

KONGSBERG

Adaptive Rotational Mechanism Assembly – 5 Enhanced (KARMA-5 Enhanced)



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The Kongsberg Adaptive Rotational Mechanism Assembly, KARMA-5 Enhanced, is under development for the BepiColombo Mission.

The KARMA-5 Enhanced is developed to handle extreme temperature conditions for deep space interplanetary cruise as well as near Sun operation. The power transfer capability is high providing the BepiColombo MTM space craft electric engine the required power throughout the mission of more than 6 years.

The KARMA-5 Enhanced consists of the mechanism with structural interfaces, drive line and position sensor, and a slip ring for rotary power and signal transfer.

The unit is sealed to avoid any contaminated airflow during launch and allow dry, clean nitrogen gas flow during all ground operations and test.

The nitrogen purging is needed to prevent degradation in humid air of the MoS₂ dry thin film lubrication system used for all gears and bearings. The dry thin film lubrication ensures very low frictional operation over the whole thermal operational range (-78°C to +150°C).

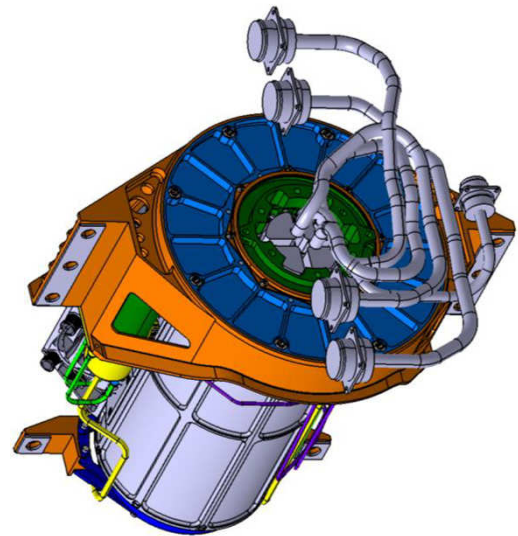
The drive actuator is specially developed for operation up to 280°C.

The slinging is a hybrid type which uses solid carbon brush technology for the power group allowing high temperature operation, while the signal tracks uses the newer gold-gold technology for low mass and volume.

The position sensor is a dual speed potentiometer solution with 0.2° accuracy over the whole temperature range.

The KARMA-5 Enhanced SADM complies to requirements by virtue of 4 main functions:

1. Retain solar array; keep S/A attached to the S/C and react forces resulting from launch loads and in orbit manoeuvre.
2. Point the S/A in desired direction in three modes: Hold Mode, Slow Mode (up to 0.5°/s) and fast Mode (up to 6°/s and accelerating at 12°/s²)
3. Transfer power and signals from S/A rotating reference frame, to S/C stationary reference frame
4. Redundant position feedback in absolute position over 360°.



Features

General

- Extreme temperature capability
- High speed and acceleration
- High pointing accuracy
- High reliability
- High load capacity
- Accurate position feedback
- Environmentally sealed with controlled gas let-out during launch

Slip-ring configuration

- Hybrid power and signal technology
- High power capability (7.5 kW)
- High temperature capability
- Continuous rotation

The BepiColombo MTM spacecraft uses two KARMA-5 SADMs.

Both SADM are driven by KDAs ELEKTRA-5 SADE with special drive capabilities for high and low speed, absolute position readout, and AD conversion of Solar Array signals.



KARMA-5 Enhanced Technical Data

Mechanism	
Motor type	Redundant two phase bipolar stepper
Rotational speed capability	Slow Mode 0.5°/s, Fast Mode : 6°/s with 12°/s ²
Full step resolution	0.012°
Pointing accuracy	< 0.05° half cone
Qualified operational life	7 years
Qualification revolutions	4600 of output shaft
Power requirements	Slow Mode: 6 W, Fast Mode: 25 W
Non-powered hold torque	> 8 Nm
Max torque capability	75 Nm
Solar Array inertia load capability	> 40 kgm ²
Typical Slip-ring performance	
Power tracks	30 / 12.5A
Signal tracks	27 / 2 A
Ground tracks	4
Total current	> 375 A
Position feedback	
Type	Potentiometer, dual speed (1:1 and 13:1)
Range	360° absolute
Accuracy	0.2° half cone (binary output from SADE)
Qualification temperatures	
Non-operational	-80 °C to +170 °C
Operational	- 75°C to +170 °C
Mass	
Depending on configuration	10 kg
Qualification loads	
Axial	1.3 kN
Radial	2.3 kN
Cross axis moment	337 Nm
Dimensions	
Length	300 mm
Diameter	230 mm
Width (panel cut out)	263 mm