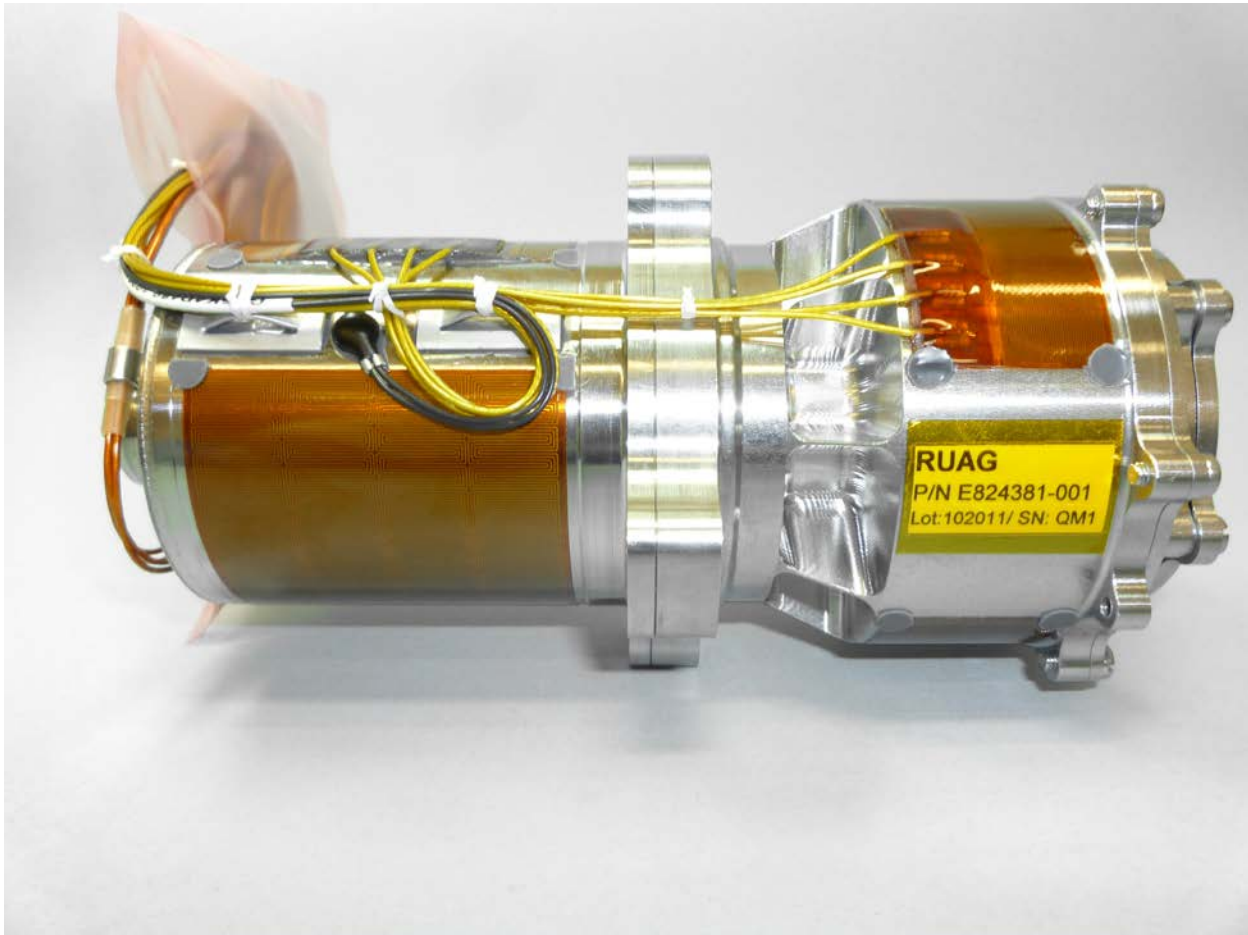


SBGM

Sealed Brush Gear Motor



GENERAL DESCRIPTION

The Sealed Brush Gear Motor (SBGM) is mainly dedicated as in orbit motion control and actuation mechanism for solar array panels. But the SBGM can also be used for other applications where a robust, simple and space qualified actuator is needed. The SBGM mechanism can be operated in motor and generator (brake) mode. No complex electronic controller is needed. When operated under space vacuum, brushed DC motors commonly show problematic behavior with regard to reliability due to brush issues in the commutator. The presented actuator solves issues like the generation of debris from the brushes, arcing, and an unstable and high brush friction by the use of a hermetically sealed housing that contains its own atmosphere. Due to the low leak rate, the internal pressure is kept at a sufficient level for more than 50 years in orbit. Torque is transferred from the motor to the gear head by means of a magnetic hysteresis coupler. A special characteristic of this coupler is its ability to not only limit the transferred torque but also to maintain the adjusted torque during slippage within the coupler.

Design highlights:

- Reliable behavior of the brushes running in air
- No need for complex electronics, as commutation is performed mechanically
- Hysteresis coupler acts as a torque limiter
- High gear efficiency through thorough use of ball bearings
- Insensitive to vibration and shock due to (soft) preloaded gear

The SBGM actuator consists of a sealed motor with a planetary gear head attached.

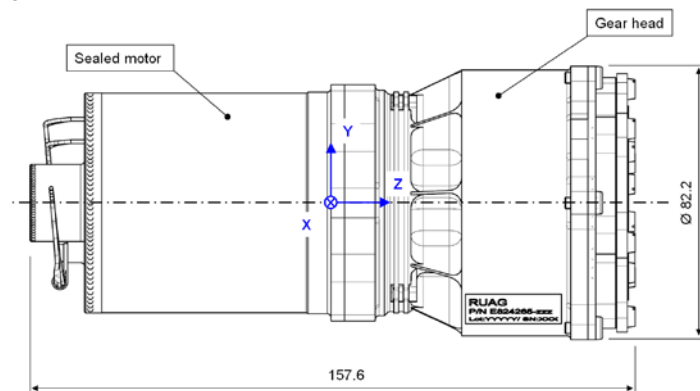


Figure 1: SBGM Overview

ESD

The SBGM mechanism is not sensitive to ESD. Therefore, no specific ESD precautions have to be considered.

VIBRATION LEVEL

For SBGM qualification and acceptance tests, the acceleration levels for X- and Y-axis, parallel to mounting plate, for random vibration levels is given as follow (values are given in a table later in this data sheet):

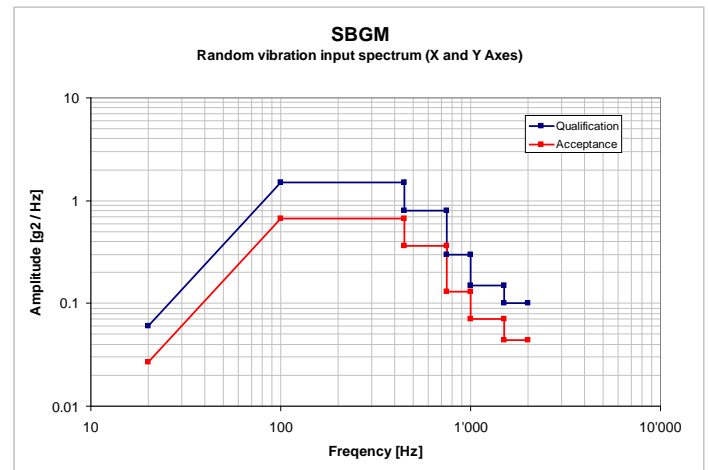


Figure 2: SBGM random vibration spectrum (X- & Y-axes)

Random vibration levels for acceleration on Z-axis correspond with the following diagram:

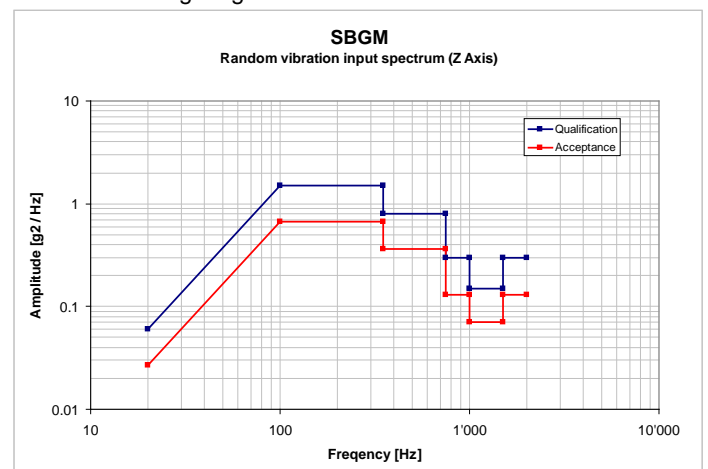


Figure 3: SBGM random vibration spectrum (Z-axis)

PACKAGING AND STORAGE

The SBGM is delivered by RUAG SPACE double bagged within a transport box protected with foam and with shock detectors mounted.

As standard, the SBGM is delivered in compliance to clean room class 8 (100'000) environment and shall be protected from direct UV light. If moved out of a clean environment, it has to be double bagged and sealed under dry nitrogen.

OPTIONS

The SBGM mechanism is available with or without heaters mounted on the motor and gearbox housing.

DELIVERABLES

- FM or PFM-Units
- Transport box (temporary only)
- EIDP (CD-ROM):
 - Certificate of Conformity
 - CIDL & ABCL
 - Logbook
 - Interface Control Document
 - User's Manual
 - RfD's / RfW's (if any)
 - NCR's (if any)
 - Minutes of Meetings
 - Acceptance Test Plan
 - Acceptance Test Report

DESIGN CHARACTERISTICS

Mechanism

Drive direction	Forward and reverse rotation (endless rotation)
Speed	2.5 V corresponds to approximately 0.03 rpm
Max. torque in generator mode	64.5 Nm
Max. generated torque in motor mode	61.0 Nm
Qualified life cycles	150 revolutions (corresponds to 54'000°)
Revolutions performance (for FMs)	35 on-ground rotations and 1 in-orbit rotation

Motor (Sealed brush motor)

Windings	With redundant windings
Winding resistance	8 - 11 Ω
Phase inductance	5 - 7 mH
Maximum voltage	9.5 V
Maximum current	0.275 A
Motor constant K_t	0.165 \pm 0.005 Nm/A
Motor constant K_e	0.15 \pm 2% V/rad/s

Gear head

Typ	4-stage planetary gear
Total gear ratio	$i = 2656.933$

Dimensions SBGM (motor and gearhead)

External diameter	82.2 mm
Total length	157.6 mm
Mass	≤ 1.7 kg

Fixation

	Platform interface	See Figure 5 and Figure 6
	Solararray interface	See Figure 7 and Figure 8

Power Consumption / Generation

	Mode of operation	Motor power
Maximum conditions	Generator (brake) mode	≤ 5.0 W
	Motor mode	≤ 5.2 W

Temperature Specification

	T_{min}	$T_{Ambient}$	T_{max}
Qualification non operating	- 105°C	+22°C	+ 125°C
Qualification operating	- 50°C	+22°C	+ 85°C
Acceptance non operational	- 100°C	+22°C	+ 120°C
Acceptance operational	- 45°C	+22°C	+ 80°C

Environment conditions during operation

Orbits	LEO	MEO	GEO
Radiation Total Dose	$\leq 5 \times 10^7$ rads		

Connector

Delivered with labeled flying leads

Radiative Interface

	Motor housing	Gear head housing
External surface	Titanium Ti6Al4V	Stainless Steel 1.4104
Emissivity (ϵ)	0.12	0.14

Static loads (on output axis)

Axial load (F_z)	200 N
Radial load (F_{xy})	200 N
Bending moment (M_{xy})	30 Nm

Environment conditions during launch

High level sine vibration:	Frequency (Hz)	X, Y & Z axes	
Qualification	5 to 22	± 10.0 mm	
	22 to 100	20 g	
sweep rate	2oct / min		
Random vibration:	Frequency (Hz)	Qualification levels	Acceptance levels
Radial axes (X- & Y-axes)	20 - 100	+ 6 dB/oct	+ 6 dB/oct
	100 - 450	1.5 g ² /Hz	0.67 g ² /Hz
	450 - 750	0.8 g ² /Hz	0.36 g ² /Hz
	750 - 1'000	0.3 g ² /Hz	0.13 g ² /Hz
	1'000 - 1'500	0.15 g ² /Hz	0.07 g ² /Hz
	1'500 - 2'000	0.1 g ² /Hz	0.044 g ² /Hz
	Overall	31.7 gRMS	21.1 gRMS
	Duration	6 min per axes	1 min per axes
Axial axis (Z-axes)	20 - 100	+ 6 dB/oct	+ 6 dB/oct
	100 - 350	1.5 g ² /Hz	0.67 g ² /Hz
	350 - 750	0.8 g ² /Hz	0.36 g ² /Hz
	750 - 1'000	0.3 g ² /Hz	0.13 g ² /Hz
	1'000 - 1'500	0.15 g ² /Hz	0.07 g ² /Hz
	1'500 - 2'000	0.3 g ² /Hz	0.13 g ² /Hz
	Overall	32.3 gRMS	21.5 gRMS
	Duration	6 min per axes	1 min per axes

Shock levels for each axes (X, Y, Z):	Frequency (Hz)	Acceleration (SRS)
	500 - 3'000	300 - 2'000 g
	3'000 - 10'000	2'000 g

FLIGHT MODEL (FM) ACCEPTANCE PROGRAMME

The SBGM flight model acceptance program normally includes the following tests:

- Friction torque test
- Random vibration (acceptance level and duration)
- Thermal vacuum test (acceptance temperature and duration)
- Generator mode test
- Motor mode test
- Maximum torque test

DIMENSIONS AND MECHANICAL INTERFACES FOR SBGM

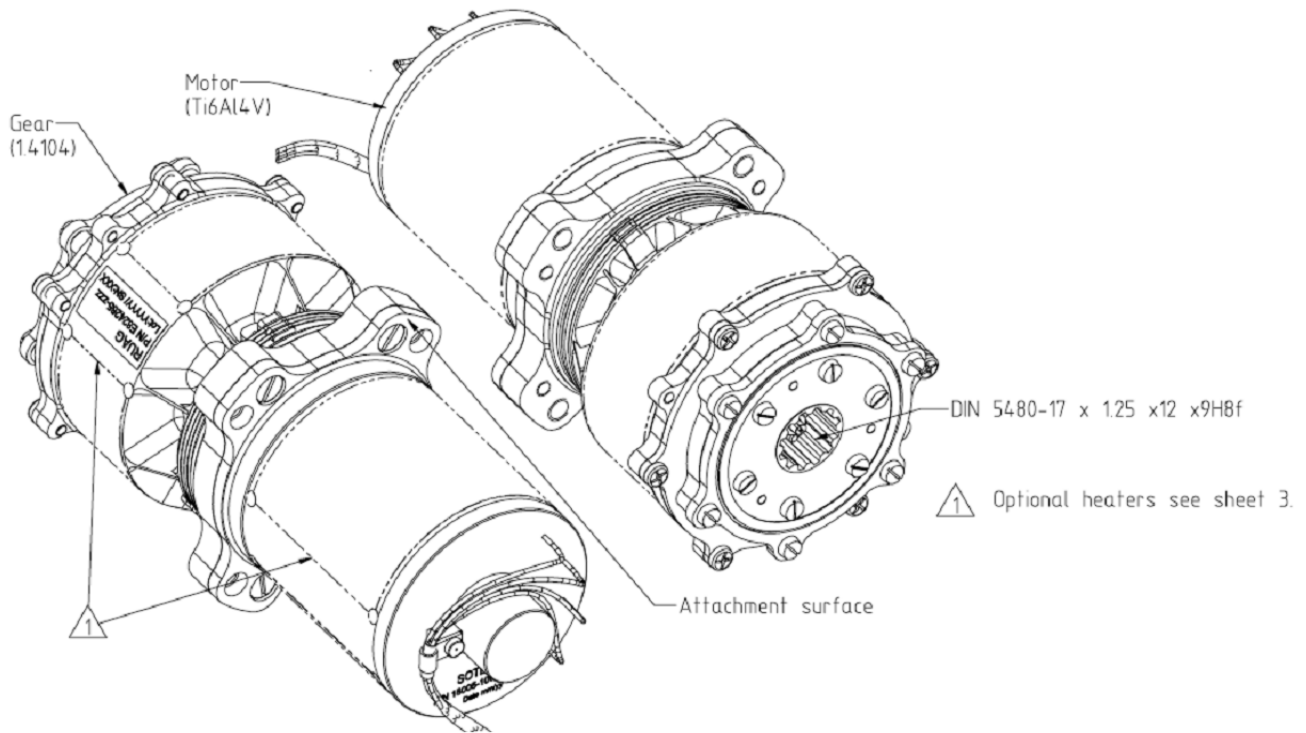


Figure 4: SBGM 3D view

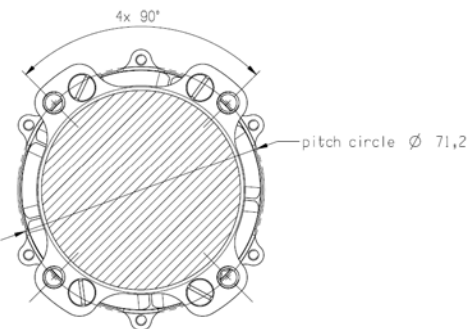


Figure 5: SBGM platform interface

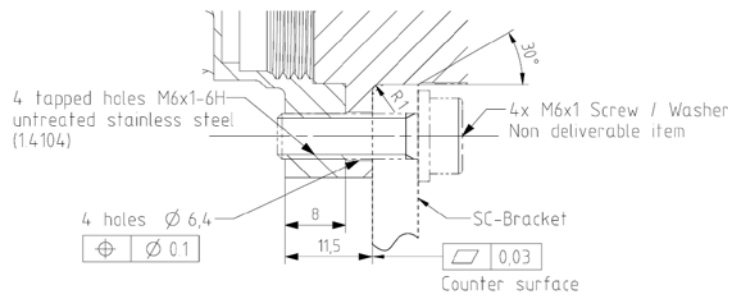


Figure 6: SBGM platform interface - Detail

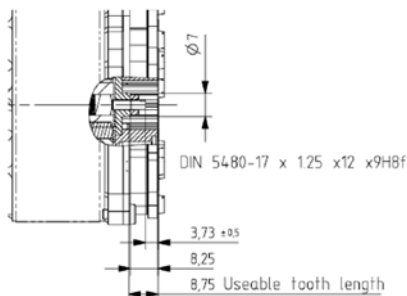


Figure 7: SBGM solar array interface

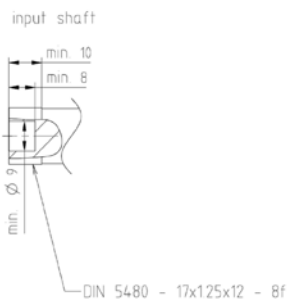


Figure 8: SBGM solar array interface - Counterpart

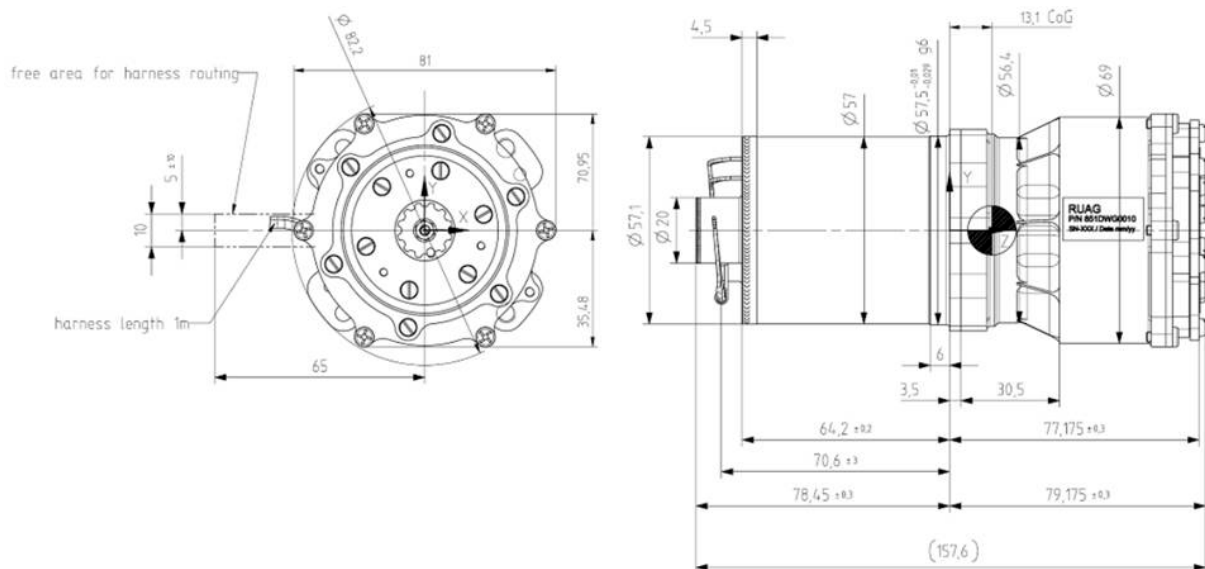


Figure 9: SBGM dimensions and envelope

ELECTRICAL INTERFACES FOR SBGM

The SBGM mechanism is delivered with labeled flying leads.

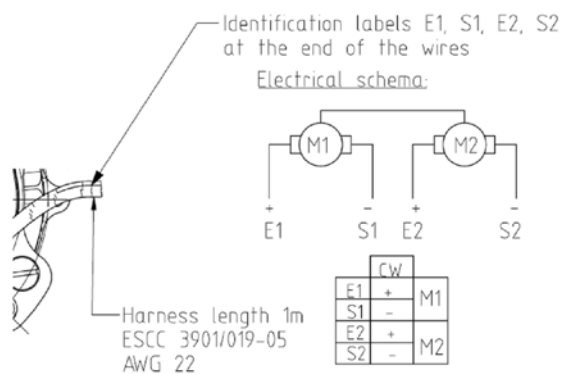


Figure 10: SBGM electrical interface of motor

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