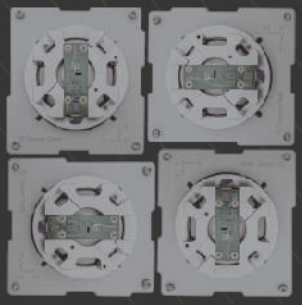
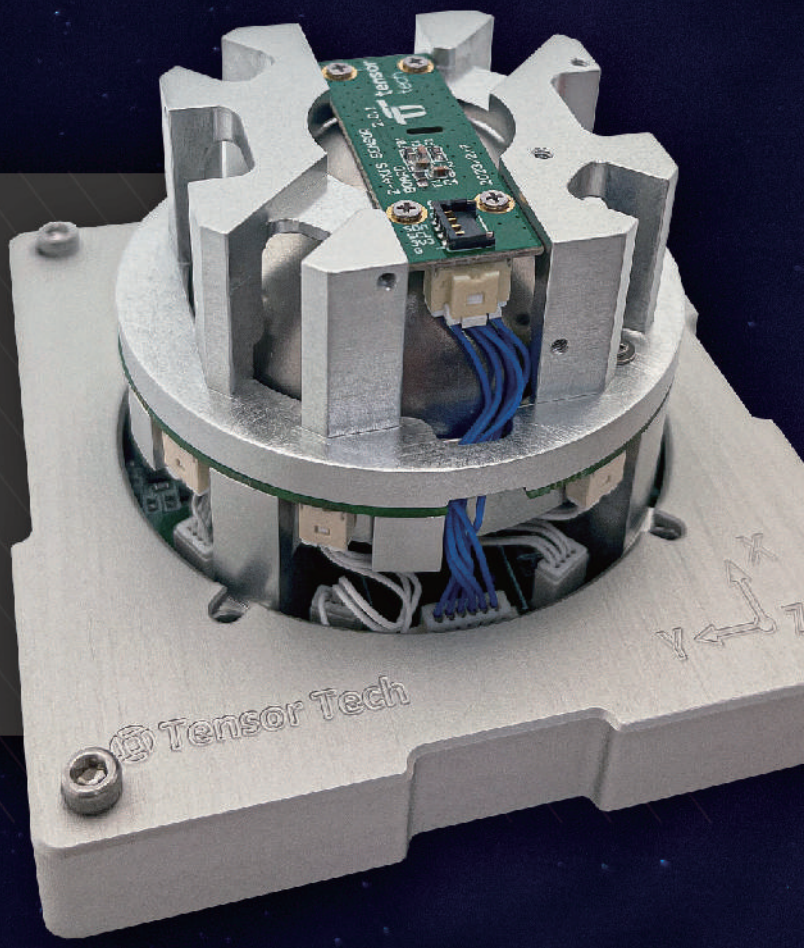
CMG SERIES

Control Moment Gyroscope

Flight Heritage Since Jan. 2022





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Control Moment Gyroscope

Tensor Tech maximizes performance for small satellites users by miniaturizing its variable-speed Control Moment Gyroscopes (CMG). It offers additional power efficiency and agility to traditional reaction wheels solutions.

The CMG have two modes: speed mode and torque mode, allowing users to control the CMG simply by setting speed or torque output values.

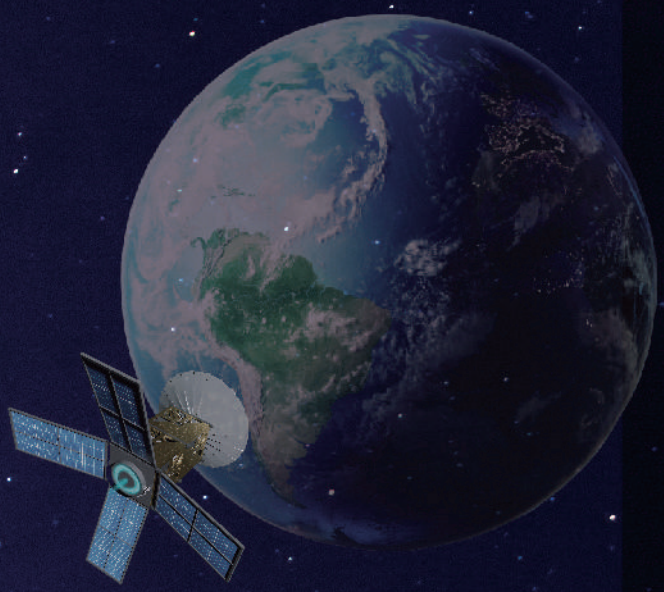
Variable-speed, single-gimbal CMG

Using gyroscopic moment instead of reaction wheel torque only

The rotor, spinning at a variable speed (Ω)and therefore provide reaction-wheel-torque, is mounted inside a gimbal (the golden part in the picture, a gimbal reference frame is defined upon it). The gimbal allows the rotor's spin axis ($\hat{g}_s$) to be tilted in different directions.

Therefore the direction of the angular momentum is changed and the spacecraft will experience a torque due to the conservation of angular momentum, this is called "gyroscopic moment".

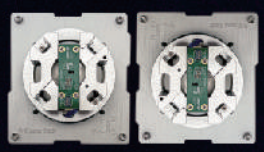
The gyro moment can be provided in $\hat{g}_t$ direction when the gimbal is rotated in $\hat{g}_g$ direction. The gyro moment in $\hat{g}_t$ direction consumes far less mechanical power compare to reaction-wheel-torque because of its perpendicularity to the angular velocity vector.

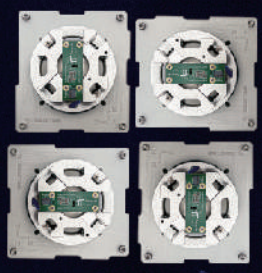


- CMG-10m is a variable-speed Control Moment Gyroscope (CMG) which is suitable for satellites up to 3U.
- CMG-20m is a scissored pair, variable-speed CMG which is suitable for satellites up to 6U.
- CMG-40m is a pyramid cluster, variable-speed CMG which is suitable for satellites up to 16U.

CMG Specifications

for up to 30 kg satellites



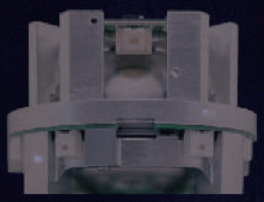


	CMG-10m	CMG-20m	CMG-40m
Angular Momentum Storage	10 mNms for 2-axis	20 mNms for 1-axis; 10 mNms for 2-axis	30 mNms for 2-axis; 20 mNms for 1-axis
Torque	1 mNm for 2-axis	2 mNm for 1-axis; 1 mNm for 2-axis	3 mNm for 2-axis; 2 mNm for 1-axis
Inner Rotor Speed Control Accuracy	< 5 rpm	< 5 rpm	< 5 rpm
Tilting Angle Control Accuracy	< 1 deg	< 1 deg	< 1 deg
Rotor Imbalance	ISO 1940 G0.4	ISO 1940 G0.4	ISO 1940 G0.4
Power Consumption @ 5V bus	1 W	1.5 W	3 W
Power Consumption @ 3.3V bus	0.6 W	1.2 W	2.4 W
Mechanical	Tuna-can & 0.1U (< 290 g)	2 x Tuna-can & 0.2U (< 580 g)	4 x Tuna-can & 0.4U (< 1160 g)
Interface	RS485 or UART	RS485 or UART	RS485 or UART

Compared to the conventional Reaction Wheels, the CMG offers a better torque-to-power ratio. Such a feature is favored by large spacecraft with more limited power budget to satellite inertia ratio. CMG also offers enhanced agility which makes it perfectly suitable for remote sensing and in-orbit-servicing missions..

The selection of CMG in the SmallSat market nowadays is very limited for its technical complexity. By spinning the rotating mass with a multi-axis magnetic actuator, the Size, Weight, and Power Consumption (SWaP) of the spacecraft AOCS can be optimized. With Spherical Motor technology, Tensor Tech provides the best solution of CMG with more volume and power budget for the payload and enhances the mission value.mission value for the clients.

CMG Specifications **for over 30 kg satellites**



	CMG-1	CMG-200m	CMG-400m
Max. Angular Momentum Storage Capability	1 Nms	0.2 Nms	0.4 Nms
Max. Output Torque	0.1 Nm	0.1 Nm	0.1 Nm
Power Consumption @ 0.5 Full Momentum, Gimbal Rate = 0, and Inner Rotor Acceleration = 0	< 5 W	< 3 W	< 4 W
Power Consumption @ Full Momentum,Gimbal Rate = 0, Output Torque = 0.1 Nm (inner rotor accelerating)	< 50 W	< 50 W	< 50 W
Power Consumption @ 0.5 Full Momentum, Gimbal Rate = 12 deg/second, Output Torque = 0.1 Nm (no acceleration on the inner rotor)	< 6 W	< 4 W	< 5 W
Total Weight of the CMG	< 2 kg	< 1.2 kg	< 1.6 kg
Size of the CMG (cm)	10 x 10 x 10		
Supplied DC bus Voltage	24 ~ 32 V		
Communication Interface	RS485 or RS422		
Control Modes	Speed Mode and Torque Mode		
Static & Dynamic Imbalance of the Rotor	ISO 1940. G0.4		
Operating Temperature Range	-40 ~ 85 degC		
Vibration	14 Grms		

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