THERMAL SYSTEMS

- › **HEAT PUMPS**

- › **ELECTRICAL HEATING AND AIR CONDITIONING SYSTEMS**

- › **HEATING AND AIR CONDITIONING SYSTEMS**

- › **BATTERY TEMPERATURE CONTROL**

- › **THERMAL MANAGEMENT**

- › **CONTROL UNITS FOR HEATING AND AIR CONDITIONING SYSTEMS**

- › **SOFTWARE AND BUS SYSTEMS**

- › **AIR CONDITIONING MODELS FOR HEATING AND AIR CONDITIONING SYSTEMS**

WÖLFLE
CLEVER. EFFICIENT. CREATIVE

🌡 HEAT PUMPS

EFFICIENT, SUSTAINABLE AND VERSATILE

E-mobility is redefining the requirements for heating and cooling vehicles. Another energy source must be found to heat rooms because there is no longer enough waste heat from the combustion engine available free of charge. A heat pump uses renewable energy (e.g. from the ambient air) to generate heat in an energy-efficient way. Depending on their efficiency, heat pumps require less than half the energy from the battery in comparison to vehicles without a heat pump. This improves the useful performance of the vehicle, while the reversible function of a heat pump also enables a cooling function. This allows cooling of the passenger compartment and battery in an energy-efficient way when needed, by releasing heat to the environment via the heat pump.

AN OVERVIEW OF SAMPLE SOLUTIONS

Our extract of implemented customer solutions will provide you with a brief overview of our range of services in the area of heat pumps:

01

HEAT PUMP TRACTOR

› Electrical compressor 750 VDC
› Integrated distribution valves
› MATLAB® based thermal management

02

HEAT PUMP ELECTRIC TRUCK

› Electrical compressor 400 VDC
› Aluminium water heat exchanger
› Fully comprehensive vibration decoupling

03

HEAT PUMP BUILDING SERVICES

› Electrical compressor 230 VAC
› Stainless steel water heat exchanger
› Production according to Pressure Equipment Directive 2014/68/EU

ASSEMBLY LINE HEAT PUMPS

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ELECTRICAL HEATING AND AIR CONDITIONING SYSTEMS

EFFICIENT, COMPACT AND PROGRESSIVE

Our solutions are produced specifically for electric vehicles. Fire resistance is especially important in this case. At Wölfle, we're also capable of limiting the blow-out temperature according to the machinery directive to maximum 60 degrees. In addition to electrical heaters, our portfolio also features electrical air conditioning systems. Our numerous years of experience in this area make these products especially low-consumption, since they feature a particularly high degree of efficiency in relation to industry-standard systems. The heating and cooling processes are optimally controlled and always oriented according to the specified battery benchmark values.

AN OVERVIEW OF SAMPLE SOLUTIONS

Our extract of implemented customer solutions will provide you with a brief overview of our range of services in the area of electrical heating and air conditioning systems:

01

ELECTRICAL HEATING FORKLIFT

› Shock and vibration resistant PA6 plastic housing with air distributor
› PWM control of the PTC heating element with sensor-based temperature monitoring
› Voltage ranges from 12 to 850 VDC

02

ELECTRICAL HEATING AND AIR CONDITIONING SYSTEM TRANSPORTER

› Metal housing with PA6 air distributor
› Integrated CAN-Bus control with temperature monitoring
› Microchannel aluminium evaporator

03

ELECTRICAL HEATING AND AIR CONDITIONING SYSTEM MOBILE CRANE

› Weight-reduced aluminium housing
› MATLAB® based automatic air conditioning
› Electrical compressor and PTC heater 440 VAC/230 VAC

ASSEMBLY LINE ELECTRICAL HEATING/AIR CONDITIONING SYSTEMS

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HEATING AND AIR CONDITIONING SYSTEMS

HIGH-POWER, LOW-NOISE AND APPLICATION-OPTIMISED

The different systems have a significant influence on the comfort in the driver's cabin. To ensure the best working conditions for the driver, Wölfle designs solutions that are suited to match their application locations and the environmental conditions. In addition to the ideal temperature level, the systems also ensure the best-possible air distribution in the interior space of the vehicle. Individual components and complete systems are laid out and calculated using our simulation software. In this way, we already take consideration of various optimisation options during the construction phase.

AN OVERVIEW OF SAMPLE SOLUTIONS

Our extract of implemented customer solutions will provide you with a brief overview of our range of services in the area of heating and air conditioning systems:

01

HEATING AND AIR CONDITIONING SYSTEM FORKLIFT

› Scope of delivery with cladding parts and PUR sound insulation
› Shock and vibration resistant PA6 plastic housing with air distributor
› LIN-Bus control unit

02

HEATING AND AIR CONDITIONING SYSTEM EXCAVATOR

› Integrated control unit with customised CAN-Bus
› MATLAB® based automatic air conditioning
› Housing consisting of expanded polypropylene (EPP)

03

HEATING AND AIR CONDITIONING SYSTEM MOBILE CRANE

› Stainless steel housing
› Customised actuators for long-term availability
› MATLAB® based automatic air conditioning

04

FRONTBOX BUS

› Housing in mix of stainless steel and aluminium
› Electrical and mechanical controls
› Modular air distribution

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🌡 BATTERY TEMPERATURE CONTROL

DURABLE, RELIABLE AND SAFE

The central component of electric vehicles is the battery. The battery supplies the energy for all vehicle functions. Optimum functionality and the lifetime of a battery are heavily dependent on the temperature range in which the battery is operated. Battery cooling is also an important challenge during the charging process. The Wölfle control system integrated in our heating and cooling systems enables a constant temperature of the installed batteries or components in all functional positions and therefore significantly increases the service life.

AN OVERVIEW OF SAMPLE SOLUTIONS

Our extract of implemented customer solutions will provide you with a brief overview of our range of services in the area of battery temperature control:

01

**BATTERY COOLING
BUS**

› Corrosion-proof metal housing
› Electrical compressor 400 VDC
› Integrated CAN-Bus control

02

**BATTERY COOLING
FIRE ENGINE**

› Customised modular construction
› Integrated pump and valve unit
› Optional PTC water heater 850 VDC

03

**HEAT PUMP AND BATTERY TEMPERA-
TURE CONTROL
SPECIAL VEHICLE**

› Efficient cooling and heating
› Electrical compressor 850 VDC
› CAN-Bus

ASSEMBLY LINE HEATING/AIR CONDITIONING SYSTEM

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THERMAL MANAGEMENT

INTELLIGENT, ADAPTABLE AND ENERGY-EFFICIENT

Thermal management in the vehicle is generally understood to mean the control of energy flows. Although thermal management is not a new requirement, the topic is gaining new and heightened attention due to electromobility, because the requirements for electric vehicles are more complex. Other heat sources and sinks arise here – such as the battery, which have very different requirements for the system. Wölfle optimises the energy balance by optimally distributing and adjusting the heat flows in the vehicle. Our system expertise - founded on model-based control systems and the simulation of thermal functions in the vehicle - enables us to react with flexibility to customer-specific requirements. An optimum thermal system enhances the economy and comfort of your vehicle.

LAB TEST BENCH TEST AND VALIDATION CENTRE

EXAMPLE OF THERMAL MANAGEMENT APPLICATION


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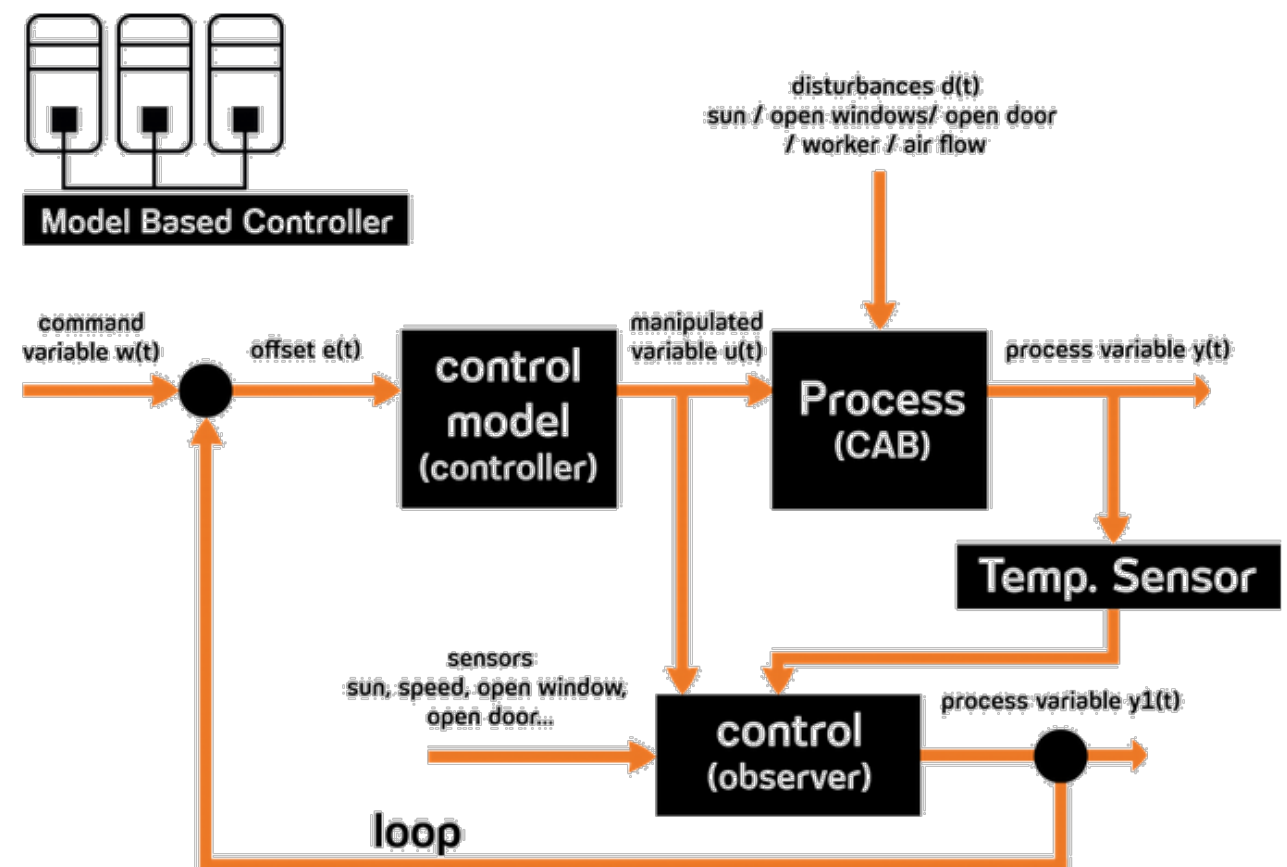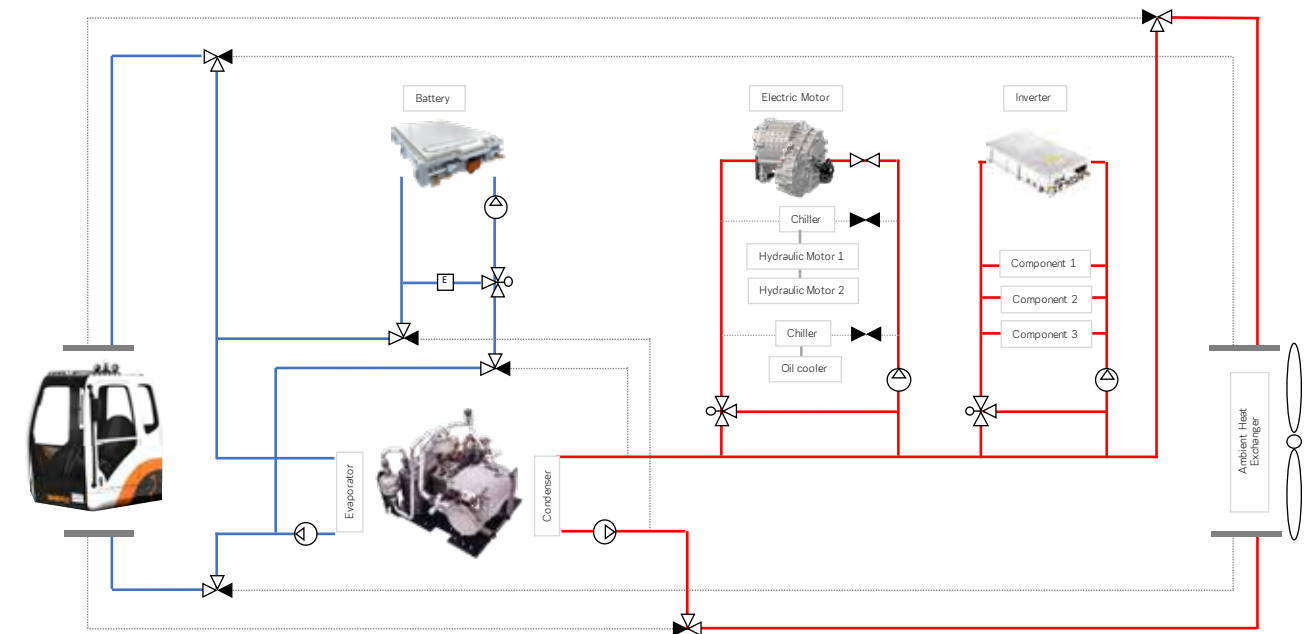
CONTROL UNITS FOR HEATING AND AIR CONDITIONING SYSTEMS

INTELLIGENT, USER-FRIENDLY, AND IDEALLY MATCHED

The challenge with any development is to design highly complex systems as easily as possible. The solution to this problem is controls from Wölfle. We always apply the best solutions, to design the controls to be as simple as possible. This produces intelligent and reliable control units that are pleasant to the touch.
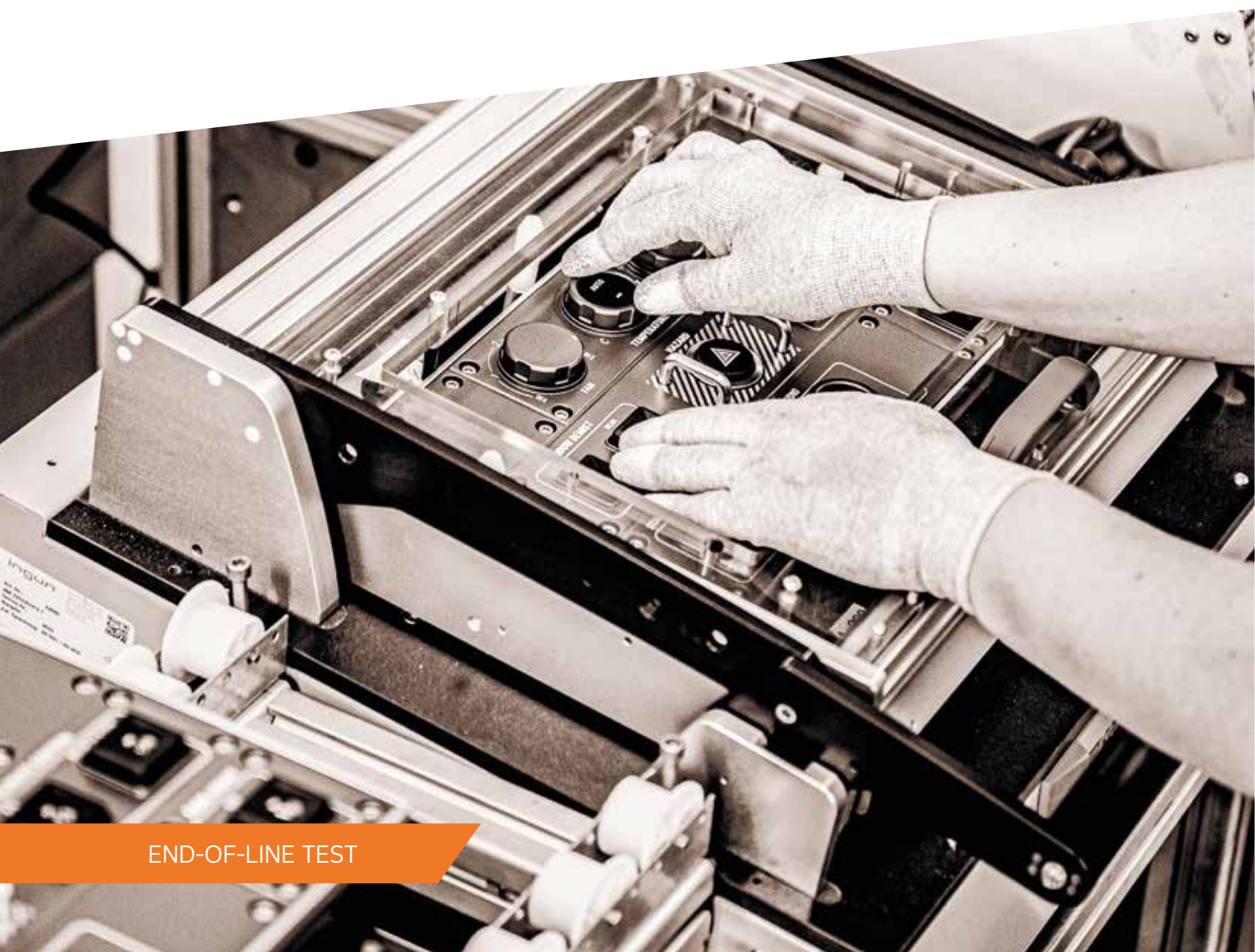
AN OVERVIEW OF SAMPLE SOLUTIONS

Our extract of implemented customer solutions will provide you with a brief overview of our range of services in the area of control units:

01

CENTER STACK OPERATING SYSTEM CAR

› Front end painted, printed, lasered and metallised
› Integrated CAN-Bus control (AUTO-SAR® 4.3 with CS)
› MATLAB® based automatic air conditioning

02

CONTROL UNIT CAR

› Front end painted, printed, lasered and metallised
› Integrated CAN-Bus control (OSEK NM)
› PID temperature controller

03

OPERATING UNIT MOBILE CRANE

› Function and backlighting with Light Guide technology
› Integrated control unit with customised CAN-Bus
› Aluminium panel with customised display

04

OPERATING UNIT FORKLIFT

› Front end painted, printed and lasered
› Customised function and backlighting
› Integrated LIN-Bus control

END-OF-LINE TEST

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AIR CONDITIONING MODEL FOR HEATING AND AIR CONDITIONING SYSTEMS

INNOVATIVE, UNIQUE, AND CONVENIENT

The demands placed on a comfortable driver's workplace are constantly increasing, which is why plants geared for the future rely on model-based control systems. These are calculated and pre-configured with the help of simulation programs (MATLAB®).

Our model involves a mathematical image of the complete system, which consists of heating and air conditioning systems, the cabin, and the periphery. The advantage is that the interior temperature does not need to be permanently measured like with a classic control system. The air conditioning model is able to calculate the interior temperature depending on the precisely measurable ambient conditions. Temperature changes due to sunlight or opening doors can be compensated without the driver feeling anything in the interior space.

CONTROL SIMULATION WITH DEMONSTRATOR
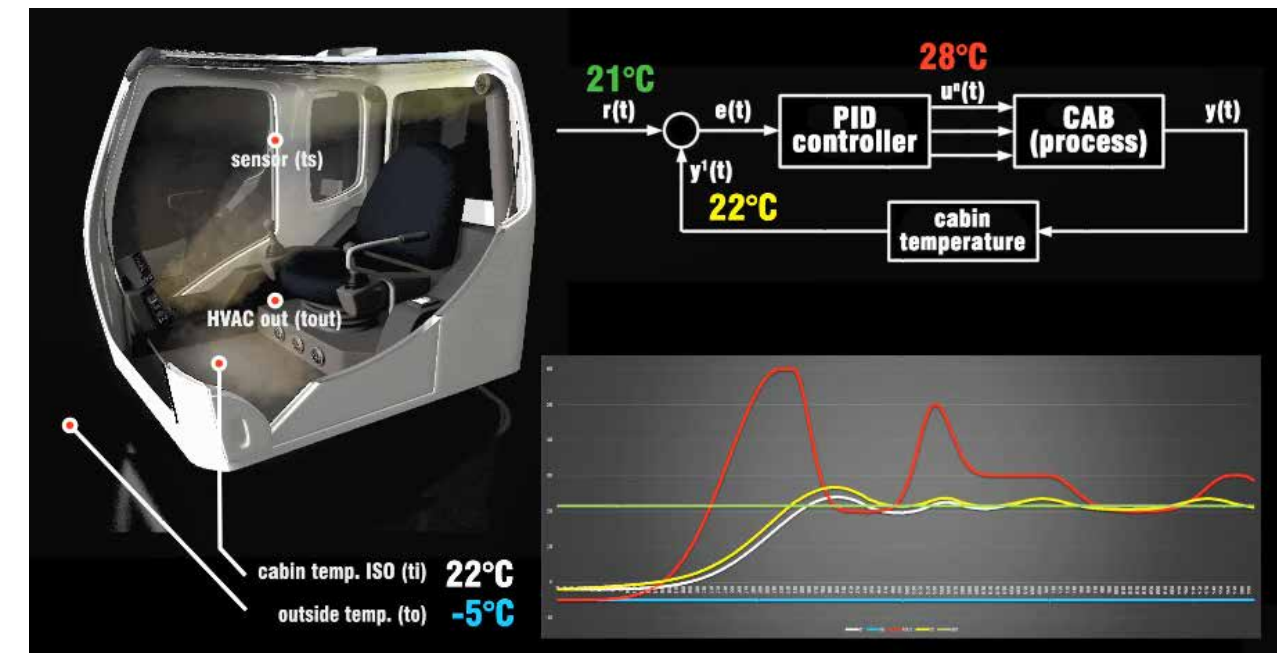
Example of a PID controller
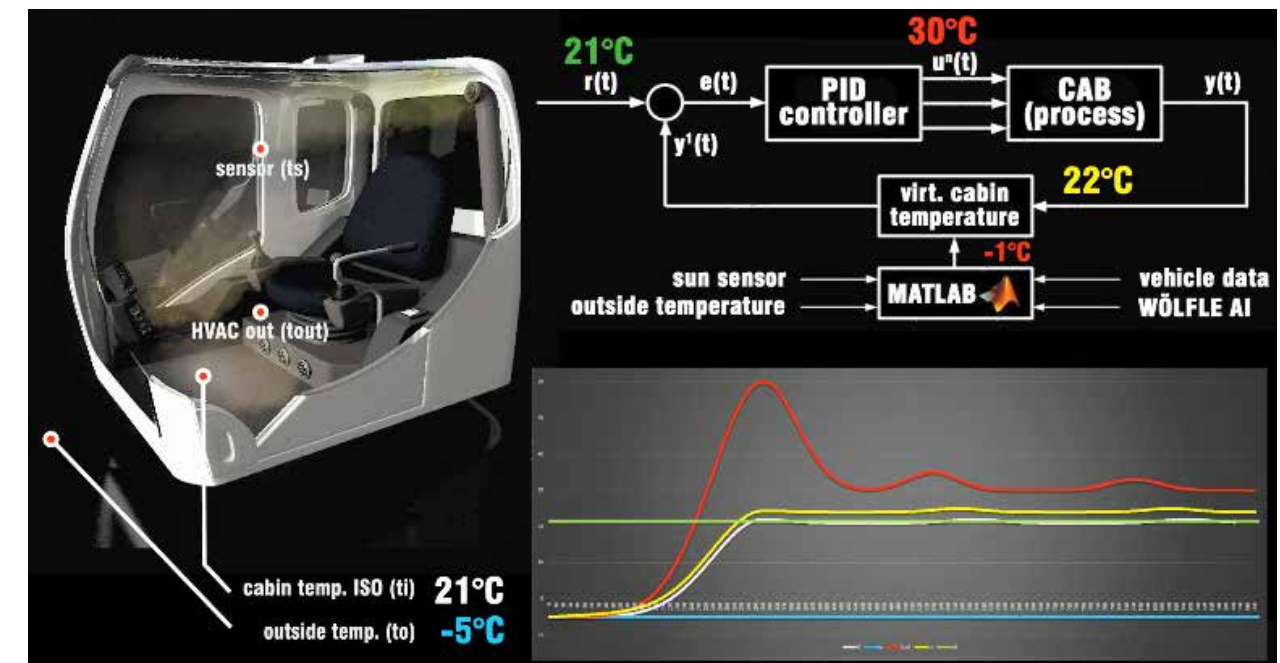
Example of a MATLAB model controller

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SOFTWARE AND BUS SYSTEMS

SAFE, INTELLIGENT AND NETWORKED

Software expertise is becoming the central discipline for functional scope, convenience, safety and innovation in vehicles. In order to support efficient and safe development processes, high-level software development in particular is model-based on MATLAB®/Simulink® and uses standard operating systems such as Autosar® or Codesys®. With over 25 years of in-house software development experience, we have accumulated extensive specialist and industry expertise and we have developed this area into a core competence.

The challenge of future E/E architectures lies in also mastering the increasingly powerful data streams. Data is generated by sensors, exchanged between control devices and must be delivered to actuators. Different bus systems exist for the different requirements of data transmission - such as transmission speed, availability, prioritisation, etc. With our development environments and various tools, we can also actively assist with commissioning on the vehicle and with fault analyses.

OVERVIEW OF THE USE OF MODERN SOFTWARE TOOLS AND PROTOCOLS

TOOLS

› Codeworrier
› Keil
› Multisim
› MATLAB/Simulink
› INCA
› ISOLAR
› CANoe
› CANalyser
› E3.Series Formboard & Cable

LANGUAGES

› C, C++, C#, Assembler, Java
› STEP7, Codesys, Logo

OPERATING SYSTEMS

› AUTOSAR® 4.3
› OSEK-NM
› Windows Compact CE
› Wölfle OWN

PROTOCOLS

› UDS, XCP, FireCan, CANopen, J1939, ISOBUS
› Customer protocols: Liebherr, Wirtgen, Ford, Ziegler, Linde, and more besides

DEVELOPMENT CENTRE

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