

RS100 & RS200 & RS400 Reaction Sphere



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Introduction to RS100 Reaction Sphere

Advanced satellites use control moment gyro (CMG) as their attitude actuator for having a better slew rate under the same power constraint. However, CMGs appear to be more expensive because of a more complicated control methodology and mechanical structure. Nevertheless, compared with reaction wheels with the same angular momentum storage capability, they have a larger output torque but are occupied with more volume and weight.

Tensor Tech's RS100 realizes a variable-speed, single-gimbal CMG driven by 2 degrees of freedom spherical motor technology. It successfully shrinks the volume and weight of a CMG by simplifying its mechanical structure. Although CMGs have comparingly complicated system dynamics, customers won't have to worry about it. RS100 embeds a speed control mode and a torque control mode. Using the speed mode, customers can develop their ADCS algorithms with precise control to the inner rotor speed and the tilting angle of the CMG; Using the torque mode, customers can treat it as a torque output unit which RS100 propagates the control and steering laws internally and assuming the slew rate of the satellite is <1 deg/s.

Features

- Max. angular momentum storage: 10 mNms
- Max. torque: 1 mNm (adjustable)
- Inner rotor speed control accuracy: <5rpm</p>
- Tilting angle control accuracy: <1 deg</p>
- Rotor imbalance: better than G0.4
- Mu-metal covered for magnetic shielding
- Optional GNSS system and 3-axis magnetorquers

Electrical & Mechanical

- Supply voltage: 3.3V & 5V
- Power consumption: <1W</p>
- Volume: 0.1U + > 64mm dia. tuna-can
- Mass: < 250 g</p>

Reliability

- Flight heritage since 2021
- 1.5U to 3U CubeSat in Low earth orbit for 3 years
- Operating temperature: -20 ~ 60 deg C
- PCB & Assembly: IPC class 3 standard

User Interface

- Controlled by the onboard computer (OBC) using I2C or UART with speed or torque command
- User-friendly customer support software for calibration, setting, and simulations on PC
- PC104 connector as the standard offer; able to customize mounting holes & electrical connectors

Spherical Motor Technology

The spherical motor has 2 degrees of freedom on its mechanical structure. In terms of rotational dynamics, it works like a variable-speed, single-gimbal control moment gyro (CMG). With patented magnetic field design and control methodology, the spherical motor can provide angular momentum and torque in 2 axes. The spherical motor can bring your satellite ADCS the same performance but lower weight, volume, and power consumption than the traditional system.



Installation Interfaces of ADCS100

We recommend installing RS100 in configuration 1. It takes the least space for users. If an optional GNSS system is ordered from Tensor Tech, we can put the GNSS antenna right on top of the tuna-can. Customers won't have to find a position on their CubeSat for this. Moreover, The GNSS receiver will be installed on RS100's main PC104 circuit board. If the customer plans to use a magnetometer for attitude determination, we suggest placing it at least 100mm away from RS100. Although there are already two hemispherical mu-metal cover up the RS100, this distance can ensure the max. magnetic flux density induced by RS100 be lower than 0.001 mTesla. In addition, putting ADCS100 inside the CubeSat like configuration 2 is feasible, too. The closer the attitude actuator (or any torque output unit) to the center of mass of the satellite, the more slew rate this ADCS can have. Of course, this makes the pointing accuracy less accurate.



Introduction to RS200 Reaction Sphere

The RS200 product is consists of two RS100 products. People call it a "scissor pair" if the tilting angles of two RS100 act reversely to each other. RS200 won't completely do so because it is aiming for providing torque in 2 axes. We recommend installing RS200, aligning its gimballing axis (Z-axis) to the Z-axis of the satellite, which has the smallest moment of inertia. Magnetorquers should control this Z-axis. Like all other RS series products, the GNSS system and magnetorquers are optional.

Single-gimbal CMG exerts gyroscopic torque in a direction that is orthogonal to its rotor shaft directional vector and tilting axis unit vector. Since the direction of this torque vector is varying through time, a scissor-pair CMG cluster can use each other to cancel the unwanted torques and utilize more gyroscopic torque instead of reaction wheel torque. (accelerating or decelerating the inner rotor) As a result, the torque-to-power ratio could be higher.

Speed mode and torque mode are provided for customers to choose from building their torque output algorithm or using the one provided by Tensor Tech.

Features

- Max. angular momentum storage: 20 mNm
- Max. torque: 2 mNm (adjustable)
- Inner rotor speed control accuracy: <5rpm</p>
- Tilting angle control accuracy: <1 deg</p>
- Rotor imbalance: better than G0.4
- Optional GNSS system and 3-axis magnetorquers

Electrical & Mechanical

- Supply voltage: 3.3V & 5V
- Power consumption: <2W</p>
- Volume: (0.1U + > 64mm dia. tuna-can)*2
- Mass: < 500 g</p>

Reliability

- Designed for 6U CubeSats in Low earth orbit for 3 years
- Operating temperature: -20 ~ 60 deg C
- PCB & Assembly: IPC class 3 standard

User Interface

- Controlled by the onboard computer (OBC) using I2C or UART with attitude command
- User-friendly customer support software for calibration, setting, and simulations on PC
- PC104 connector as the standard offer; able to customize mounting holes & electrical connectors

Introduction to RS400 Reaction Sphere

The RS400 product is consists of four RS100 products. People call it a "pyramid cluster". It is the most common way of using single gimbal CMG because the redundancy is ensured and gyroscopic torque could be fully exerted in 3 axes.

If customer's deployer has four tuna-cans, we suggest to install these four RS100 in the bottom of the satellite like the picture showed below. If there has no such volume available, installing these four RS100 inside the CubeSat is feasible as well. Just remember to tell the RS400 the information of the position of these four RS100 during the setting process using Tensor Tech's customer support software.

Moreover, if customers plan to build your own ADCS using its speed mode, there already exist a mature steering law for these CMGs so customers won't have to worry about how to control this cluster. If a torque mode is chosen, RS400 will output with the torque commanded by the on board computer using internally embedded control and steering algorithms.

Features

- Max. angular momentum storage: 20 mNm
- Max. torque: 4 mNm (adjustable)
- Inner rotor speed control accuracy: <5rpm</p>
- Tilting angle control accuracy: <1 deg</p>
- Rotor imbalance: better than G0.4
- Mu-metal covered for magnetic shielding

Electrical & Mechanical

- Supply voltage: 3.3V & 5V
- Power consumption: <4W</p>
- Volume: (0.1U + > 64mm dia. tuna-can)*4

Reliability

- 8U,12U,16U CubeSats in Low earth orbit for 3 years
- Operating temperature: -20 ~ 60 deg C
- PCB & Assembly: IPC Class 3 standard

User Interface

- Controlled by the onboard computer (OBC) using I2C or UART with attitude command
- User-friendly customer support software for calibration, setting, and simulations on PC
- PC104 connector as the standard offer; able to customize mounting holes & electrical connectors

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