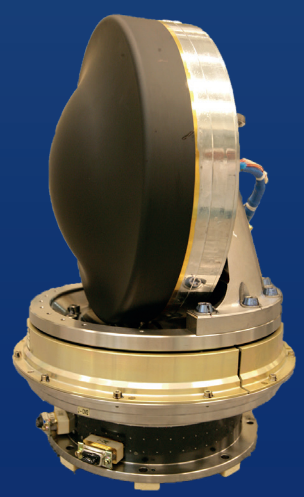
DEFENCE AND SPACE
Spacecraft Equipment

CMG 15-45 S

A compact, cost-effective, high performance Control Momentum Gyroscope solution for medium satellites

A v i o n i c s



A cost-effective solution for new-generation observation and science missions.

The demand for agile satellites has increased considerably over the last few years, be it for commercial or military applications, Earth observation, astronomy, optical instruments or radar payloads. Even for medium satellites, when it comes to providing a high output torque at low mass, power consumption and cost, reaction wheels are no match for Control Moment Gyroscopes (CMGs). Airbus DS offers the CMG 15-45S (15Nms, 45Nm Standard), a compact, high performance CMG optimized for 1,000kg class satellites.

KEY FEATURES

- Brings to your 1000kg class satellite a 3°/s agility in 2s
- 45 Nm torque available, with only 2 Nm applied at gimbal, within 18 kg and 25 W:100 times the torque of a classic wheel
- Rigid preload in the bearings to withstand launch loads (no locking device)
- Precise balancing of the wheel and very low friction in the gimbal bearings for very low disturbances
- Highly accurate pointing performances (high frequency controller using a high resolution optical encoder)
- Dedicated single electronics channel per CMG, with MIL 1553 bus interface
- Easy satellite integration

QUALIFIED FOR THE FOLLOWING

- Thermal: mechanism -20 to +55°C, electronics -25 to +60°C
- Vibration: 20g sine, mechanism 10grms, electronics 15grms
- Shock: mechanism 800g, electronics 1600g over 2000Hz to 10kHz
- Radiation: Total Dose TID compatible with typical 10 years LEO, SEP tolerant, latch-up immune
- EMI/EMC: MIL-STD-461

PERFORMANCES

- Momentum: 15Nms per CMG
- Torque: 45Nm
- Gimbal axis angular range: unlimited
- Lifetime: 10 years LEO
- Gimbal maneuver: more than 2,400,000
- Angular resolution: 22 bits
- Pointing performance: < 10mrad
- Angular momentum stability: < 0.03%

HERITAGE

- Airbus CMG products have cumulated over 1 millon hours on orbit, without failure

INTERFACES

- Mass: 18.4 kg per CMG (mechanism 15.7kg, electronics 2.7kg)
- Volume: mechanism ø 270mm x h 350mm, electronics 310 x 300 x 150mm3 (1 box for 4 CMG)
- Power: 25W @15Nms per CMG
- Power bus: 22–37V
- TM/TC: MIL 1553B bus

CMG 15-45 S PRINCIPLE

A high-performance product optimized for agile small satellites

CMGs have been known for decades, but used to be considered difficult to operate owing to singularities during satellite maneuvers (except by over-sizing the momentum capacity). Recent developments in guidance algorithms to suppress singularities now mean that the full capacity of the CMG cluster can be exploited, minimizing the momentum demand for each CMG.

With four CMGs of only 15Nms, it is now possible to slew a satellite in the one ton class at more than three degrees per second in less than two seconds. Such a low momentum demand offers many advantages compared to a conventional oversized solution: the equipment is more compact and performances are improved.

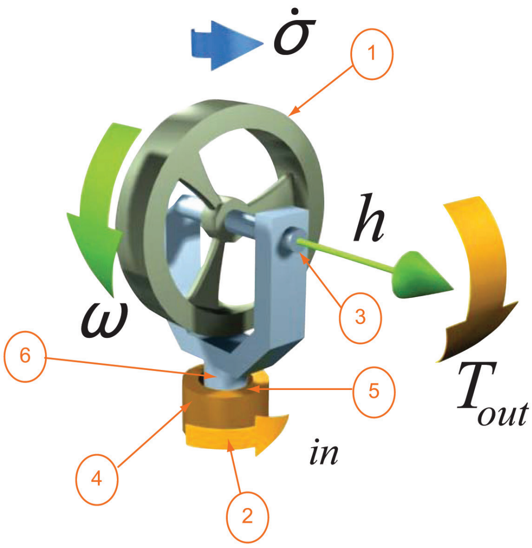
A product based on proven technologies

Both the equipment and its electronics have been designed for series production to minimize recurring costs.

The wheel and the gimbal mechanism use standard components from European manufacturers qualified by CNES and ESA. The electronics are based on an ASIC running at high frequency and a MIL 1553 data bus interface.

A compact product with simple interfaces

The components are assembled in an optimized architecture that minimizes the volume and the mass. The CMG can be mounted on a single base plate with a minimal footprint and no additional hardware is required to install the equipment. The CMG 15-45S integrates easily into satellites of one ton or even less. This compact architecture, which has been patented by AIRBUS DS, has been retained for our other CMG models.



The kinetic momentum is fulfilled by the wheel (1) at constant speed. The precession of the wheel is fulfilled by the gimbal motor (2). The output loads are supported by the ball bearing of the wheel (3) and of the gimbal (4). An angular encoder allows the measurement of the gimbal position (5). The signals and power are led to the wheel through sliprings (6).

$$\vec{T}_{out}(t) = \vec{h}_{wheel} \wedge \dot{\vec{\sigma}}_{gimbal}$$

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