

## DEFENCE AND SPACE

Spacecraft Equipment

# CMG 40-60 S

A compact, cost-effective,  
high performance

Control Momentum

Gyroscope solution

for medium to large satellites



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**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 small and medium satellites, when it comes to providing a high output torque at reasonable mass, power consumption and cost, reaction wheels are no match for Control Moment Gyroscopes (CMGs). Airbus DS offers the CMG 40-60 S (40Nms, 60Nm Standard), a compact, high performance CMG with integrated micro-vibrations dampers optimized for 1,000 - 2,000kg class satellites.

## KEY FEATURES

- Brings to your 1000kg-2000kg class satellite a 3°/s agility in 2s
- 60 Nm torque available, within 18 kg and 45 W:100 times the torque of a classic wheel
- Easy satellite integration thanks to the limited footprint and the one side fixation principle, and thanks to the integrated tilted wedge.
- 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
- Integrated dampers to filters residual disturbances (micro-vibrations)
- Highly accurate pointing performances (high frequency controller using a high resolution optical encoder)

## QUALIFIED FOR THE FOLLOWING

- Thermal: mechanism -30°C to +35°C (Operating), electronics -30°C to +60°C (Operating), -40°C to +70°C storage, -25°C start up
- Vibration: 20g sine with noching down to 2g base at damper modes, random 10grms in plane /15grms out of plane
- Shock: mechanism 2000g, electronics 1600g over 2000Hz to 10kHz
- Radiation: otal Dose TID compatible with typical 10 years LEO, SEP tolerant, latch-up immune
- EMI/EMC: MIL-STD-461

## PERFORMANCES

- Momentum: 30 to 40Nms per CMG
- Torque: 60Nm
- Gimbal axis angular range: unlimited
- Lifetime: 10 years LEO
- Gimbal maneuver: more than 7,300,000
- Angular resolution: 22 bits
- Pointing performance: < 10mrad in maneuver, < 1 mrad in quasi-static phase

## HERITAGE

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

## INTERFACES

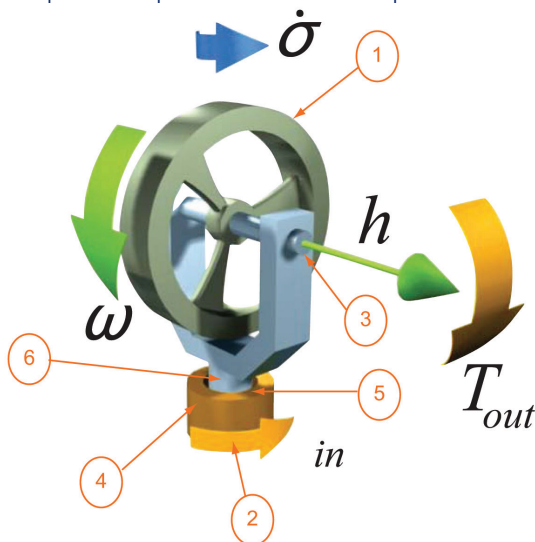
- Mass: 38 kg per CMG (mechanism 32kg, electronics 6kg)
- Volume: mechanism 370mm x 465mm x 500mm, electronics 310 x 210 x 175mm3 (per box for 2 CMG)
- Typical power (quasi-static): 55W @40Nms per CMG
- Power (max maneuver): 115W per CMG
- Power bus: 22-37V

## CMG 40-60 S PRINCIPLE

### A high-performance product optimized for agile mini satellites

CMGs have been known for decades, but used to be considered difficult to operate owing to singularities during satellite manoeuvres (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 40Nms, it is now possible to slew a satellite in the two tons 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.



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).

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

### 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 as the wedge and the micro-vibrations dampers are built-in. The CMG 40-60S integrates easily into medium satellites of two tons or even less. This compact architecture, which has been patented by AIRBUS DS, has been retained for our other CMG models.