

## ThinGap Motor Technology Description

ThinGap, LLC - November 4, 2015

ThinGap is a world leader in high performance electromechanical conversion. Our technologies replace conventional iron core motors with an ironless composite stator and high energy lightweight rotor. The ironless stator eliminates all cogging torque and iron saturation. ThinGap motors are exceptional in applications requiring torque linearity, velocity smoothness, positioning accuracy, and a high power-to-weight ratio.

ThinGap motor torque - speed curves differ from traditional iron core permanent magnet (BLDC) motors. The most prominent difference is increasing torque capacity with speed, as shown in Figure 1. The motor torque increases with speed due to an increase in convective cooling. At very high speeds the speed related losses outpace convective cooling increases causing torque capacity to level off and eventually decrease.

Maximum continuous torque can be achieved at stall and low speed operation if motor cooling is sufficient to maintain stator temperature at or below the rated stator temperature.

Due to the relatively flat torque-speed curve the power of the motor continually increases throughout the speed range. Maximum power is achieved at maximum speed as shown in Figure 2.

The ironless stator is composed of copper windings that have exceptional heat capacity. This heat capacity allows for short duration peak torque and power operation. ThinGap publishes 10 and 30 second peak torque and power levels as shown in Figures 1 and 2.

ThinGap motors can operate throughout the speed and torque range with the applied voltage

proportional to speed and the current proportional to torque. Linear relationships between speed and voltage, and torque and current are maintained through the entire operating region of the motor.

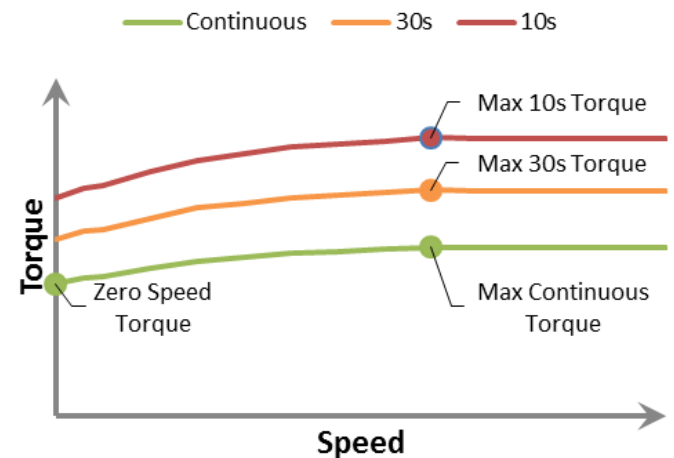


Figure 1 – Typical torque-speed graph

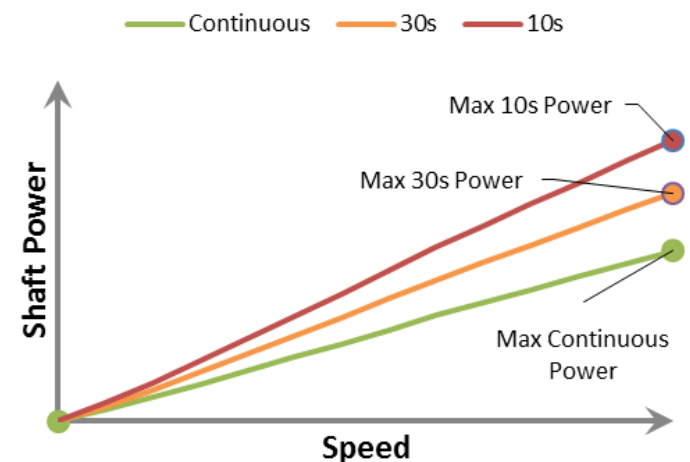


Figure 2 – Typical power-speed graph