

Technical note

Comparison of 4-pole and 2-pole designs for large motors and generators (typically rated over 7 MW)



Synchronous motor, type AMS 1250, air-to-air cooled.

Large motors and generators (typically rated over 7 MW) are available in both 4-pole and 2-pole designs. 4-pole synchronous motors and generators have solid rotors with salient poles while 4-pole induction motors and generators have squirrel cage rotors. In 2-pole motors and generators the rotors are cylindrical. 4-pole motors and generators are smaller and lighter than their 2-pole counterparts, which can be an important factor in applications where space is limited, such as the marine sector.

Cooling arrangements

The compact design of ABB's 4-pole motors and generators means straightforward, symmetrical cooling with good control of hotspots. In 4-pole synchronous motors and generators the solid rotors are designed to maximize the surface of the field coils exposed to the cooling air, resulting in highly efficient cooling. The design of 2-pole rotors – with their slot wedges and retaining rings – means that access to cooling air is more restricted.

Critical speed

4-pole motors and generators always run below their first lateral critical speed. This means that they can operate across their entire speed range without 'forbidden speed windows' – a factor which provides increased versatility, especially in motors that are used with VSDs. ABB's 4-pole rotor design with salient poles (i.e. synchronous motor or generator rotor) has a large diameter with plenty of inertia, providing excellent speed stability.

Vibration and noise performance

Subcritical operation and sturdy rotor design mean that ABB's 4-pole motors and generators have good vibration performance. As the first lateral critical speed is well separated from the operating speed, vibration conditions remain consistent throughout the entire operating range. 2-pole rotors, by contrast, have to pass through their critical speed, which will require more advanced rotor balancing control and processing during manufacturing. 4-pole motors and generators also have significantly better noise performance than 2-pole motors and generators due to the lower rotor speed.

Servicing and maintenance

ABB's 4-pole motors and generators have long service intervals thanks to their robust rotor design with a limited number of components. Unlike 2-pole rotors, 4-pole rotors have a bolted pole tip and no retaining rings – which means maintenance of 4-pole rotors is fast and easy. The lower speed of 4-pole motors and generators, compared to 2-pole motors and generators, means that they are subject to less general wear and tear. When considering servicing requirements, however, it is important to take the entire system into account. Gearboxes have such high maintenance requirements that a system consisting of a 4 pole motor or generator with a gearbox generally needs more maintenance than a 2-pole motor or generator operating without a gearbox.

Generators driven by gas or steam turbines

Many units operating at 3000 rpm are actually driven by a 3600 rpm turbine. The turbine is therefore not used at its optimal operating point, which reduces the utilization factor of the system. A 2-pole generator is often used because this avoids the need for a gearbox, but in many cases a 4-pole generator with gearbox would have a lower investment cost and provide a better utilization factor. For systems running at 3600 rpm, 2-pole generators are the favored option because gearboxes are not needed. Above or below 3000/3600 rpm, 4-pole generators are the preferred option.

Motors for turbo compressors

For turbo compressors operating at 3000/3600 rpm, 2-pole motors are favored as no gearbox is required. In systems operating at fixed speeds above 3000/3600 rpm, 4-pole motors are the preferred option.

Application summary

Speed	4-pole	2-pole
Fixed		
below 3000/3600 rpm	++ Gearbox often needed	Gearbox always needed
3000/3600 rpm	Gearbox always needed	+ Gearbox not needed
above 3000/3600 rpm	++ Gearbox always needed	Gearbox always needed
Variable (using VSD)	++ Subcritical operation means wider speed range	Super critical operation: motor/generator has to pass through critical speed
	Operating range can be increased by exceeding 50/60 Hz frequency	

++ favored option
+ slightly favored option