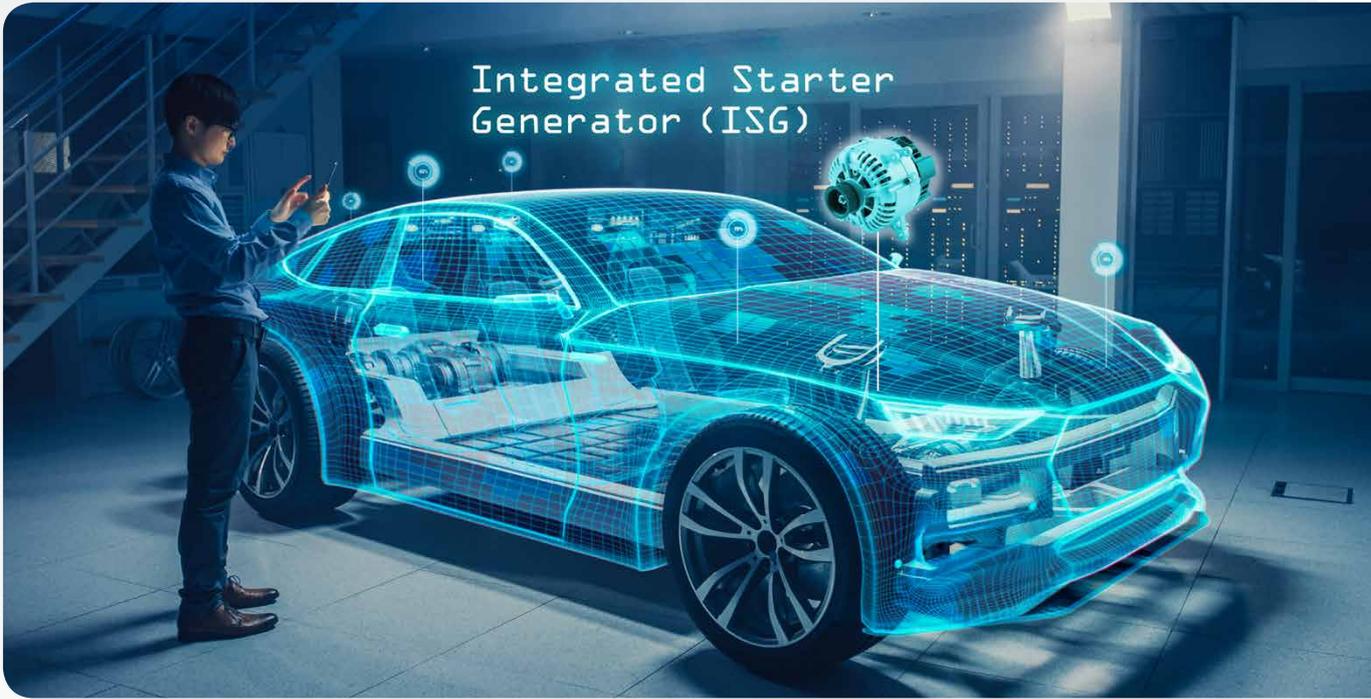
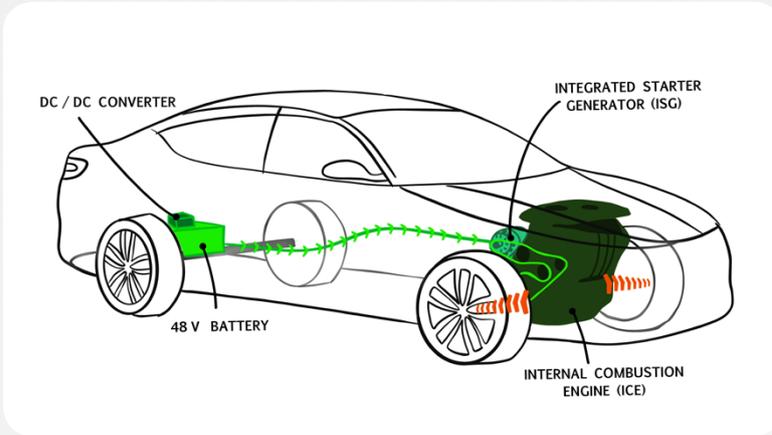


## CASE STUDY



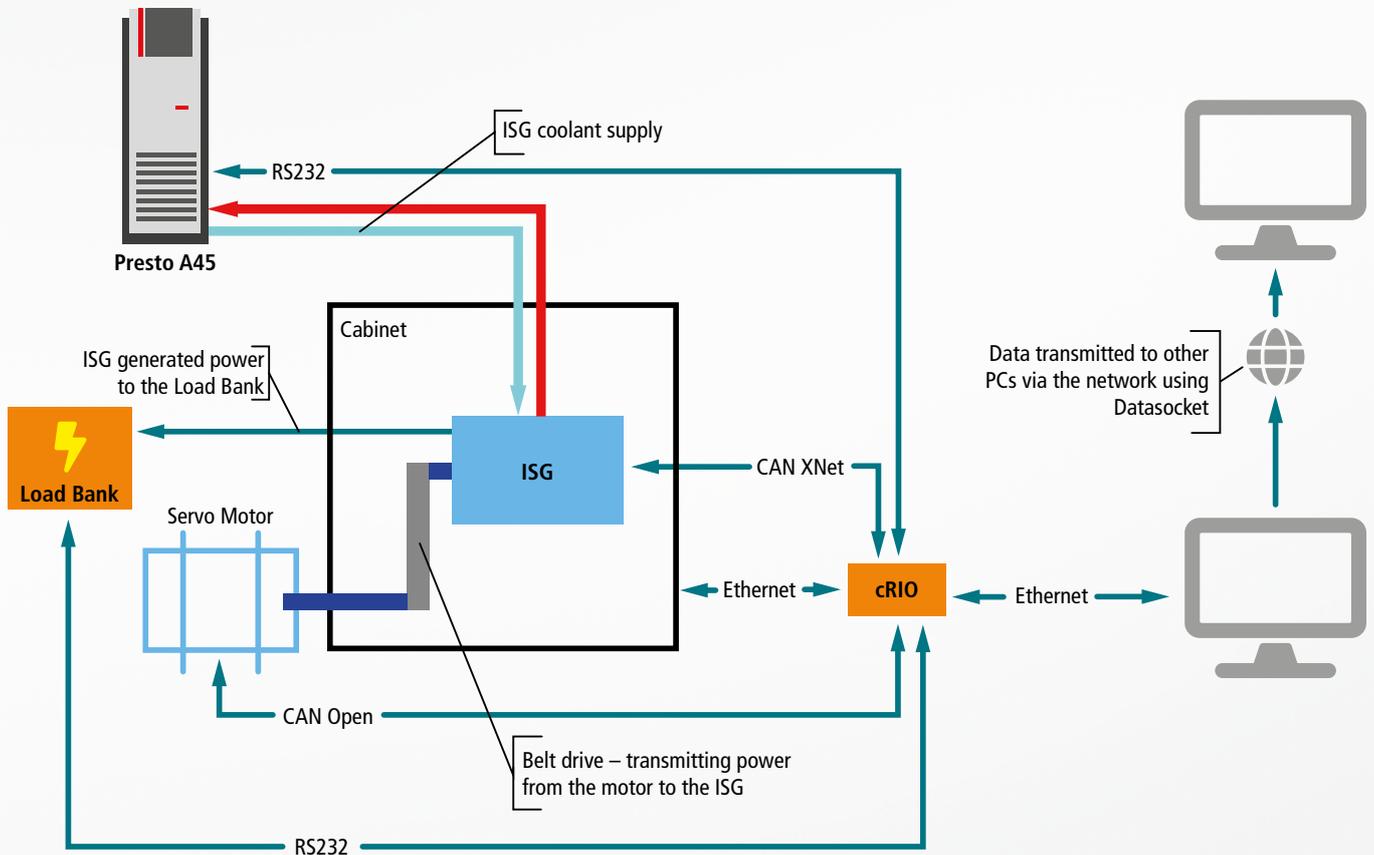
### TEMPERATURE CONTROL FOR DYNO TESTING OF INTEGRATED STARTER GENERATORS

The Integrated Starter Generator (ISG) is one of the most important components of a hybrid powertrain. It both generates energy from the internal combustion engine (ICE) to charge the batteries within the vehicle but also acts as the starter motor for the ICE and can supply power in certain operating conditions. During its operation the ISG generates heat which is normally removed by the vehicles internal coolant lines. During different test bench processes, a precise temperature control system replicates these coolant lines.



## APPLICATION REQUIREMENTS

In this worked example, the temperature range for the customer application is defined between  $-40\text{ }^{\circ}\text{C}$  to  $90\text{ }^{\circ}\text{C}$  using a typical automotive coolant. As a special requirement, the international automotive supplier needs to accurately set the flow at low rates such as 6 l/min. In doing so, they can mimic the coolant flow within a specific vehicle during high load on a dynamometer test bench. Furthermore, the customer requires the temperature control system to be connected to their own internal software so that it can be controlled safely from a remote control room.



Scheme of the PRESTO A45 integrated in the customers process system

## JULABO'S SOLUTION APPROACH

The customer uses a PRESTO A45 Highly Dynamic Temperature Control System with a working temperature range of -45 °C to 250 °C in combination with a flow meter/fluid by-pass. With this setup, it is possible to maintain the temperature of the ISG while at the same time precisely regulating the flow rate of the fluid. The additional accessories are integrated at the rear of the unit to minimize the amount of space needed for operation.

The PRESTO is integrated in the customer process system and control interface.

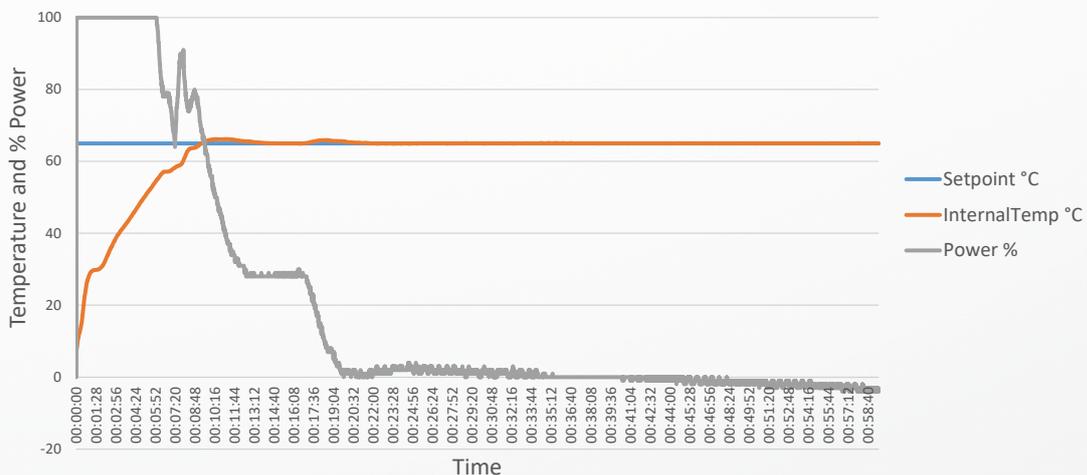


Details of the PRESTO A45 with accessories at the customers site

## EXEMPLARY TESTING PROCESS

A testing requirement for the ISG is a power generation test carried out at two speeds. For this test, the temperature of the ISG is set to 65 °C. The PRESTO A45 reaches an internal temperature of 65°C from 10 °C within 9 minutes. The temperature is held at 65 °C for a further 9 minutes until the core components of the ISG are at the ideal temperature.

The testing process is activated and the ISG speed set to 2500 rpm with a power generation of approximately 5 kW (electrical output) and held for 15 minutes. At 35 minutes into the process, the ISG speed is increased to 4800 rpm with a power generation of approximately 8 kW (electrical output).



Temperature Control of ISG (Chart 1)

Prior to the initiation of the ISG power generation test, the PRESTO A45 was maintaining 65 °C with 30 % (1.8 kW) power. As soon as the ISG was brought up to 2500 rpm, its own heat generation required the PRESTO to reduce its power down to between 0-2 % (0.12 kW) heat input to maintain the consistent 65 °C. During the increased heat generation at 4800 rpm the ISG required active cooling of 3-4 % (0.14 kW) cooling input to remove heat from the generator (the negative % on Chart 1 denotes cooling).

This is only one of several specific examples. Overall the PRESTO was able to simulate real life thermal control for all testing programs, giving consistent and reproducible results for the customer.

## CONCLUSION

Manufacturers of ISG's place their product through rigorous test conditions such as different temperatures, speeds, power generation and long term stress testing. On the test bench the manufacturers need to precisely replicate the coolant lines so that generated heat can be removed from or added to the ISG to simulate real world conditions. This is where JULABO can help with its PRESTO Highly Dynamic Temperature Control Systems. The units can be customized with a broad range of additional accessories like flow meter, fluid by-pass, heat exchanger, booster pump or expansion tank for various application scenarios. With our years of experience, we are providing custom PRESTO solutions to accurately control temperature and flow when it is needed most.



Various accessories are available for the PRESTO Highly Dynamic Temperature Control Systems

## SHORT INFO ABOUT JULABO

JULABO GmbH, founded in 1967 in Germany, develops sophisticated temperature control technology and stands for innovation and competence in this area. Our units equipped with state-of-the-art control technology are used when highest temperature accuracy or fastest response to temperature changes is important. More than 600,000 JULABO units installed worldwide demonstrate the high acceptance among users in research and industry. With proven quality "Made in Germany" and fast and competent service by local contact partners, JULABO has developed to a market leading company for temperature control solutions.