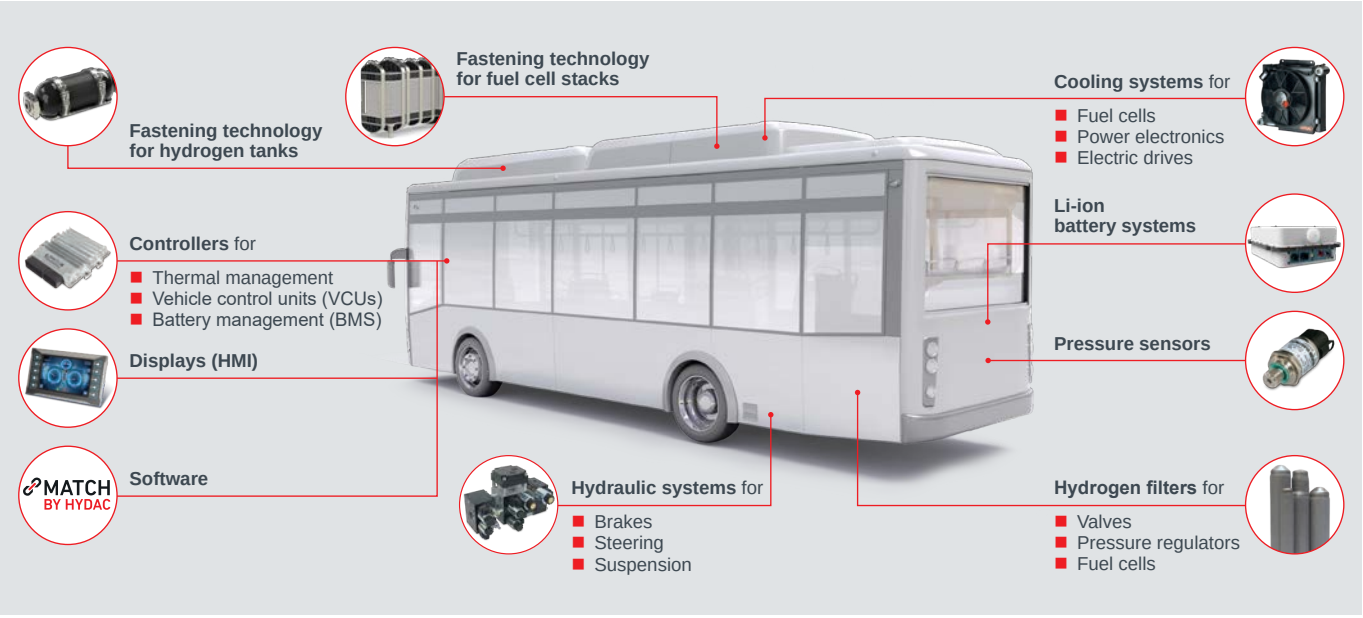
Hydrogen

We have a long way to go before all the questions on the topic of hydrogen have been answered. This is because the production, supply and use of hydrogen still pose challenges for companies. With HYDAC, you have an expert at your side who brings tried-and-tested products and years of industry expertise to the table as well as innovative solutions. From new developments to series production – HYDAC will help you to implement your project successfully.

Gain insights into our areas of expertise

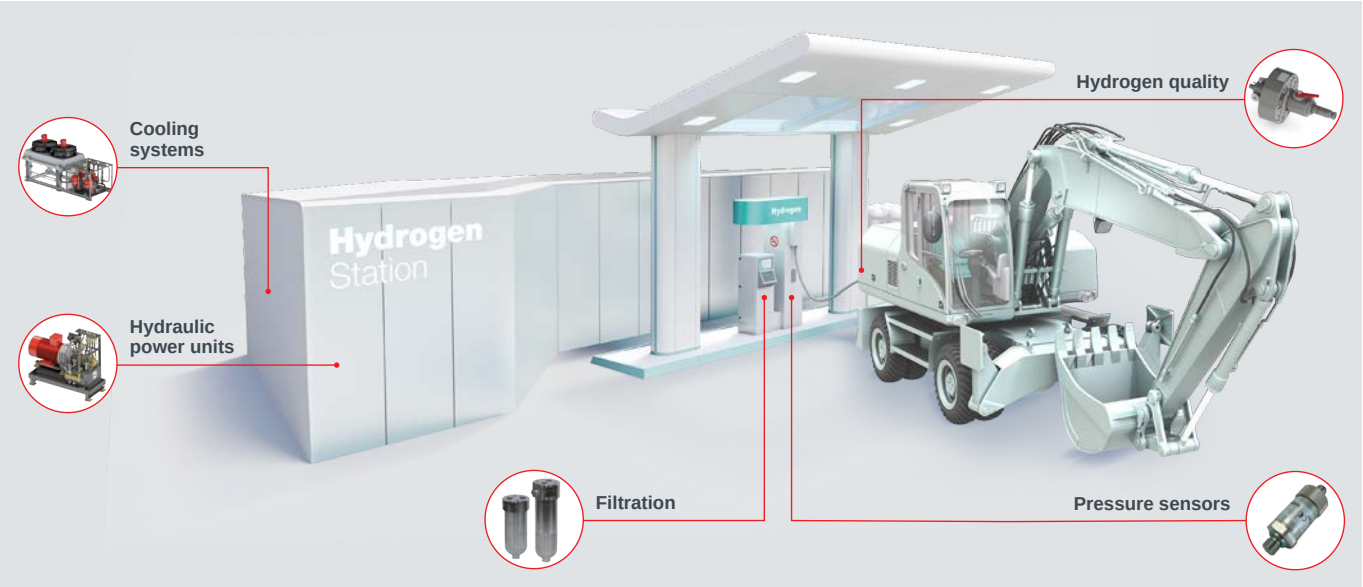
Fuel cell systems & hydrogen engines

As the technology of the future, fuel cells hold a lot of potential in mobile and industrial solutions. This is because hydrogen-powered trains and other emission-free transport technologies have been on the rise for some time. In order to operate these in a functionally safe and energy efficient way, we are already able to offer you an extensive product portfolio which we are constantly expanding.



Hydrogen refuelling infrastructure

Hydrogen is gaining in importance worldwide. The refuelling station infrastructure is constantly evolving and so are refuelling technologies in terms of availability, energy efficiency and costs. And HYDAC is right in the middle of it – we are constantly expanding our portfolio with new developments and innovations.



Fuel cell systems & hydrogen engines

Rely on alternative energy sources for your mobile machinery

Filter & separator technologies

Fuel cells react to the smallest particles and harmful gases – that's why our reliable filter and separator technologies are essential to protect the fuel cell from contamination.

- Extends service life
- Ensures high air & hydrogen quality
- Avoids breakdowns during operation
- Certified according to EC 79 / 2009

Fuel cell thermal management

Compared to combustion engines, almost 100 % of the heat energy is dissipated into the cooling water, which significantly increases the cooler surface area. As a result, cooling and thermal management systems become more complex – but HYDAC is by your side.

- Innovative solutions for complex cooling systems
- Development partner
- Broad standard product portfolio

Control technology

To operate fuel cell systems and tank systems in a functionally safe and energy efficient manner, a full understanding of current flows, material flows and information flows is required. With this understanding and our ability to develop complex software systems, HYDAC is in the position to offer customised control architectures.

- Extremely powerful controllers
- Functionally safe software architecture
- Customised controller architecture

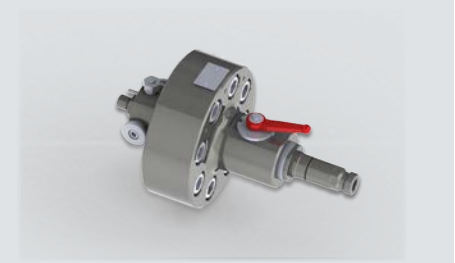
Hydrogen tank systems

Hydrogen is stored at 350 or 700 bar in carbon fibre tanks. Operation is enabled by “On-Tank-Valve” (OTV) multifunctional assemblies, together with fusible valves (TPRD) and pressure regulators. As a leading company, HYDAC offers customised solutions for your H2 tank system.

- Years of experience in assembling cylindrical pressurised gas tanks (CNG & FCEV) using flexible stainless steel bands & neck mount systems
- Pressure transmitters for high & low pressure applications (EC79-2009 certified)

Hydrogen refuelling infrastructure

Innovation and know-how: solutions for hydrogen refuelling stations



Particulate contamination / hydrogen gas cleanliness

Hydrogen is subject to high cleanliness requirements because particulate contamination causes system failures. As a long-standing expert in technical cleanliness, we offer the right products for maximum cleanliness.

- PSA-H70: Sampling of filling stations & evaluation of the particulate contamination load
- Complete gas filtration portfolio for low to high pressure ranges, suitable for particulate & liquid separation

Hydrogen cooling

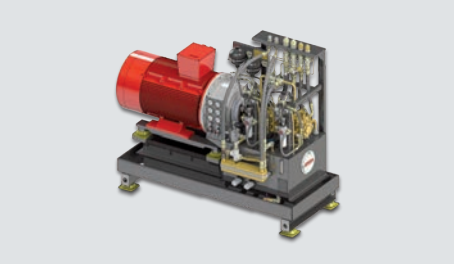
To cool compressor systems, we supply efficient cooling systems and heat exchangers tailored to your requirements. With our tried-and-tested standard products and tailor-made solutions, we offer an all-round package for hydrogen cooling.

- Customised solutions for compressor cooling
- Cooling systems for low temperature pre-cooling according to SAE J2601

Pressure sensors

The refuelling process at hydrogen stations is pressure controlled – which means reliable and safe sensor technology is required. HYDAC offers you a complete portfolio of pressure sensors specially developed for hydrogen applications.

- Hydrogen pressure sensors from low to high pressure ranges (16 – 1050 bar)
- Reliable, safe sensor technology
- ATEX and SIL2 certified



Drive technology for compressors (compressor systems)

The goal of many hydrogen compressor operators is fail-safe, energy efficient and resource-conserving operation.
We check whether a conventional or variable speed drive unit has the greatest possible savings potential for you.

- Conventional & variable speed drive units
- Continuous condition monitoring on request
- Oil analysis at the HYDAC FluidCareCenter on request

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Local Expertise.
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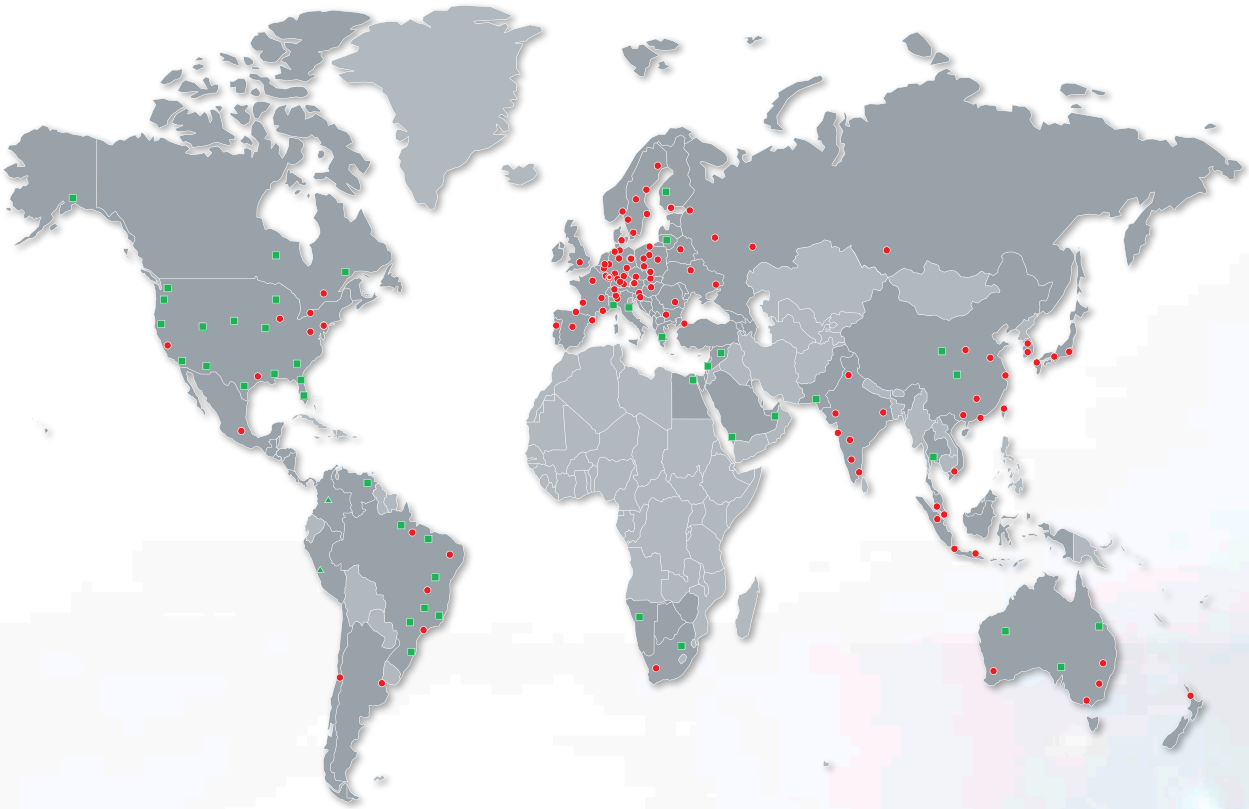

- HYDAC Head Office
- HYDAC Companies
- HYDAC Sales and Service Partners
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NOTE

The information in this brochure relates to the operating conditions and applications described.
For applications or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

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