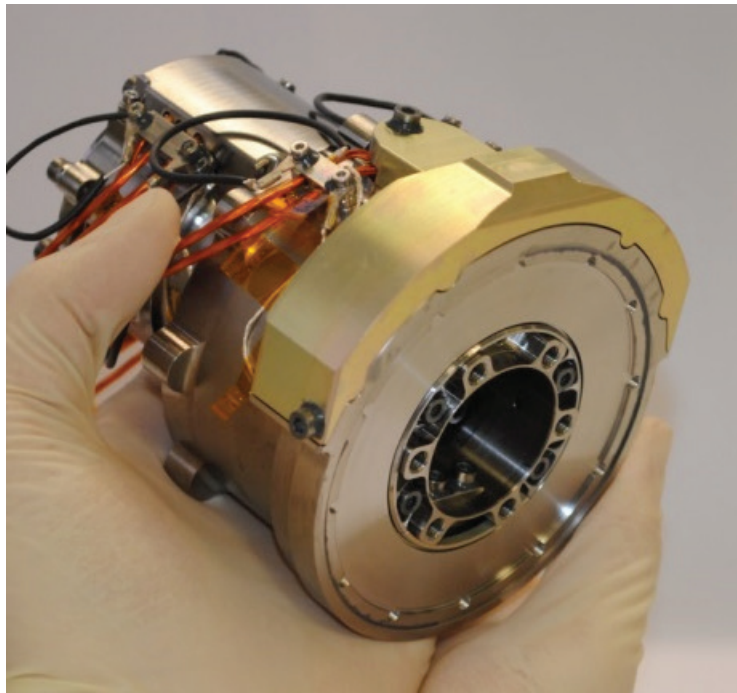


Geared Actuator 15 (GA15)

The GA 15 Geared Actuator (GA) is a low mass actuator with high output torque and high unpowered detent torque, maintaining its pointing direction in unpowered condition even under high back driving torques.



The GA 15 geared actuator (GA) is a low mass actuator with high unpowered detent torque feature, maintaining its pointing direction in un-powered condition even under high back driving torques.

A sensor system making use of latching Hall effect sensors and a potentiometer sensor system – both in coarse / fine arrangement – provides an indication of the position. The GA15 is equipped with adjustable hard end stops. The motor windings, the Hall effect sensors, the potentiometers and the thermistors are redundant.

The Geared Actuator GA15 was developed based on the actuator built to drive the Thruster Pointing Mechanisms of the Mercury Transfer Module of the ESA / JAXA mission Bepi Colombo. A total of 2 QMs and 9 FMs of these actuators were built for the Bepi Colombo programme.

The main advantages of the GA15 are:

- Low mass: The whole GA15 mass including all sensors is below 1.45 kg
- High torque: The measurable output torque of the actuator is 61 Nm
- High unpowered detent torque: The purely magnetic unpowered detent torque of the actuator is 13.8 Nm without taking into account friction (which gives additional margin)
- Long Life: Life test according to ECSS
- ECSS compliant: The actuator is developed in accordance to ECSS within ESA development programs

Options

The following options are available:

- Excluding Hall effect reference sensors, reducing the actuator mass to 1.33 kg
- Custom reference position indicated by the Hall effect sensors
- Custom position of the hard end stops relative to reference position, therefore customizing the pointing range
- Custom angles at the output shaft hole pattern along the pitch circle diameter
- Custom angles at the housing hole pattern along the pitch circle diameter
- Custom motor winding resistance, 2 or 3 phase, bipolar or unipolar windings

The GA15 is part of the RSA modular actuator system, containing motor NEMO and planetary gear PG of the RSA modular actuator system. To fulfill specific requirements, the 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 GN₂ 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 Test

- 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

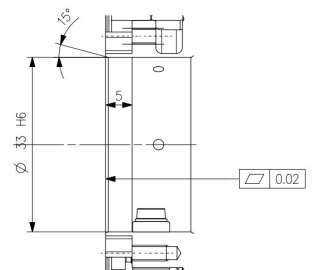
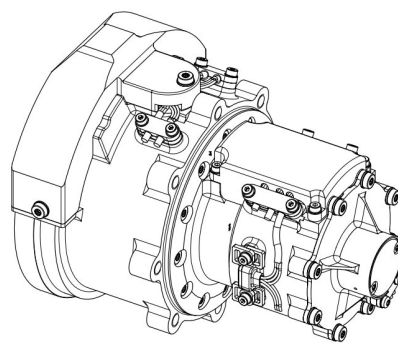
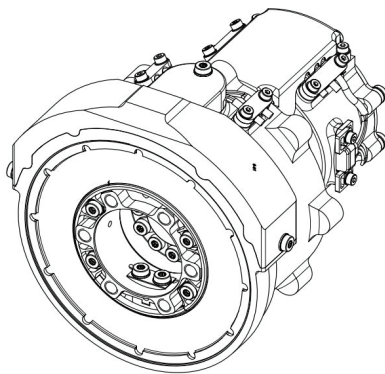
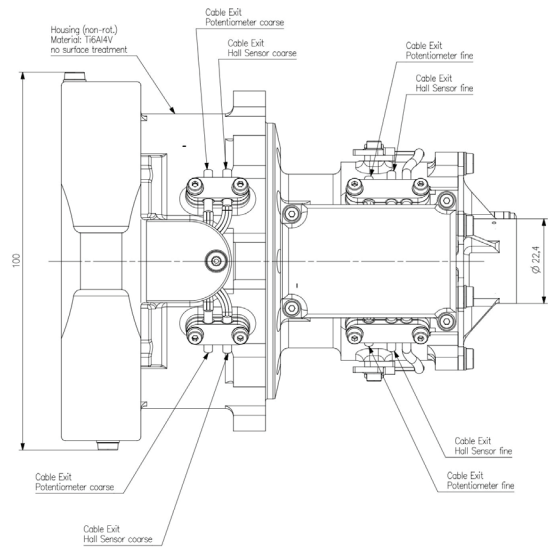
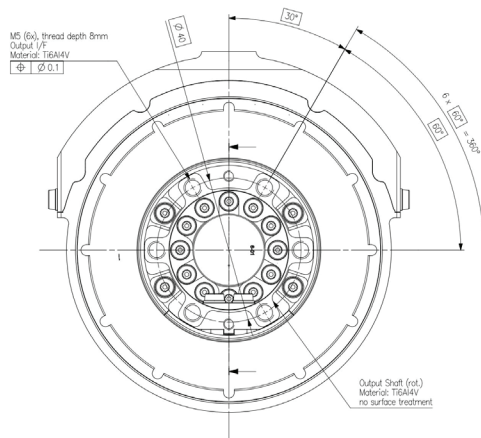
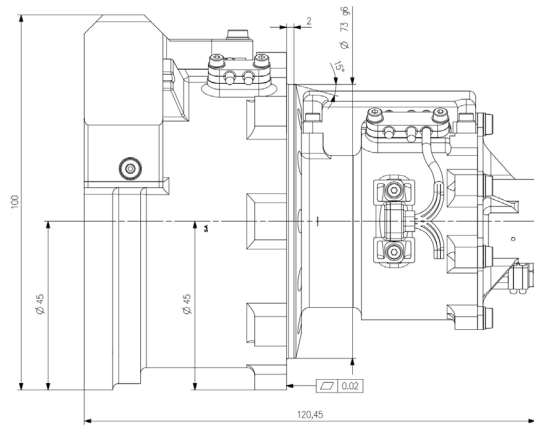
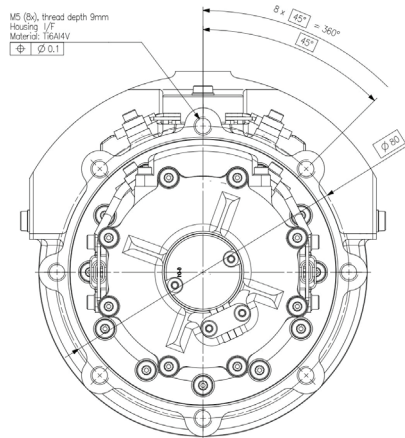
| Description | Value |
|---|--|
| General Characteristics | |
| Mass | < 1.45 kg < 1.33 kg without Hall effect reference sensors |
| Envelope | See Mechanical ICD |
| Drive direction | Clock-wise and counter-clock-wise rotation |
| Pointing range | 250°, customer specific reduction possible or full rotation without end-stops |
| Full Steps per output revolution | 80640 |
| Backlash at output shaft | < 0.0031° |
| Lifetime | 15 years in orbit + 5 years storage |
| Life profile (life qualification) | 4000 small cycles (+/- 0.1 deg), 200 medium cycles (+/-/-/+ 2 deg), 80 large cycles (+/-/-/+ 120 deg), at +20°C ambient, 514560 small cycles (+/- 0.1 deg), 33560 medium cycles (+/-/-/+ 2 deg), 5560 large cycles (+/-/-/+ 120 deg), 50% at -40°C, 50% at +100°C in vacuum |
| Measurable Output Torque | cold (-50°C) 100 Nm ambient (+20°C) 61 Nm hot (+110°C) 86 Nm |
| ECSS factorized "Delivered Output Torque" | 15 Nm |
| Unpowered holding torque at output shaft (min. motor magnetic detent torque multiplied with total gear ratio, without actuator internal friction which gives additional margin) | 13.4 Nm |
| Clean Detent Torque | yes, stable detent positions at any half step and at any full step |
| Rolling bearing material (rings and balls) | AISI 440C |
| Lubrication | PFPE based fluid lubrication |
| Backdrivability in ambient air | Yes. backdriving torque: 22 Nm (@ max. magnetic detent torque, bearing friction, unpowered, and 70% worst case overall gear efficiency) |

| Description | Value |
|---|--|
| Motors | |
| Winding resistance | cold (-50°C) 54 Ω ambient (+20°C) 75 Ω hot (+110°C) 102 Ω |
| Voltage | 26V +/- 10% |
| Power consumption at 20°C and nom. voltage | < 10 W |
| Operation | 2 Phase bipolar wave drive alternatively: Full Step, Half Step or micro-stepping, unipolar version available |
| Redundant Windings | yes |
| Maximum allowable motor winding temperature | 150°C |
| External magnetic moment | < 1 Gauss at a distance of 20 mm |
| Reference Position Sensor | |
| Reference position indication | Binary |
| Sensor approach | coarse and fine sensor |
| Type | bipolar latching Hall-effect sensors |
| Repeatability of reference position | better than ± 0.0088 deg |
| Supply voltage | 4.5 V to 24 V |
| Voltage, maximum | 25 V |
| Supply current for each Hall sensor | typ. 4 mA |
| Output saturation voltage | < 400 mV |
| Output leakage current | < 2 μ A |
| Output rise time and fall time | < 2 μ s |
| Output ON current | 25 mA |
| Power supply | 30 mW per sensor The redundant sensors will only be powered if the associated nominal sensor fails |
| Absolute Position Sensor | |
| Absolute angle measurement | Yes |
| Sensor approach | Coarse and fine sensor |
| Type | Potentiometer |
| Angular Accuracy | better than ± 0.02 deg |
| Angular Repeatability | better than ± 0.002 deg |
| Supply voltage range | -6 V to +6 V |
| Fault voltage range | -17.5 V to +17.5 V |
| Supply current for potentiometer | shall be limited to 10 mA or less |
| Total resistance coarse potentiometer | 34 kOhm $\pm 20\%$ |
| Total resistance fine potentiometer | 28.5 kOhm $\pm 20\%$ |
| Dead band of fine potentiometer | <3 deg / 160 |

| Description | Value |
|---|---|
| Temperature Sensor | |
| Motor thermistor type | PT1000 |
| Redundant | Yes |
| Ground Storage | |
| Ground storage temperature | +10°C / +40°C |
| Ground storage humidity | 20% / 50% RH |
| Temperature Range | |
| In orbit non-operational temperature | -100°C / +125°C |
| In orbit operation temperature | -40°C / +100°C |
| Allowable temperature gradient between output shaft and housing | 10°C |
| Thermal resistance between output shaft and housing in vacuum | 7 K/W |
| Electrical Connectors | |
| Electrical Connector | flying leads |
| External Surfaces | |
| External Finish | housing and output shaft: Ti6Al4V, untreated, stainless steel, passivated |
| External Loads | |
| Axial (+20°C, isothermal, non-operating, no other external loads) | 1180 N |
| Radial (+20°C, isothermal, non-operating, no other external loads) | 2400 N |
| Bending (+20°C, isothermal, non-operating, no other external loads) | 145 Nm |
| Stiffness | |
| Axial stiffness (GA15 attached to rigid bodies) | > 95000 N/mm |
| Radial stiffness (GA15 attached to rigid bodies) | > 75000 N/mm |
| Torsional stiffness for a small (0..7 Nm) output shaft torque when the motor is unpowered | 5500 Nm/rad ±25% |
| Bending stiffness | > 75000 Nm/rad |

| Vibration | | |
|------------------------------|--|-----------------------------|
| Vibration load (quasistatic) | 100 g lateral, 91 g axial | |
| Vibration load (sine) | Frequency in Hz | Level in g |
| | 5 | 0,88 |
| | 35 | 43 |
| | 57 | 70 |
| | 100 | 70 |
| Vibration load (random) | Frequency in Hz | Level in g ² /Hz |
| | 20 | 1.10E-01 |
| | 60 | 2.00E+00 |
| | 100 | 2.00E+00 |
| | 165 | 8.00E-01 |
| | 350 | 8.00E-01 |
| | 1000 | 9.90E-02 |
| | 1010 | 1.00E-02 |
| | 2000 | 1.00E-02 |
| | Total: 23.14 gRMS | |
| Shock Input | | |
| Shock load | Frequency in Hz | SRS (Q=10) in gSRS |
| | 100 | 20 |
| | 1000 | 1000 |
| | 10000 | 1000 |
| Export Licenses | | |
| Export Licenses | No components are under export control | |

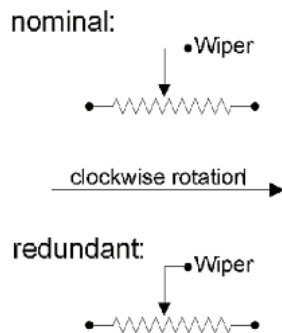
Dimensions and Mechanical Interface



Potentiometer

The GA15 is equipped with a potentiometer type absolute angle sensor system.

Redundancy is provided for both (coarse and fine) potentiometers. The nominal and redundant branch of the potentiometer is wired. Each branch of the potentiometer (nominal, redundant) has 3 terminals. The potentiometer shall be operated as a potential divider.



Harness

The GA15 is equipped with flying lead wires. Cable length is TBD by the customer.

Hall Sensor

The GA15 is equipped with a hall sensor type reference angle sensor system. A dedicated Hall sensor PCB is part of each Hall sensor.

Redundancy is provided for both (coarse and fine) hall sensors. The nominal and redundant branch of the hall sensor is wired. Each branch of the hall sensor (nominal, redundant) has 3 terminals.