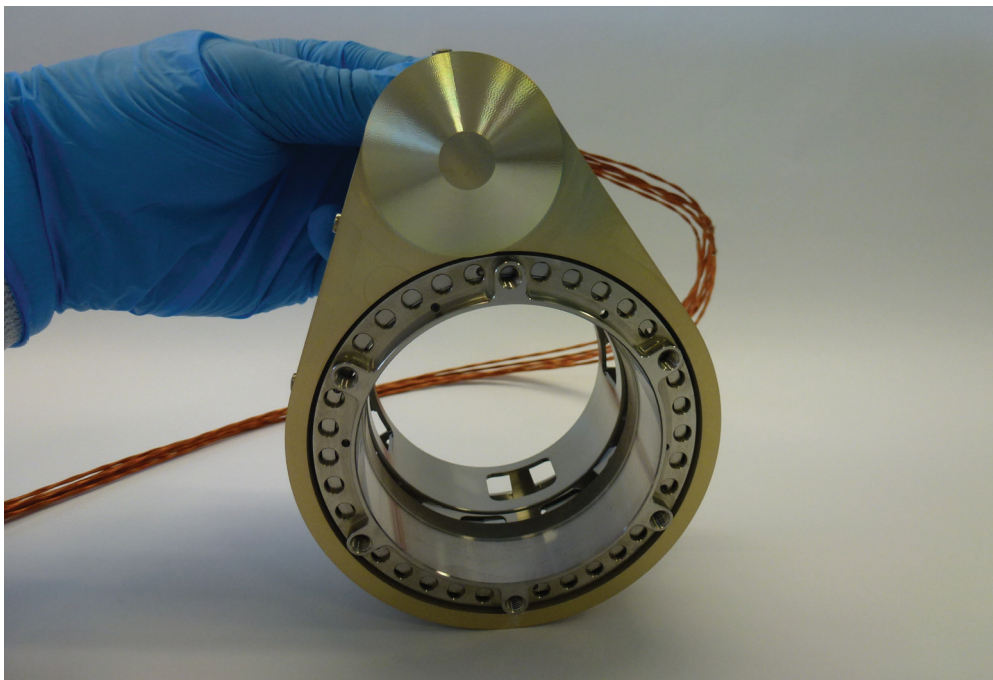


# Hollow Shaft Actuator 3 (HS3)

The Hollow Shaft Actuator (HS3) is a low mass long life high detent torque actuator developed for antenna pointing applications.



The Hollow Shaft Actuator (HS3) consists of a permanent magnet high detent torque stepper motor, a planetary gear and a spur gear actuating a shaft which is supported by a pre-loaded pair of high precision thin section bearings.

A sensor system making use of potentiometer provides angular position indication.

An optional thermistor may provide the motor temperature.

The HS3 actuator can be equipped with hard end stops.

The motor windings, the angular sensors and the thermistors are redundant.

The main advantages of the HS3 actuator are:

- Large Through Hole of  $\varnothing$  72 mm
- Low Mass
- Long Life
- High Detent Torque
- Clean Detent Torque
- Noise-Free Angular Sensing
- Various optional equipment out of the RSA modular actuator system

## Options

The following options are available:

- Different position of the hard end stops relative to reference position or no end stops for continuous rotation
- Specific angles at the output shaft hole pattern
- Specific angles at the housing hole pattern
- Different gear ratio / step size
- Electrical end-switches
- A coarse/fine reference sensor based on latching Hall effect sensor
- Harmonic Drive Gear HD26 instead of Planetary Gear PG26 (having different gear ratio)
- Backlash free gear
- Custom motor winding resistance, 2 or 3 phase, bipolar or unipolar windings

The HS3 is part of the RSA modular actuator system, containing motor NEMO26 and planetary gear PG26 of the RSA modular actuator system. To fulfill specific requirements, the full range of motors and gears of the RSA modular actuator system can be exploited.

## Packaging, Handling and Storage

The item is delivered double bagged with GN<sub>2</sub> and desiccants in a plastic box. Foam pads provide protection against handling loads.

The item shall only be handled in a clean room CC100000 or better. The item contains electrostatic discharge (ESD) sensitive parts. ESD precautions shall apply to protect the item against electrostatic discharge.

## Deliverables

- FMs or PFMs
- Transport box
- EIDP: Certificate of Conformity, Configuration Item Data List, Parts-, Materials- and Processes-List, Logbook, Mechanical and Electrical Interface Control Document, User Manual, Requests for Deviation and Requests for Waiver, Non Conformance Reports, Minutes of Meetings, Acceptance Test Plan, Acceptance Test Report

## Acceptance Tests

- Dimensional inspection
- Visual inspection
- Mass measurement
- Functional check of sensors
- Functional check of motor
- Vibration test
- TV cycling test
- Starting current test at ambient conditions

## Performance

Description	Value
<b>General Characteristics</b>	
Mass without harness	< 950 g without angular sensor < 1.290 g including potentiometer
Envelope	See Mechanical ICD
Drive direction	Clock-wise and counter-clock-wise rotation
HS3 output speed	[0.057255...°] * [full step rate]
Maximum step rate	600 Hz no load response rate
Steps per HS3 output revolution	6288
Backlash at HS3 output shaft	< 30 arcmin (optional: backlash-free)
Lifetime	15 years in orbit + 5 years storage
Life profile (life test)	47.000 revs
Power consumption at 20°C	< 6 W per Phase
Powered holding torque at HS3 output shaft Unpowered holding torque at HS3 output shaft ( = min. motor magnetic detent torque multiplied with total gear ratio, without HS3 internal friction)	11.5 Nm (one phase powered) > 0.5 Nm (> 1 Nm optional)
Delivered Output Torque at HS3 output shaft • full step, 200 Hz step rate, 200mA/phase • wave drive, low step rate, 200mA/phase Calculated in full accordance with ECSS (all HS3 internal losses and magnetic detent torque are factorized with ECSS uncertainty factors <sup>1)</sup> and with the motorisation factor „2“)	3.0 Nm 3.0 Nm
Measurable Output Torque at HS3 Output Shaft	6.9 Nm
Rolling bearing material (rings and balls)	AISI 440C
Lubrication	PFPE based fluid lubrication
Backdrivability in ambient air	Yes

<sup>1)</sup> ECSS-E-ST-33-01C uncertainty factors applied for motorisation budget:

Component of resistance	Symbol	Theoretical Factor	Measured Factor
Inertia	$I$	1,1	1,1
Spring	$S$	1,2	1,2
Motor mag. losses	$H_M$	1,5	1,2
Friction	$F_R$	3	1,5
Hysteresis	$H_Y$	3	1,5
Others (Harness)	$H_A$	3	1,5
Adhesion	$H_D$	3	3

<b>Motor</b>		
Winding resistance	150 $\Omega$ per phase (or any resistance out of the modular actuator system, e.g. 68 $\Omega$ )	
Winding inductance	18 mH per phase	
Number of phases	2	
Operation	Bipolar	
Redundant Windings	Yes	
Shortened Winding Torque Reduction	30% (motorization factor still > 2)	
External magnetic moment	< 1 Gauss at a distance of 30mm	
Clean detent torque	Yes Stable high detent torque positions at any full step position and at any half step position	
<b>Angular Position Sensor</b>		
Absolute angular measurement	Yes	
Type	Potentiometer	
<b>Motor Temperature Sensor (optional)</b>		
Motor thermistor type	Rosemount 118MF 500 A	
Redundant	Yes	
<b>External Loads</b>		
Axial force (+20°C, isothermal, non-operating, no other external loads)	3000 N	
Radial force (+20°C, isothermal, non-operating, no other external loads)	2000 N	
Bending moment (+20°C, isothermal, non-operating, no other external loads)	60 Nm	
Allowable dynamic peak torque at output shaft	26 Nm	
<b>Stiffness</b>		
Axial stiffness (HS3 attached to rigid bodies)	90500 N/mm (119000 N/mm)	
Radial stiffness (HS3 attached to rigid bodies)	41000 N/mm (98000 N/mm)	
Torsional stiffness when the motor is unpowered	1500 Nm/rad	
Bending stiffness	108000 Nm/rad (194000 Nm/rad)	
Stated Values for low stiffness configuration, values in bracket for high stiffness configuration.		
<b>Vibration</b>		
Quasistatic load (qualification level)	90g	
Sine vibration load (qualification level)	Frequency in Hz	Level in g
	5	1
	21	35
	50	35
	100	55

Random vibration load (qualification level)	Frequency in Hz	Level in g <sup>2</sup> /Hz
	20	0.008
	60	2
	100	2
	2000	0.007
	Total: 17.59 gRMS	
<b>Shock Input</b>		
	Frequency in Hz	SRS in g
Shock load	100	33
	1000	1000
	1000	1000
<b>Ground Storage</b>		
Ground storage temperature	+10°C / +40°C	
Ground storage humidity	20% / 50% RH	
<b>Temperature Range</b>		
In orbit non-operational temperature	-70°C / +125°C (qualification)	
In orbit operation temperature	-52°C / +125°C (qualification) -40°C / +100°C (nominal)	
Allowable temperature gradient between HS3 shaft and HS3 housing	10°C	
Thermal resistance between HS3 output shaft and HS3 housing in vacuum	7 K/W	
<b>Radiation Environment</b>		
Geostationary Environment		
<b>Electrical Connectors</b>		
Electrical Connector	DAMA 26P-NMB-FO (High Density D-Sub 26P)	
<b>External Surfaces</b>		
External Finish	Interfaces: stainless steel, passivated	
<b>Export Licenses</b>		
Export Licenses	No components are under export control.	

## Dimensions and Mechanical Interface

