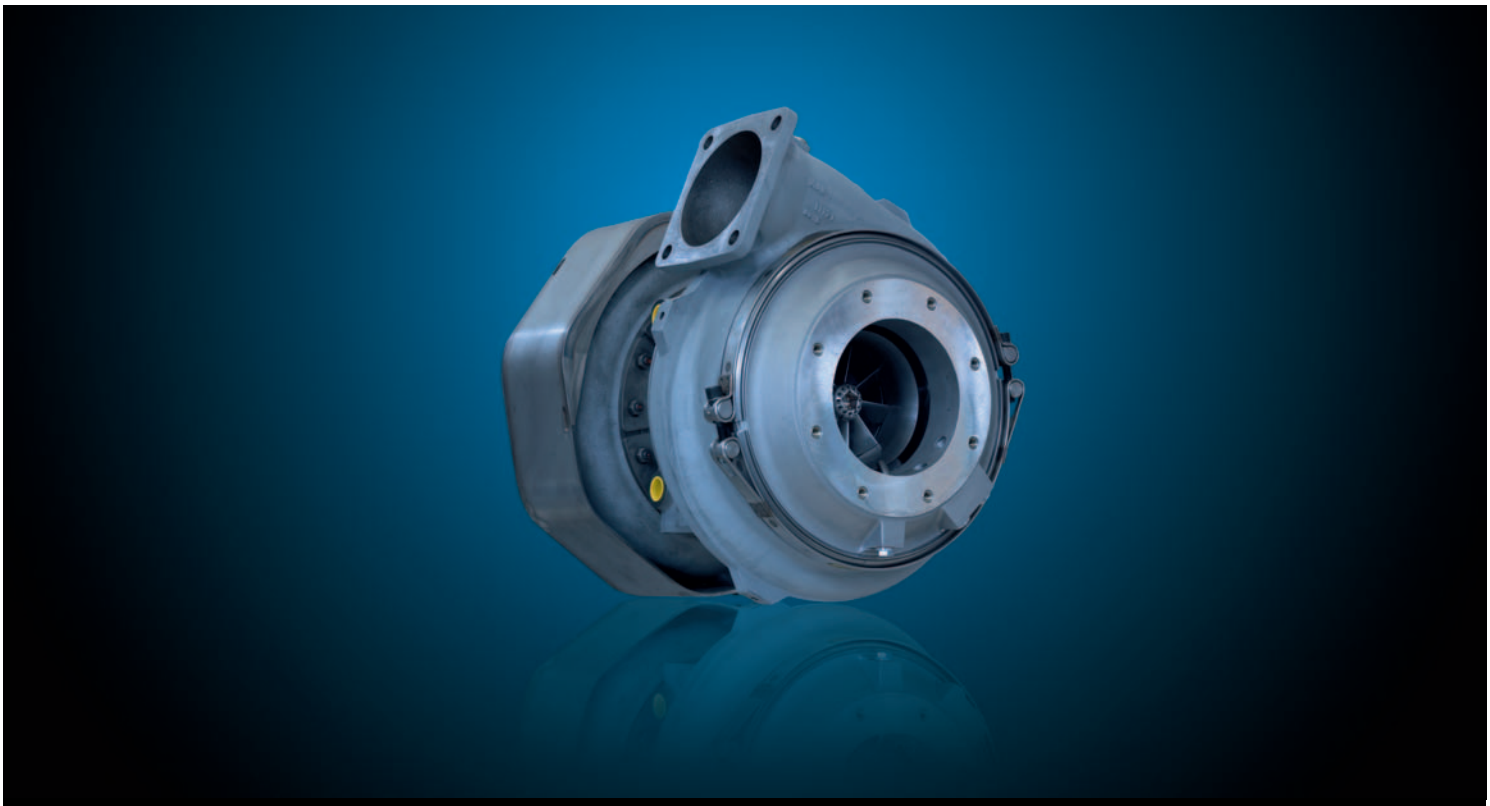


Product information

ABB Turbocharging
A100-M/H

Power and productivity
for a better world™

ABB's new A100 turbocharger series

The A100-M series for medium-speed and A100-H series for high-speed engines are designed specifically to meet future demand for higher compressor pressure ratios with single-stage turbocharging.

Growing demand for energy, rising fuel costs and stricter emissions legislation are having an important influence on engine development in the medium- and high-speed segment. It goes without saying that these same factors, plus the ongoing trend towards higher engine power densities and higher power output, are also impacting turbocharger technology: Higher engine mean effective pressures require higher turbocharger pressure ratios, while optimization of combustion technology, new engine-internal measures and the focus on exhaust after-treatment systems all influence the development of modern turbocharging systems. In short, highly efficient turbocharging systems are vital for energy-efficient engines.

High compressor pressure ratios are required today not only to increase the power output, which was the key aim in the past, but also because they play a significant role in emissions reduction. They are needed, for example, for the Miller/Atkinson process, which is used in some form in almost all modern diesel and gas engines. In diesel engines this process helps to reduce NO_x emissions, while in gas engines it is used to shift the point at which knocking begins. Extra reserves of pressure ratio are also required for engines operated at high altitudes.

Turbocharger performance – a crucial factor

During the past decade engine-builders have managed a significant increase in mean engine power output in the medium-speed segment, while at the same time cutting specific fuel consumption and lowering engine emissions (Fig. 1). This same period has also seen a substantial increase in the demands made on the turbocharger's thermodynamic and mechanical performance.

The next generation of diesel and gas engines will fully utilize the considerable potential of the A100-generation turbochargers. Full-load pressure ratios of up to 5.8 in continuous operation with aluminium compressor wheels, at high efficiencies, set new benchmarks for power density in turbocharger construction and take the known limits of single-stage turbocharging a significant step further.

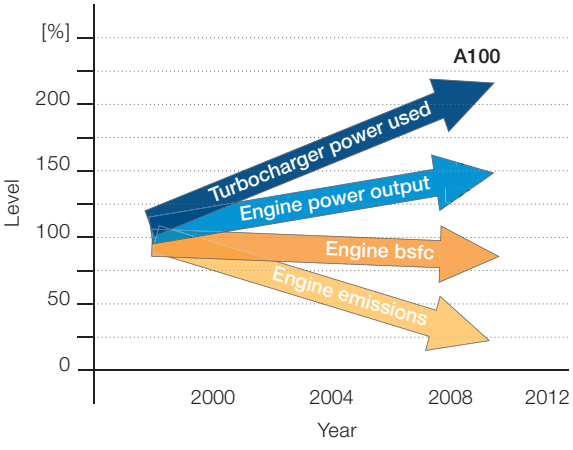
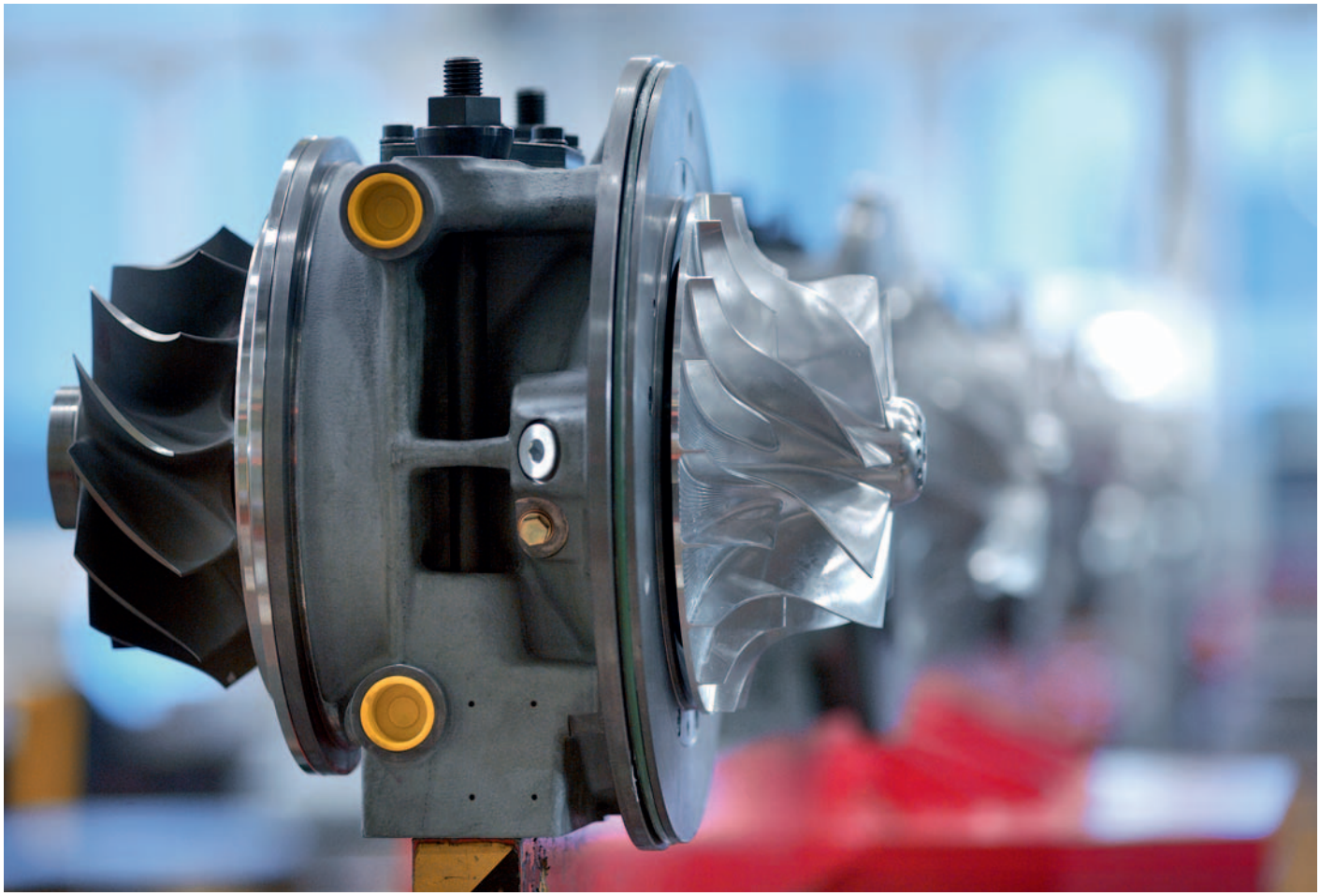


Fig. 1: Increasing demands made on turbocharger performance



From TPS to A100-M/H turbochargers

Ten years after their introduction, more than 30,000 TPS series turbochargers are successfully operating on small medium-speed diesel engines and large high-speed diesel and gas engines rated from 500 kW to 3300 kW. While these turbochargers continue to be the preferred choice for engine series rated at today's power levels, market demand for ever-higher engine power densities and higher efficiencies, as well as the need to curb engine emissions, calls for new engine concepts and a new generation of turbochargers. It is for these advanced engines that ABB has developed the high-pressure A100-M/H series – the A100-H series for high-speed engines and the A100-M series for small medium-speed engines.

The frame sizes of the A100 radial turbochargers have the same outer dimensions as the field-proven TPS turbochargers and, also like the TPS, have the oil inlet and outlet ducts integrated in the foot. This ensures that in the case of further development of current TPS-turbocharged engine platforms, these engines can be fitted with A100 radial turbochargers without having to make any major changes to the turbocharger mounting.

Design concept

A100 radial turbochargers are of modular construction with a minimized number of component parts and are designed to allow matching to the special requirements of each diesel and gas engine application. Different casing materials are available for different turbine inlet temperatures.

A range of specific design and configuration features enables the A100-M radial turbochargers for small medium-speed engines to also be used with HFO or with pulse turbocharging systems. Since the exhaust-gas temperatures with these engines are usually lower than with high-speed engines, the bearing casings of A100-M turbochargers can be supplied with or without water-cooling. Options include coated nozzle rings and multi-entry turbine inlet casings.

Aluminium compressor wheels are standard

For the A100 radial turbocharger ABB developed a cooling technology that allows the continued use of aluminium for the compressor wheels even at such very high pressure ratios, and without compromising the high operational reliability and long component exchange intervals users have come to expect with this material. This has avoided changing to cost-intensive titanium components.

Cooling with compressor air was shown by an extensive test program to be the most efficient solution and also to be the easiest and least costly for the engine builder to implement. The concept is already proven in the field, having been offered as an optional feature for the larger ABB TPL..-C turbochargers for several years now.

Containment concept successfully tested

The A100 casings take full account of the much higher mechanical demands made on them. During their design ABB worked closely with engine-builders to ensure the same compactness as the TPS as well as optimum mounting of the turbocharger on the engine console. The safety of the containment concept – a vital consideration in view of the significantly increased power density – has been confirmed both numerically and experimentally by turbocharger containment tests on the test rig.

The stronger shaft required because of the higher power transmission was also a factor in the design of the A100 bearing assembly, which was based on TPS bearing technology. On the turbine side, the casing centring concept which has proved so successful with the TPS..-F has been retained and ensures safe and efficient turbocharger operation.

Thermodynamic performance

Three entirely new compressor stages, each with different compressor wheel blading, allow the compressor volume flow range of today's TPS..-F turbochargers to be covered by the new A100-M/H turbochargers with significantly higher pressure ratios (Fig. 2).

The A100 turbocharger features a single-piece aluminium compressor wheel. New high-pressure diffusers and compressor blading were developed in addition to the innovative wheel cooling to ensure the full-load pressure ratios of about 5.8 with aluminium wheels. A range of compressor stages is available for every turbocharger frame size, allowing optimal matching to every application. The compressor map in Fig. 3, which is based on measurements taken on the recently released A140 turbocharger, shows the high efficiencies, excellent map widths and more than adequate overspeed margins achieved. 80 % compressor efficiency is achieved on a typical generator line for a full-load pressure ratio of 5.8.

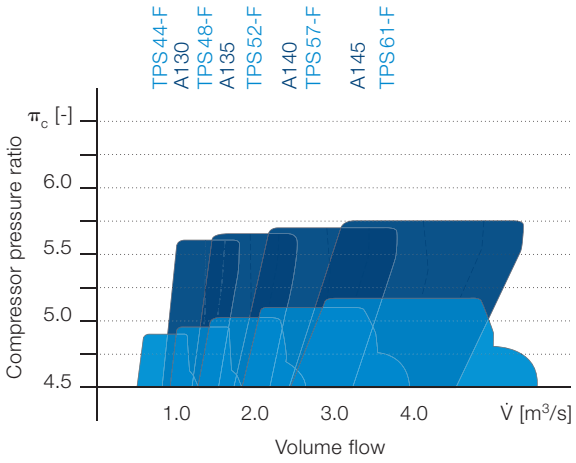


Fig. 2: Pressure ratio vs volume flow range for A100 radial turbochargers at full load (for certain specifications even higher values can be achieved).

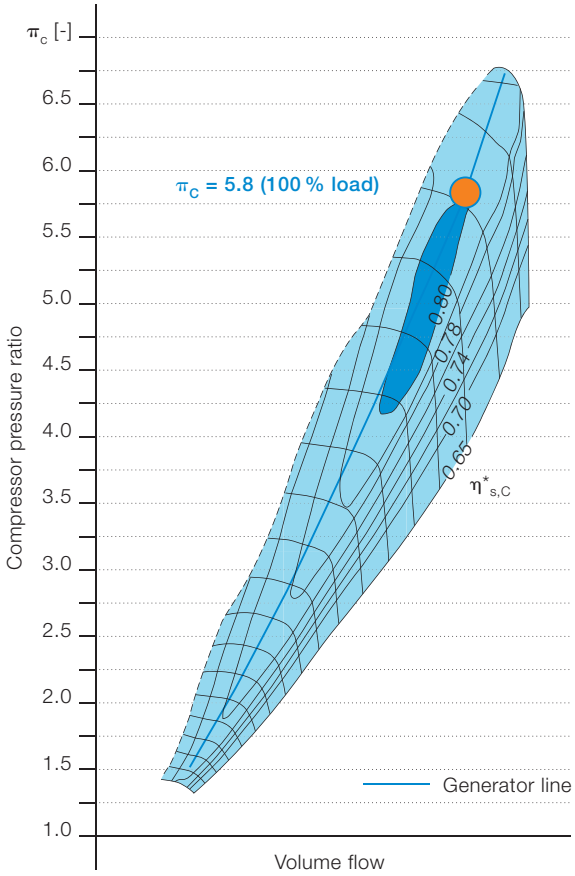


Fig. 3: Compressor map (A140)

New turbine stages

A new generation of mixed-flow turbines has been developed for use with the A100 turbochargers in addition to the existing TPS mixed-flow turbine stage.

A characteristic of this new turbine family is the larger operating range, allowing the new compressor stage's high pressure ratio potential to be exploited over an even wider range of application. The turbine's design has been optimized in each specific volume flow range, so that the individual stages exhibit higher turbine efficiencies than the current TPS turbine stages. Further development of the sealing technologies has reduced the bypass flows so that flow losses are also lower. This has allowed, in particular, a substantial improvement in turbocharging performance at higher boost pressures (Fig. 4).

A quantum leap in turbocharger development

A wide range of available compressor and turbine specifications makes the A100 ideally suited for applications on engines in the marine, industrial and power generation as well as traction sectors. Figure 5 shows its outstanding thermodynamic potential in the case of a full-load-optimized turbocharger specification. The comparison with TPS turbocharger efficiency illustrates well the performance gain precisely in engine applications making very high demands on the achievable compressor pressure ratio, and therefore the quantum leap the A100 represents in turbocharger development for single-stage turbocharging of modern medium- and high-speed engines.

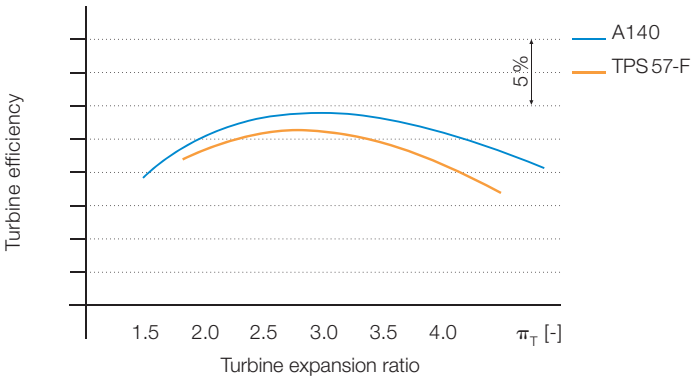


Fig. 4: Turbine efficiencies, A140 and TPS 57-F

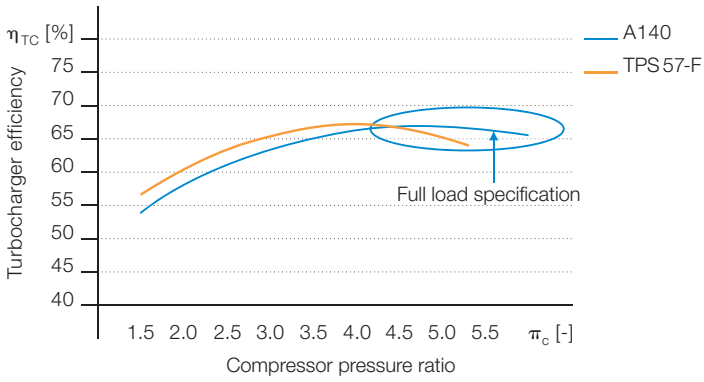


Fig. 5: Turbocharger efficiency of A140 with full-load-optimized specification

Qualification program

Like all newly developed ABB turbochargers, the A100 was put through a mandatory qualification program on ABB's own combustion test rigs to ensure reliable operation in future engine applications. The comprehensive series of tests ranged from thermodynamic checking of the new compressor and turbine stages to mechanical qualification of all newly designed component parts.

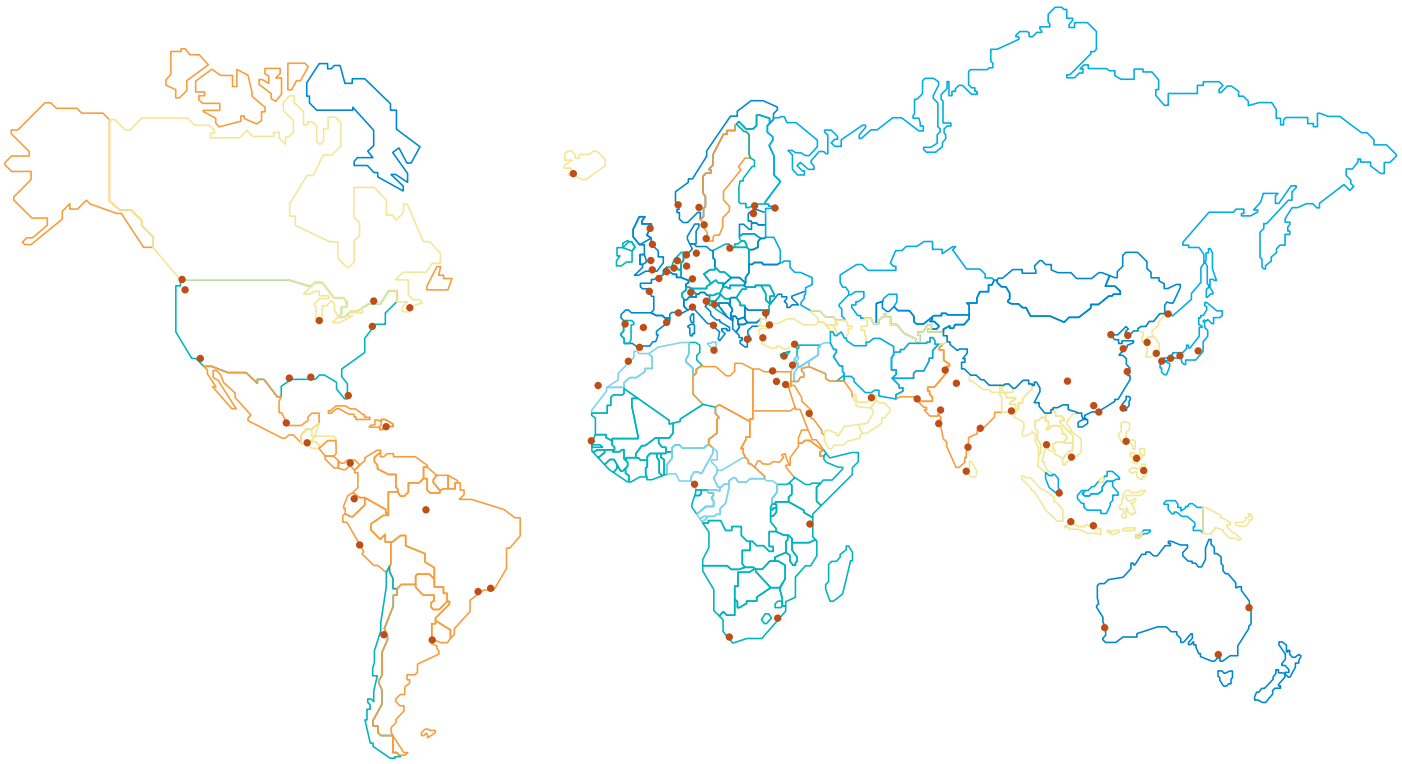
Maintenance and service

The maintenance intervals for the A100 turbochargers have been kept similar to those for the proven TPS turbochargers. Although the demands made on thermodynamic and mechanical performance are higher, the turbochargers of the new A100 generation will satisfy all requirements in respect of high reliability and low-maintenance operation. The necessary service know-how and logistics support for the new turbochargers is ensured by a network of some 100 ABB service stations around the world. Users of advanced diesel and gas engines fitted with A100 series turbochargers can rely on the same high ABB service standards they are used to today being maintained in the future.

Introduction program

In the run-up to the series introduction of the A100, engine test rig trials were carried out to verify the thermodynamic performance. The high pressure ratios and efficiencies that can be achieved with the A100 allowed the high power densities expected on the engine side to be clearly demonstrated. Hundreds of running hours on the test rig have also confirmed the high performance level of the A100 in continuous operation. In the meantime, the first two turbochargers in this series, the A140-M/H and A135-M/H, with pressure ratios of up to 5.8 at full load, have been introduced to the market. Further sizes will be introduced in due course.

ABB Turbocharging Service network



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