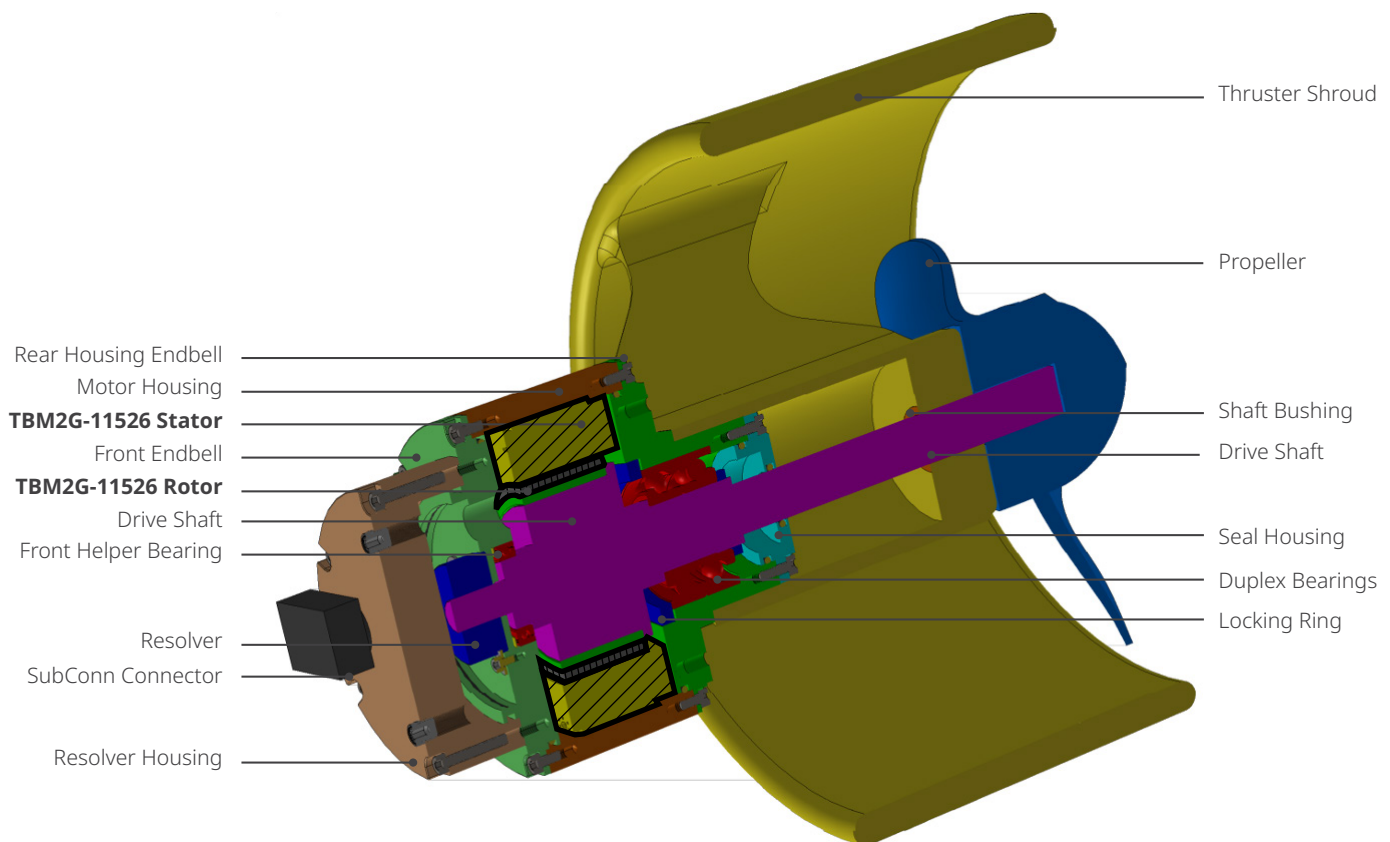


## TBM2G Frameless Motors for Propulsion Systems and Extreme Environments

**Servo motors are often used in extreme environments — for example, submersible vehicle propulsion systems, spacecraft, semiconductor manufacturing under high-vacuum conditions, hygienic equipment subject to high-pressure washdowns, and more.**

We offer many housed motors that are specialized for use in extreme environments — such as the submersible Goldline S Series, washdown-ready AKMA and AKMH Series, radiation-hardened motor variants and more. However, for the most compact, lightweight machine design, another compelling option is to embed a frameless motor directly within the structure of the machine.



### Propulsion system incorporating TBM2G servo motor from Kollmorgen

#### Why frameless?

Frameless motors lack the housing, bearings, shaft and end bells of a traditional housed motor. Instead, the stator is housed within the framework of the machine itself, and the rotor is supported by the machine's own bearings. This means the motor is virtually maintenance-free, with no wear points.

It also means the machine can be designed to protect embedded motors from environmental damage — for example, isolating motors against washdown fluids, providing heatsinking for thermal management in high vacuum environments, shielding against ionizing radiation, or housing motors within a dynamically sealed or oil-filled, pressure-compensated design for submersible vehicle propulsion systems.

## Integrating frameless motors with other motion components

A complete motion system based on frameless servo motor technology incorporates additional components, depending on the application's functional requirements and design constraints.

- **Feedback device (required).** An encoder (absolute or incremental, depending on the application) or a resolver reports rotor position to the servo drive to enable closed-loop velocity and position control. Hall tracks on an encoder or optional Hall effect sensors built into the TBM2G motor provide the information necessary for the servo drive to properly commutate the current delivered to the motor.
- **Thermal sensor.** TBM2G servo motors are available with multiple standard sensor options to monitor winding temperature if necessary.
- **Gearing.** Frameless motors can be used with compact, zero-backlash harmonic (strain wave) gearing as well as with cycloidal, spur and planetary gears.
- **Brakes.** Electromagnetic or mechanical brakes may be required to provide holding torque and protect application components while in an unpowered state. TBM2G performance is unaffected in close proximity to brake elements.
- **The machine's own shaft and bearings.** TBM2G frameless motor sets include a stator and a rotor coupled directly to the rotating shaft of the machine axis, supported by its own bearings. There's no need to change the overall machine design — only to determine a point on the shaft where the rotor can be added.

## Additional design considerations

Kollmorgen can help you navigate several design choices to maximize application performance — for example:

- **Housing design.** Make sure the stator is supported by material that can adequately dissipate heat. Steel is a good thermal conductor, and aluminum is better. A minimum wall thickness of 4–6 mm is typically required.
- **Thermal sensing.** During prototyping, you may want to use a thermal sensor to gauge how hot the motor runs while the axis is performing at its required torque/speed load point.
- **Radiation hardening.** For space and other high-radiation environments, Kollmorgen can often modify materials to resist premature degradation as well as high-vacuum outgassing.
- **Cold-water applications.** In subsea and other cold-water environments, Kollmorgen can show you how to use the natural liquid-cooling effect to push motor performance even further.
- **Design for manufacturability.** A thorough understanding of the application's assembly process helps ensure an efficient and safe manufacturing workflow to reduce cost and complexity while likely improving machine serviceability.
- **Outside resources.** If you need additional expertise or support to design and assemble your solution with confidence, we can help connect you with the right resources.

