

What is cogging in iron core direct drive motors?

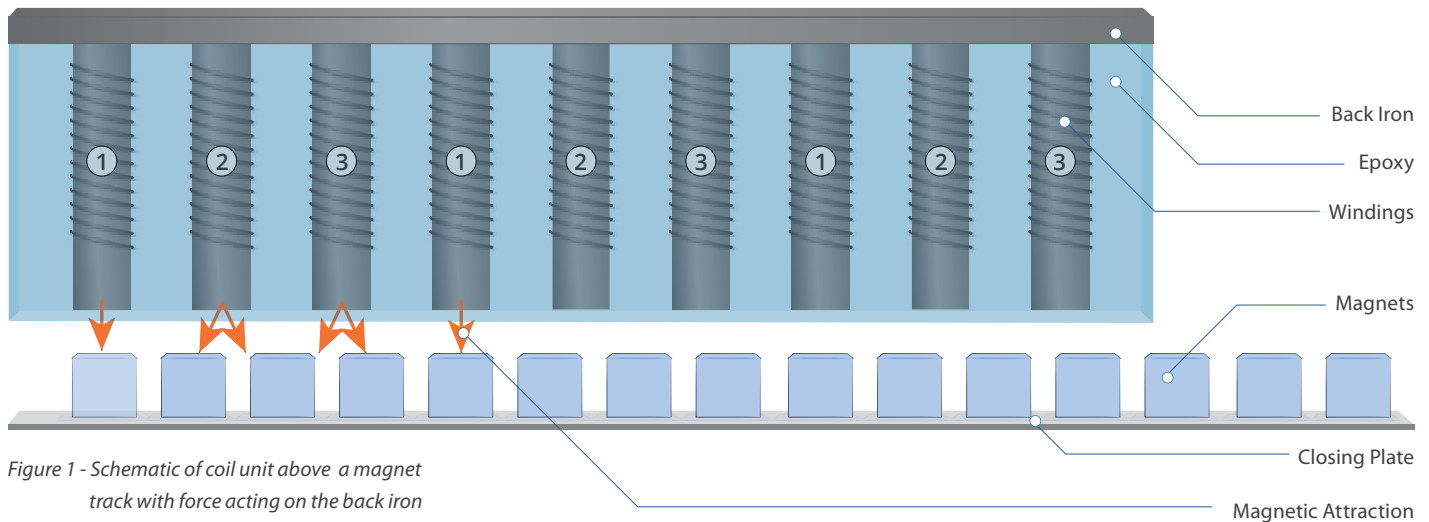


Figure 1 - Schematic of coil unit above a magnet track with force acting on the back iron

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Cogging force is a phenomenon caused by the attraction of the iron lamination stack of the motor to the permanent magnets. The direction of this force is either the same or opposite to the moving direction. By moving the motor over the magnet track the cogging effect can be noticed, the motor has a preferred position above the track and will move towards a permanent magnet.

Cogging is regarded as an unwanted characteristic of motors because it introduces a velocity ripple and jerkiness in the movement if it is not compensated for. It can also affect positional accuracy because the coil unit still has a force acting on it, when it is stationary.

Because the cogging force is a periodic phenomenon it is pretty easy to predict and provide the appropriate control to minimize the effect on the movement profile. At low speeds the frequency of the ripple is also low so it is easy to smooth it out with appropriate control. At high speeds the inertia of the

motor will cause it to coast over the preferred positions and cogging will be less noticeable. As a consequence this effect will be most difficult to negate at medium speeds.

General guideline

The provided information is mostly based on simulations and provides generic information since the effect differs per motor series. This information is only intended to be used as a guideline. Actual results measured at the application can be different.

K- Factor

Cogging is present in motors with an iron core, which includes torque motors, ironless motors do not exhibit this phenomenon. As previously mentioned it is caused by the magnetic attraction between the iron teeth and the magnets. Other names for this phenomenon are no current force or detent force. There are several factors which can influence the K-factor magnitude. As the K-factor varies, the amount of force generated by the motor per unit of current varies.

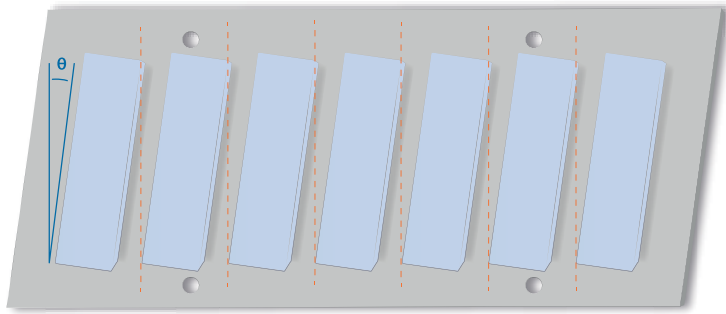


Figure 2 - Skewed magnets, to incline the magnets in the direction of the motion. As a result, each tooth of the motor will pass more gradually over the magnet.

- › Skewing of the magnets
- › Optimal pole / slot ratio
- › Optimal magnet pole width

Typical Cogging Values

Through simulations and experience, it is determined that as a rule of thumb, the cogging values are as follows. It is assumed that the motor is not energized.

T-series	QTR-series
3% peak to peak of Fp	3% peak to peak of Tc

QTL-series	U-series
1% peak to peak of Tc	0% peak to peak of Tc

Below is a list of influences on the K-factor, they vary stochastically:

- › Iron teeth position
- › Magnet strength
- › Magnetic angle
- › Magnet position

Next to these factors the magnitude of the cogging is dependent on the airgap. The cogging will increase when the airgap becomes smaller. The reason is that the magnetic field strength perceived by the iron will be higher. A strategy can be to increase the air gap.

Energizing the motor will also increase the cogging value as the iron will be increasingly magnetized at higher currents. There are several ways to reduce the cogging. These measures have been implemented in Tecnotion motors:

Conclusion

To reduce the effects of the disruptive force of cogging it is key to use a motor that is designed to reduce cogging. Direct drive motors of Tecnotion are designed to reduce cogging.

We can mail you, on request, a white paper with detailed information on [Accurate cogging and linear ripple models for parametrized Feed Forward](#).

Our team of Application Engineers can support in your challenges with Cogging. Please contact us at: support@tecnotion.com or at: +31 546 898 475.

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Tecnotion direct drive motors are seamlessly integrated into a wide range of applications such as semiconductors, machine tooling, robotics, display applications, and the printing industry.

As the independent supplier of linear- and torque motors, we provide specialized motor technology to place in customers motion solutions. With a wealth of experience, we are accustomed to designing and building any motion question, from catalog to customized products.