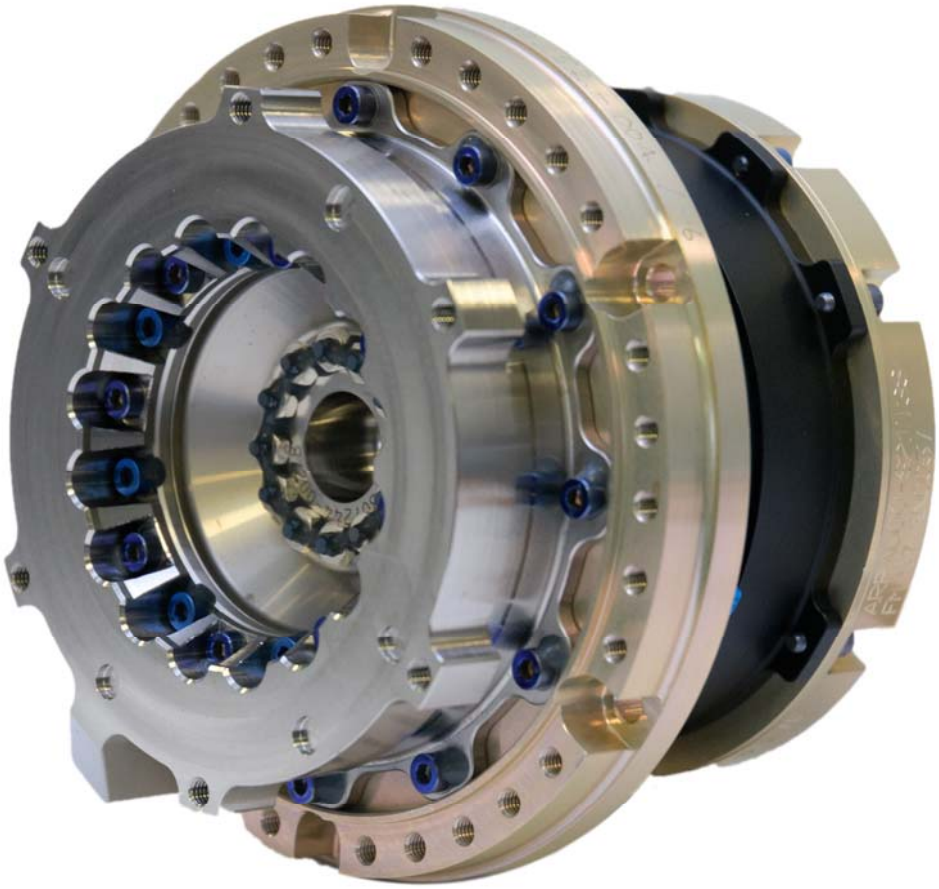
SARA®21

Satellite Antenna Rotary Actuator



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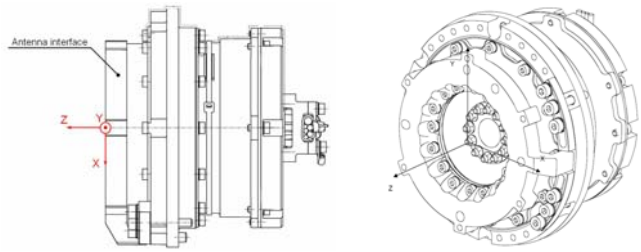
Together ahead. RUAG

GENERAL DESCRIPTION

The SARA 21 Satellite Antenna Rotary Actuator (SARA) is designed to drive any type of space borne mechanism, while also transmitting a position signal to the onboard electronic. It is used to activate a mechanism operating in one of several rotational axes. Typical uses include antenna pointing, solar array deployment and customized applications. The large range of applications on satellites in LEO, MEO and GEO orbit for scientific or a telecommunications purpose allows using a standard product to minimise costs at system level. The SARA is fully space qualified and consists of: an actuator; two potentiometers for coarse - and two potentiometers for fine position feedback. Within the qualification program, 125000 fine pointings in orbit have been achieved and the SARA 21 has over 45 years of accumulated of flight heritage since 2004.



The main function of the SARA 21 is to fine point antennas on orbit in forward or reverse direction. The SARA 21 has a very precise rotational resolution (step size) of 0.00625° and a maximum speed of 30°/min (one rotation per 12 minutes). The position of the SARA is measured using four (two coarse and two fine) redundant potentiometers delivering an accuracy of ±0.50° (coarse) and ±0.01° (fine). The position feedback of the potentiometer is an analogue 0 V to 5 V signal. The deadband of the coarse and the fine potentiometer is 1%. The potentiometers have a total resistance of 10 kΩ ±10%.

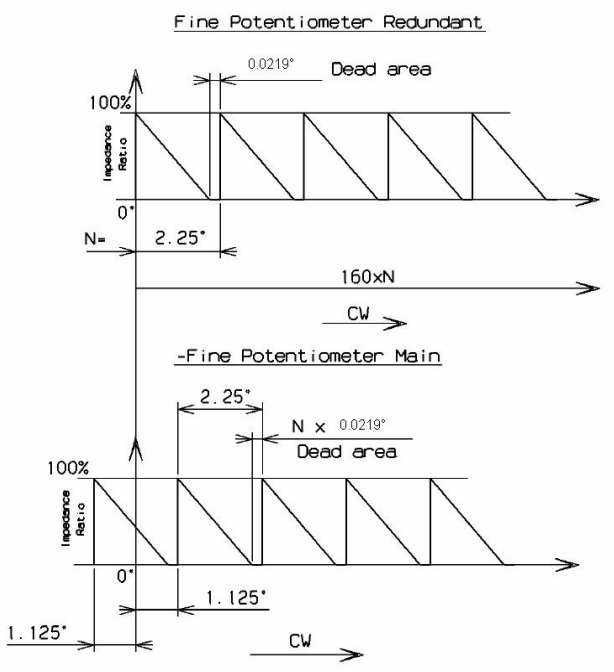


Figure 1: SARA 21Fine potentiometers

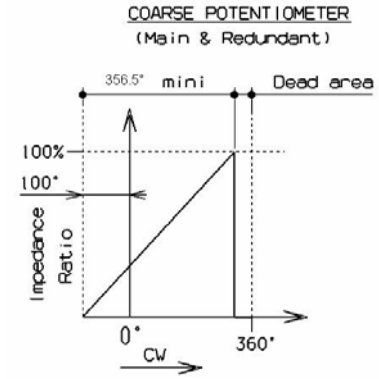


Figure 2: SARA 21Coarse Potentiometer

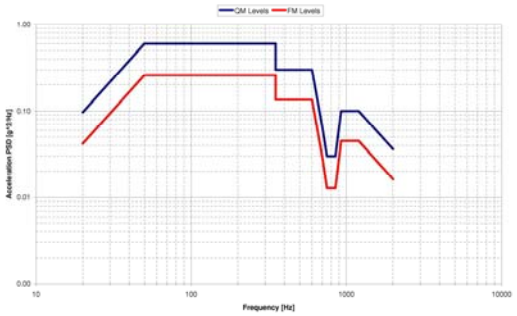
The SARA® is powered using a two phase hybrid stepper motor with redundant windings giving 57600 stable (un-powered) positions of the output shaft over one revolution. The SARA 21 shall be powered directly with a dual phase sinusoidal 23.4 V to 28.6 V input with a maximum current of 400 mA.

ESD

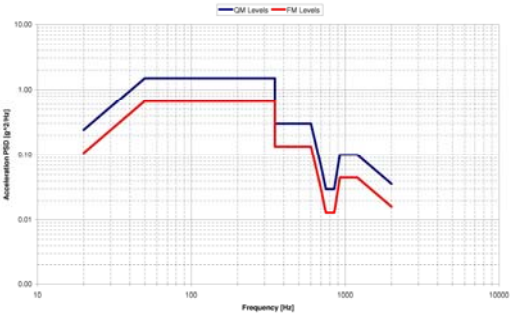
The SARA 21 is an ESD (electrostatic discharge) sensitive device. Electrostatic charge as high as 4000 V readily accumulate on the human body and can discharge through the test equipment without detection. Although the SARA® features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

VIBRATION LEVEL

For SARA 21 the qualification and acceptance tests the acceleration levels for X- and Y-axis, parallel to mounting plate, for random vibration levels is given as follow:



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



PACKAGING AND STORAGE

The SARA 21 is delivered by RUAG SPACE mounted on a handling tool equipped with shock detectors.

The SARA 21 must be kept in a clean room class 8 (100000) environment and shall be protected from direct UV light. If moved out of a clean environment, it has to be double bagged and sealed in antistatic protective foil (ESD) under dry nitrogen.

OPTIONS

The SARA 21 is available with or without the fine potentiometers for position feedback.

DELIVERABLES

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

DESIGN CHARACTERISTICS

Mechanism	
Drive direction	Forward and reverse rotation (endless rotation)
Speed range	0 to 1 rev / 12 min
Maximum rotation speed	0.5°/s
1 revolution	57600 steps
1 step	0.00625°
Qualified life span	15 years in orbit + 5 year storage (2 years integrated on Satellite)
Revolutions performance	500 orbital rotations or 125000 fine pointings (± 0.5°)

Motor	
Winding resistance	76 Ω ±10%
Number of steps per revolution of motor	360
Stabile positions (motor is unpowered)	360
Holding torque (unpowered motor)	≥ 7 Nm
Holding torque (powered motor)	≥ 30 Nm
Nominal torque (powered motor)	≥ 25 Nm

Position Measurement (coarse)	
Potentiometer resistance	10.0 kΩ ± 10%
Potentiometer accuracy	± 0.5°
Potentiometer linearity	± 0.5%

Position Measurement (fine)	
Potentiometer resistance	10.0 kΩ ± 10%
Potentiometer accuracy	± 0.01°
Potentiometer linearity	± 0.5%

Dimensions

External diameter	120 mm
Total length	89 mm
Mass	M ≤ 2.0 kg

Fixation

	PF interface	See Figure 3 to 6
	SA interface	See Figure 3 to 6

Power Consumption

	V_{BUS}	Total Power
Maximum conditions	23.4 V - 28.6 V	≤ 17 W

Temperature Specification

	T_{min}	$T_{Ambient}$	T_{max}
Ground Storage	+ 10°C	+22°C	+ 40°C
In orbit non operational	- 100°C		+ 100°C
Cold start-up limit	- 65°C		
In orbit operational	- 50°C	+22°C	+ 85°C

Environment conditions during operation

Orbits	LEO	MEO	GEO
Radiation Total Dose		No EEE parts	

SARA Connector

D-SUB Connector	DCMA37P

Radiative Interface

	Motor housing	*Rear cap*
External finish (nature)	Black paint	Alodine 1200
Emissivity (ε)	0.85	0.15
Absorption (α)		0.08

Conductive interface

	Case 1	*Case 2*
Axial load (F_z)	10’000 N	0 N
Radial load (F_{xy})	0 N	8’000 N
Bending moment (M_{xy})	0 Nm	200 Nm

Stiffnesses	
Axial stiffness (K_z)	≥ $21*10^6$ N/m
Radial stiffness (K_{xy})	≥ $35*10^6$ N/m
Torsion angular stiffnes ($K_{\theta z}$)	≥ 10000 Nm/rad
Bending angular stiffness ($K_{\theta xy}$)	≥ 50000 Nm/rad

Environment conditions during launch

High level sine vibration:	**Frequency (Hz)**	**⊥ MOUNTING PLANE**	**// MOUNTING PLANE**
	5 to 22	± 10.0 mm	± 10.0 mm
	22 to 100	20 g	20 g
sweep rate		2oct / min	
Random vibration:	**Frequency (Hz)**	**⊥ MOUNTING PLANE**	**// MOUNTING PLANE**
	20-50	+6 dB/oct	+6 dB/oct
	50-210	1.500 g²/Hz	1.500 g²/Hz
	210-285	1.500 g²/Hz	-20 dB/oct
	285-296	1.500 g²/Hz	-96 dB/oct
	296-350	1.500 g²/Hz	0.060 g²/Hz
	350-396	0.300 g²/Hz	0.060 g²/Hz
	396-417	0.300 g²/Hz	+95 dB/oct
	417-600	0.300 g²/Hz	0.300 g²/Hz
	600-700	-30 dB/oct	0.300 g²/Hz
	700-750	-35 dB/oct	0.100 g²/Hz
	750-850	0.030 g²/Hz	0.100 g²/Hz
	850-925	+45 dB/oct	0.100 g²/Hz
	925-1200	0.100 g²/Hz	0.100 g²/Hz
	1200-2000	-6 dB/oct	-6 dB/oct
I	Global	25.50 g_{rms}	22.42 g_{rms}

Shock levels for each axes (X, Y, Z):	**Frequency (Hz)**	**Shock input levels**
	500	300 g
	3000	2000 g
	10000	2000 g

FLIGHT MODEL (FM) ACCEPTANCE PROGRAMME

The flight model acceptance programme normally includes the following tests:

- Inspection and control
- Mass measurement
- Functional characteristics measurement
- Vibration tests (FM-level)
- Thermal vacuum cycling with performance tests

DIMENSIONS AND MECHANICAL INTERFACES FOR SARA 21

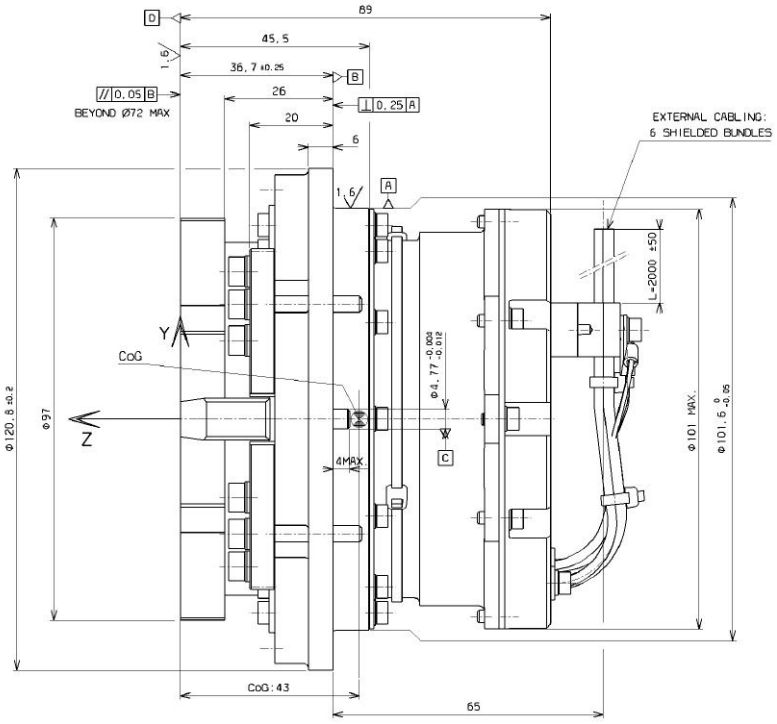


Figure 3: SARA 21 plan view

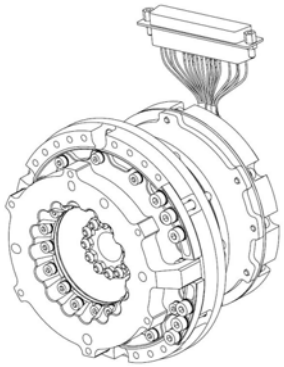
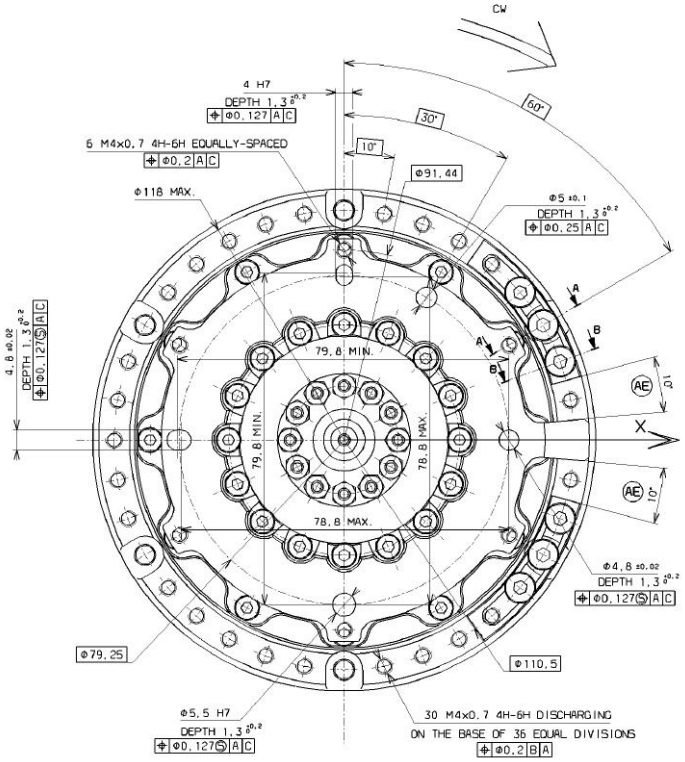


Figure 4: SARA 21-D Antenna Interface side view



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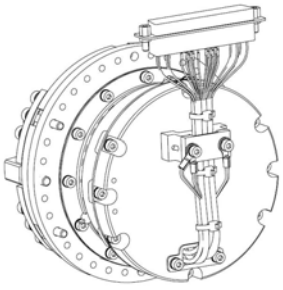

Figure 5: SARA 21-D rear view

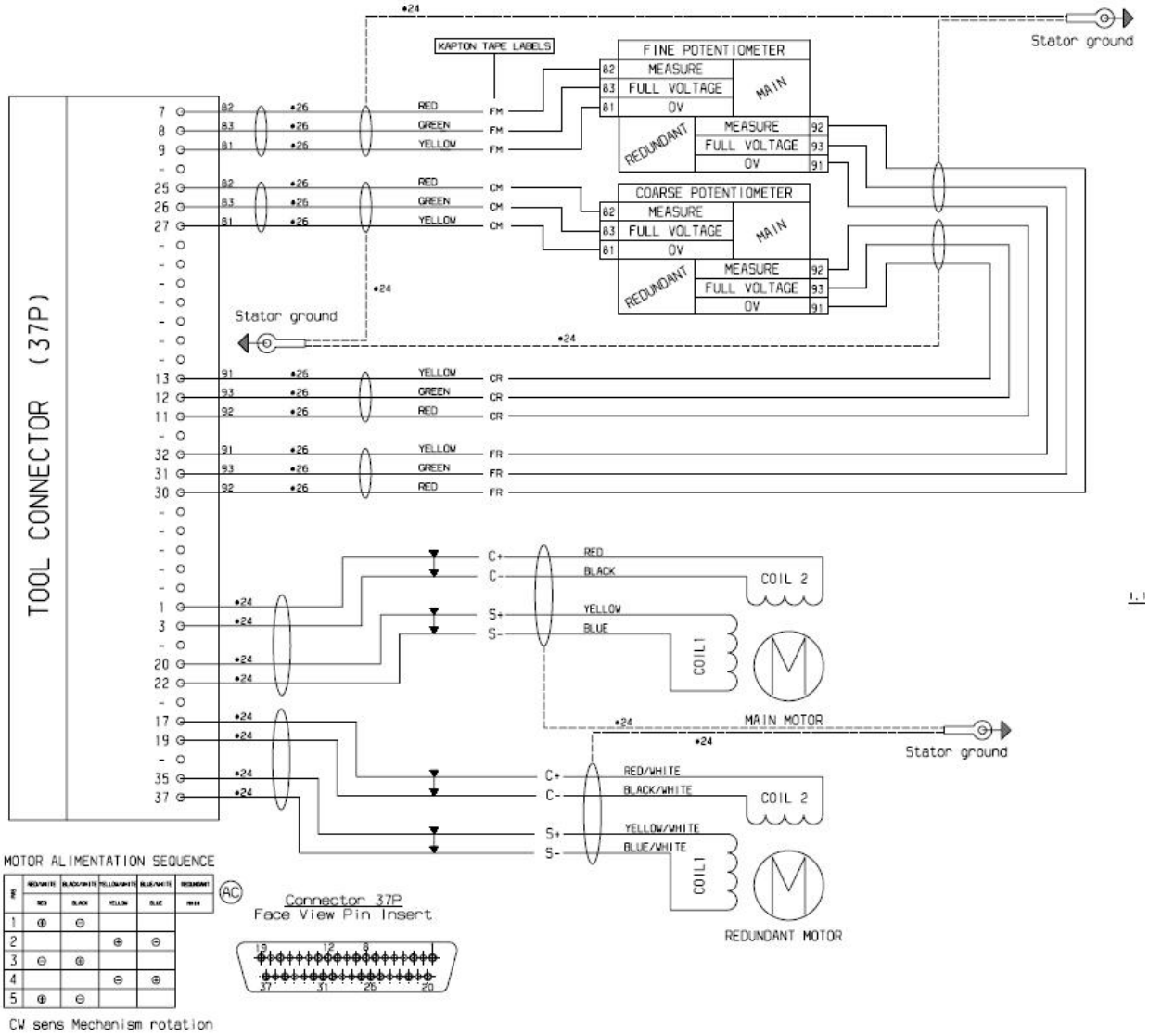

Figure 6: SARA 21 electrical interface