

space  
satellite



together  
we go further ADCS

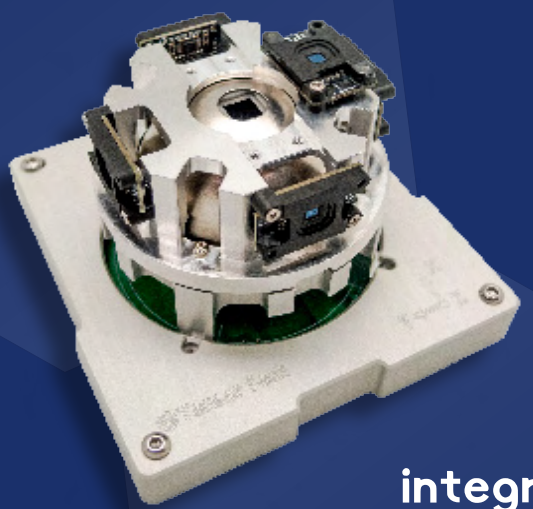


together  
we go further

tensor tech is an innovator of satellite attitude determination and control systems, with expertise in guidance, navigation, and control.

we offer a suite of space-qualified products ranging from flight-proven subsystems to highly reliable components and scalability based on customer requirements.

# ADCS



integrated  
attitude  
determination  
and  
control  
system

 flight heritage since jan. 2022

tensor tech's **ADCS** uses variable speed control moment gyroscopes ( **CMG** ) for pointing and tracking, which is more power effective than reaction wheels.

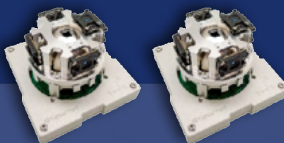
actuators are fully scalable through various **CMG** configurations. the **ADCS** includes estimator and control algorithms with a wide variety of sensors for all **ADCS** control modes.

# ADCS

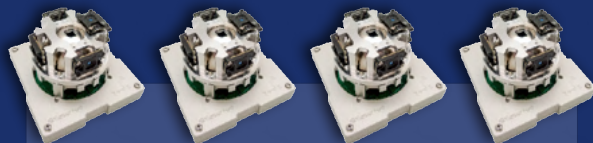
specifications



10m



20m



40m

included hardware

- 1 × CMG-10m Control Moment Gyroscope
- 6 × FSS-15 Fine Sun Sensor
- MEMS gyroscope
- Triaxial magnetorquer and magnetometer
- Micro-Controller serve as ADCS computer

- 2 × CMG-10m Control Moment Gyroscope
- 6 × FSS-15 Fine Sun Sensor
- MEMS gyroscope
- Triaxial magnetorquer and magnetometer
- Micro-Controller serve as ADCS computer

- 4 × CMG-10m Control Moment Gyroscope
- 6 × FSS-15 Fine Sun Sensor
- MEMS gyroscope
- Triaxial magnetorquer and magnetometer
- Micro-Controller serve as ADCS computer

optional accessories

GNSS receiver & antenna

GNSS receiver & antenna

GNSS receiver & antenna

pointing knowledge

< +/- 0.1 deg @ sun can be captured;  
< +/- 1 deg @ sun cannot be captured

< +/- 0.1 deg @ sun can be captured;  
< +/- 1 deg @ sun cannot be captured

< +/- 0.1 deg @ sun can be captured;  
< +/- 1 deg @ sun cannot be captured

pointing accuracy

< +/- 0.2 deg @ sun can be captured;  
< +/- 1 deg @ sun cannot be captured

< +/- 0.2 deg @ sun can be captured;  
< +/- 1 deg @ sun cannot be captured

< +/- 0.2 deg @ sun can be captured;  
< +/- 1 deg @ sun cannot be captured

power consumption @ 5v bus

< 1 W

< 2 W

< 4 W

power consumption @ 3.3v bus

< 1 W

< 1 W

< 1 W

mechanical

Tuna-can & 0.2U (< 300 g)

2 × Tuna-cans & 0.4U (< 600 g)

4 × Tuna-cans & 0.8U (< 1200 g)

angular momentum storage

< 10 mNms for 2-axis (adjustable)

< 20 mNms for 1-axis;  
< 10 mNms for 2-axis (adjustable)

< 30 mNms for 2-axis;  
< 20 mNms for 1-axis (adjustable)

torque

< 1 mNm for 2-axis (adjustable)

< 2 mNm for 1-axis;  
< 1 mNm for 2-axis (adjustable)

< 3 mNm for 2-axis;  
< 2 mNm for 1-axis (adjustable)

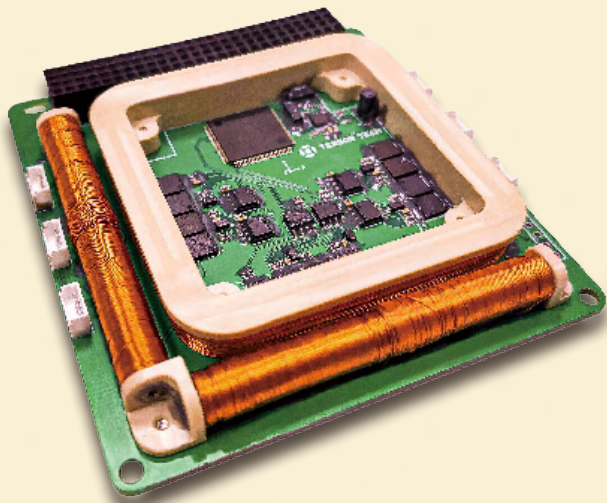
interface

I<sup>2</sup>C, UART and RS485/422\* (optional)  
\*The user can only select one from the two.

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# ADCS-MTQ



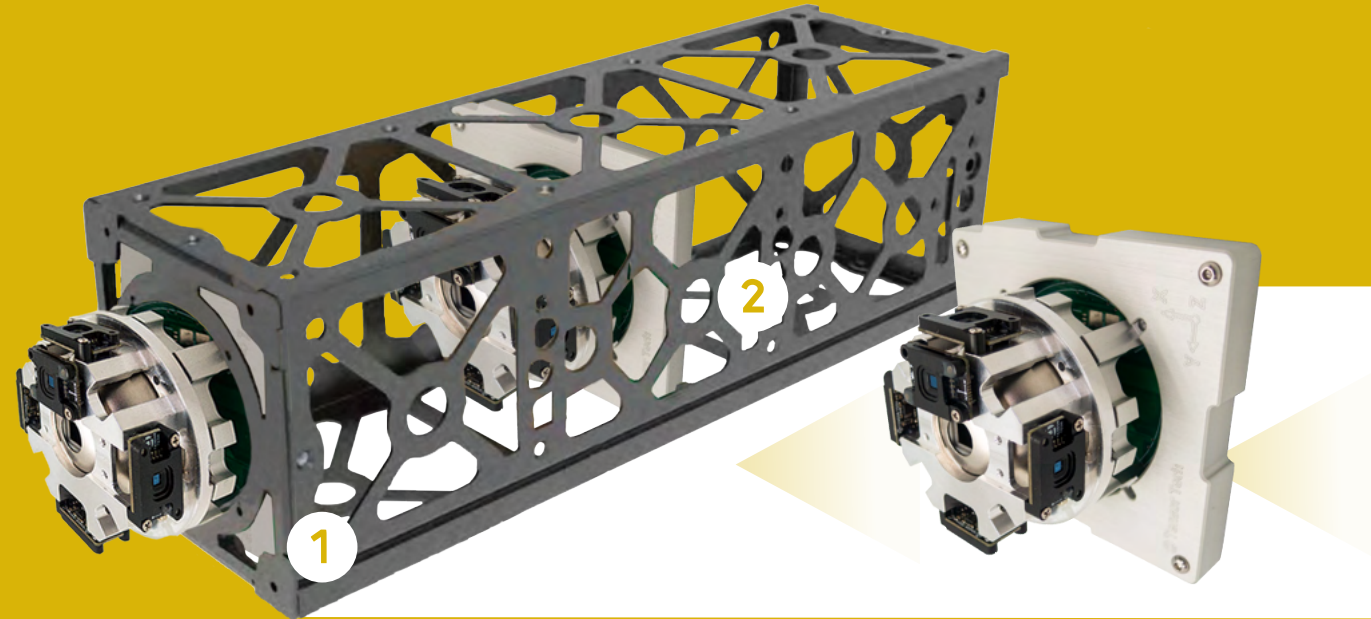
integrated  
attitude  
determination  
and  
control  
system

## specifications

included modes	<ul style="list-style-type: none"><li>Direct magnetic dipole moment control</li><li>De-tumbling from &lt; 30 deg/s to &lt; 1 deg/s within 12 hrs</li><li>Sun-pointing with accuracy up to &lt; 10 deg when six optional FSS-15 Fine Sun Sensor are equipped</li></ul>
included hardware	Micro-controller, Triaxial magnetorquer, and Magnetometer
optional accessories	GNSS receiver & antenna
power consumption @ 5v bus	< 1 W
power consumption @ 3.3v bus	< 1 W
magnetic dipole moment	< 0.2 Am <sup>2</sup> for 2-axis; < 0.1 Am <sup>2</sup> for 1-axis (adjustable)
mechanical	0.2U (< 140 g)
interface	I <sup>2</sup> C, UART and RS485/422* (optional) *The user can only select one from the two.



## installation interfaces



installing the ADCS or CMG in tuna-can  
(configuration 1 ) is recommended, as this  
takes up the least space in the satellite.

however, it is feasible to install the ADCS or  
CMG within the cubesat structure shown in  
configuration 2.

**configuration 1.**  
**install in the bottom of 3U+/6U+ satellite**  
#occupied volume : 0.2U

**configuration 2.**  
**install in the middle of cubesat**  
#occupied volume : 0.4U

# CMG



control  
moment  
gyroscope

 flight heritage since jan. 2022

tensor tech’s minimized variable speed control moment gyroscope (**CMG**) features its lower mass, smaller volume, and more power effective compared with reaction wheels.

the **CMG** includes speed and torque modes, allowing users to control the **CMG** directly by simply setting speed or torque output values.

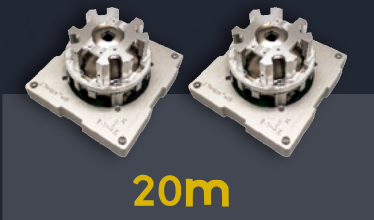


# CMG

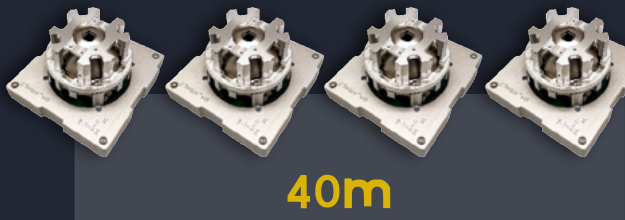
specifications



**CMG-10m** is a variable speed control moment gyroscope ( **CMG** ) which is suitable for satellites up to roughly **3U**.



**CMG-20m** is a scissored pair, variable speed control moment gyroscope ( **CMG** ) which is suitable for satellites up to roughly **6U**.



**CMG-40m** is a pyramid cluster, variable speed control moment gyroscope ( **CMG** ) which is suitable for satellites up to roughly **12U**.

angular momentum storage	< 10 mNms for 2-axis (adjustable)	< 20 mNms for 1-axis; < 10 mNms for 2-axis (adjustable)	< 30 mNms for 2-axis; < 20 mNms for 1-axis (adjustable)
torque	< 1 mNm for 2-axis (adjustable)	< 2 mNm for 1-axis; < 1 mNm for 2-axis (adjustable)	< 3 mNm for 2-axis; < 2 mNm for 1-axis (adjustable)
inner rotor speed control accuracy	< 5 rpm	< 5 rpm	< 5 rpm
tilting angle control accuracy	< 1 deg	< 1 deg	< 1 deg
optional GNSS system and 3-axis magnetorquers		optional GNSS system and 3-axis magnetorquers	
rotor imbalance	ISO 1940 G0.4	ISO 1940 G0.4	ISO 1940 G0.4
power consumption @ 5v bus	< 1 W	< 1 W	< 4 W
power consumption @ 3.3v bus	< 1 W	< 1 W	< 1 W
mechanical	Tuna-can & 0.1U (< 250 g)	2x Tuna-can & 0.2U (< 500 g)	4x Tuna-can & 0.4U (< 1000 g)
interface	I <sup>2</sup> C, UART, and RS485/422* (optional) *The user can only select one from the two.	I <sup>2</sup> C, UART, and RS485/422* (optional) *The user can only select one from the two.	I <sup>2</sup> C, UART, and RS485/422* (optional) *The user can only select one from the two.



# FSS-15

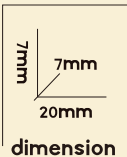
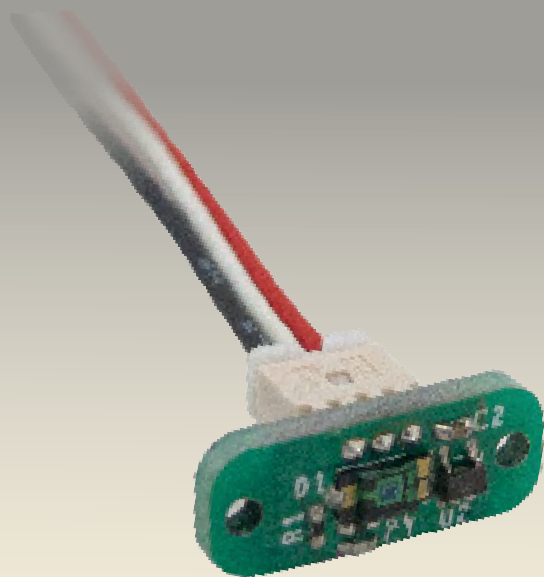
fine sun sensor

- flight heritage since jan. 2022
- FSS-15M** with magnetometer
- FSS-15D** higher update rate



## specifications

- 2-axis digital sun sensor embedded with calibration error table and micro-controller
- embedded firmware for radiation-caused transient error detection and recovery
- field of view ( FOV ) |  $\pm 60$  deg; 45 deg for optimal performance
- accuracy |  $\pm 0.1$  deg with 45 deg FOV (1-sigma);  
 $\pm 0.5$  deg with 60 deg FOV (1-sigma)
- sampling rate | 2, 4, 8, and 16 Hz adjustable by the user
- current consumption @ sampling |  $< 2$  mA
- current require @ IDLE |  $< 0.5$  mA
- mechanical | 22.00  $\times$  15.00  $\times$  5.26 mm ( $< 4$  g)
- radiation tolerance |  $> 10$  krad
- interface | I2C and UART (adjustable)



# CSS-10

## coarse sun sensor

CSS-10 is a coarse sun sensor with a simple and robust design. this sun sensor is suitable for spacecrafts with low pointing requirement or need a robust input for sun-acquisition algorithm. multiple sun sensors are recommended to be installed on different faces of the satellite to maximize the field of view of the sun sensor array.

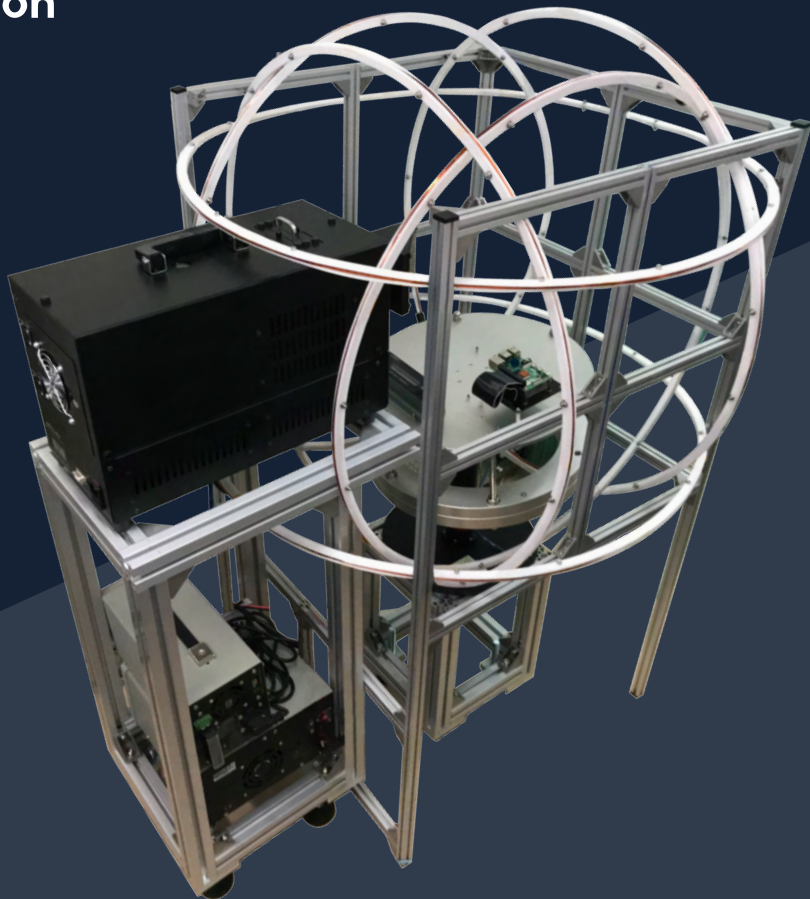
### specifications

- 1-axis analog coarse sun sensor
- < 5 deg (1-sigma) of sun determination accuracy is achievable following the user manual's calibration instructions
- hardware protection for short-circuit-caused system failure prevention
- six coarse sun sensors can provide a full sky ( $4 \pi$ ) FOV coverage ( $\pm 60$  deg for each sensor)
- an analog-to-digital converter should be installed to extract information.
- three pins including Vcc, GND, and output line.

field of view	$\pm 60$ deg
power consumption	< 0.1 mA
mechanical	20.00 × 10.00 × 5.70 mm (< 0.5 g)
radiation tolerance	> 10 krad

# ADCS-Testbed

attitude  
determination  
control  
system  
testbed



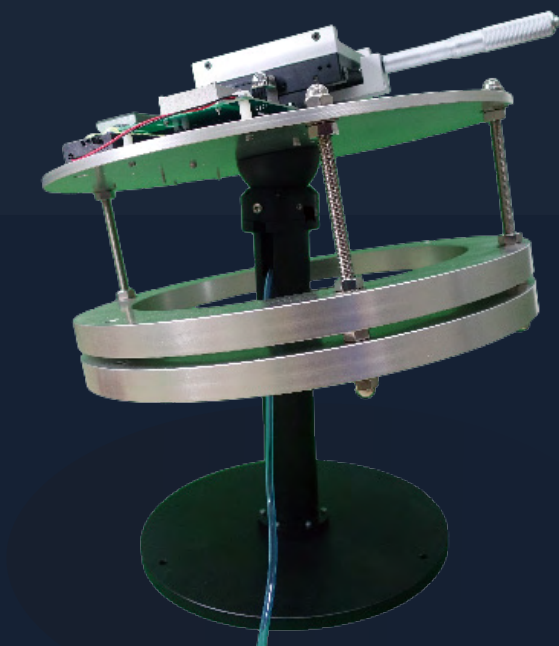
an attitude determination and control system ( **ADCS** ) testbed is required for **ADCS** examination and calibration. the testbed consists of an air-bearing platform, a triaxial helmholtz cage, and a solar simulator.  
this fully scalable testbed can measure the mass properties of the device under test, which is optional to the customer

## specifications

❖ <b>triaxial helmholtz cage</b>	
Max. magnetic flux density	1 gauss (adjustable)
Working area	350 x 350 x 350 mm (adjustable)
❖ <b>air-bearing platform</b>	
Manual adjusted x/y axis platform	
Turbine torque	5 $\mu$ Nm
Travel angle	$\pm$ 45 deg; Max. load 30 kg (16U CubeSat, adjustable for a larger load)
❖ <b>solar simulator</b>	
Spectral matching	AM0, Class A, ASTM
Spatial non-uniformity of total irradiance	< 2%
Time instability	< 1%
Light spot dimension	40 x 40 mm (adjustable)
Collimation	< 4 deg

# ADCS

air bearing platform



single board computer and tactical grade inertia measurement unit ( **IMU** ) are integrated onto the air bearing platform. moreover, readouts of the **IMU** are used to propagate and fuse the attitude of the platform. the determined attitude could be remotely accessed using the dedicated software and serve as a reference for improving the tested **ADCS**.

## specifications

mass	± 10 mg
center of mass	± 0.1 mm
moment of inertia	± 2%



space has defined some of humanity’s most outstanding achievements, and it continues to shape our future today.

we are motivated by the impact we can have by bringing reliable technologies to our customers, as the company’s core spirit, “together, we go further”.

# our service

 ADCS hardware in the loop

 ADCS integration

 AOCS performance analysis

 mass properties measurement

 jitter analysis and measurement

 processor in the loop

 original equipment manufacturing

 original design manufacturing



# **ADCS** together we go further



**tensortech.com.tw**



**info@tensortech.com.tw**