SEPTA®31

Solar Array Drive Assembly

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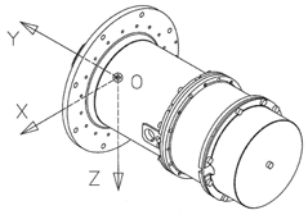
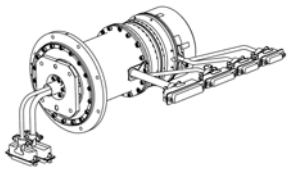
Together ahead. RUAG

GENERAL DESCRIPTION

The SEPTA 31 Solar Array Drive Assembly (SADA) is designed to fulfil a large range of applications on satellites with a mass of approximately 500 kg in LEO and MEO orbit that are used for scientific or telecommunications purposes by using a standard product to minimise costs at a system level. The SADA is fully space qualified and consists of: an actuator, a slip ring assembly (composed of a collector for power and signal transfer) and two potentiometers for position feedback. Cold redundancy can be achieved by equipping the SADA with two identical embedded drive electronics for main and redundant operation. Within the qualification programme, 35 000 in orbit revolutions (including a safety margin) have been achieved and the SEPTA 31 has over 120 years of cumulated flight heritage since 2001.





The main functions of the SEPTA 31 are to sustain and rotate the Solar Array Panel in both forward or reverse directions, as well as transfer power, signals and grounding from the Solar Array to the satellite. The SEPTA 31 has a very precise rotational resolution (step size) of 0.01° and a maximum speed of 60°/min (one rotation per 6 minutes). The position of the Solar Array is measured using two redundant potentiometers delivering an accuracy of ±0.5°.

The collector consists of 60 current transfer rings made from gold plated brass, rated for the following currents: 48 power tracks at 1.65 A_{RMS}; 2 ground tracks at 1.65 A_{RMS}; 10 signal tracks at 0.25 A_{RMS}. Moulding of rings and contacts wires, together with wires and soldering points, within a charged space qualified epoxy gives a very high electrical insulation.

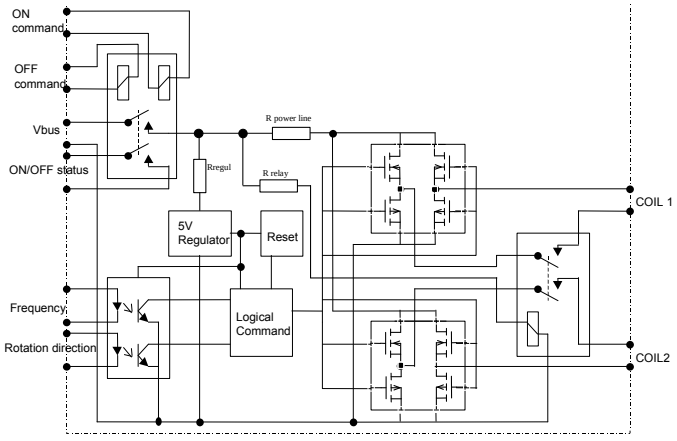
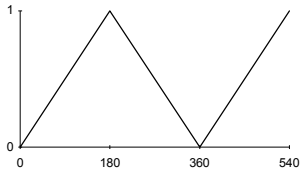


Figure 1: SADE Block Diagram SEPTA 31-E/R

Position measurement is achieved using main and redundant potentiometers, which feedback an analogue 0 V to 5 V signal, delivering a continuous angular position of the SADA with a full measurement scale of 180°. The potentiometers have a total resistance of 4 kΩ ±5%.



The SADA is powered using a two phase hybrid stepper motor with redundant windings giving 36 000 stable (un-powered) positions of the output shaft over one revolution.

OPTIONS

The SEPTA 31-E/R and -E/S incorporate fully space qualified electronics integrated at the rear of the SEPTA 31 on two separate PCB's. The SEPTA 31-E/S version can be fed using 50 V±1 V regulated power bus, the SEPTA 31-E/R version is powered using an unregulated 21 V to 36 V power bus.

The SEPTA 31-M version without embedded electronics can be powered directly with a dual phase sinusoidal 21 V to 36 V input with a maximum current of 80 mA. This version may be upgraded to provide a main and redundant zero position switch using a Reed Relay (SEPTA 31-M/RR).

The following SEPTA 31 Models are available:

	Drive Electronics 21V to 36V	**Drive Electronics** 50V ±1V	**Potentiometer**	**Reset Switch**
SEPTA 31-E/R	x	-	x	-
SEPTA 31-E/S	-	x	x	-
SEPTA 31-M	-	-	x	-
SEPTA 31-M/RR	-	-	x	x

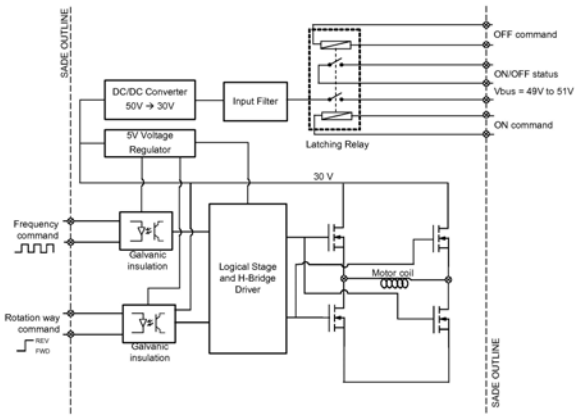
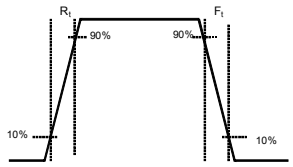


Figure 1: SADE Block Diagram SEPTA 31-E/S

COMMAND SIGNALS ON-OFF TIMING

The command signals for frequency and direction are following the on/off timing characteristics as given below:



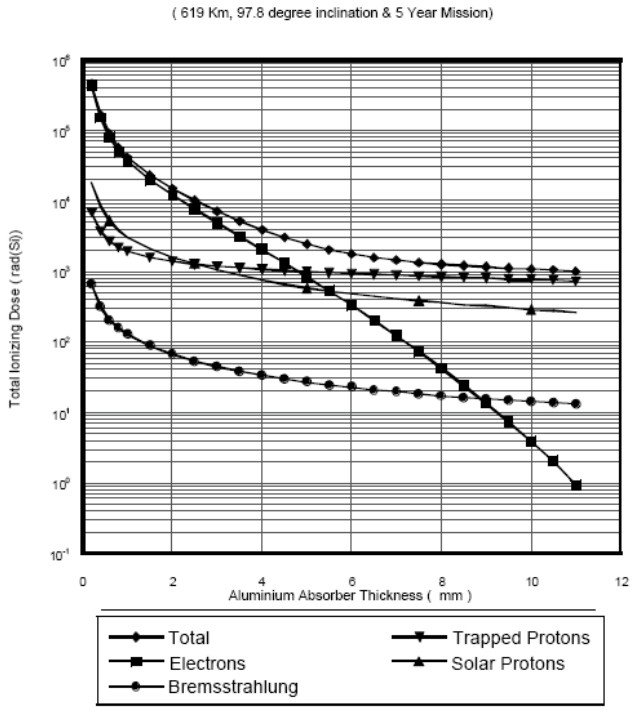
High level:	2.4-5 V
Low level:	<0.4 V
R_t	<0.5 ms
F_t	<0.5 ms
Duration	>1 ms

SADE INTERFACE

Pin J3/4	Function	I (mA)	V (V)	F (Hz)	R (Ω)	Rt (ms)	Ft (ms)	Width (ms)	I/F
6	+ On/Off Status	1000	28						I/O
5	- On/Off Status	1000	28						I/O
3	+ Power Bus	200	36						Power
1	- Power Bus	200	0						Power
8	+ Off (SADE OFF)	24	12		500	0.5	0.5	1	O
7	- Off (SADE OFF)	24	12		500	0.5	0.5	1	O
14	+ On (SADE ON)	24	12		500	0.5	0.5	1	O
11	- On (SADE ON)	24	12		500	0.5	0.5	1	O
10	+ Direction (Sens)	10	5						I
9	- Direction (Sens)	10	5						I
13	+ Frequency (Pulse)	10	5	100					I
12	- Frequency (Pulse)	10	5	100					I
4	- Thermistor				15000				O
2	+ Thermistor				15000				O
int	+ Motor Coil Sine	200	30	100					Power
int	- Motor Coil Sine	200	30	100					Power
int	+ Motor Coil Cosine	200	30	100					Power
int	- Motor Coil Cosine	200	30	100					Power

RADIATION ENVIROMENT

The following space radiation environment curve was applied during SEPTA 31 qualification testing. Higher radiation tolerance may be achieved by increasing the thickness of the SADE housing in order to fulfill the required environment conditions.

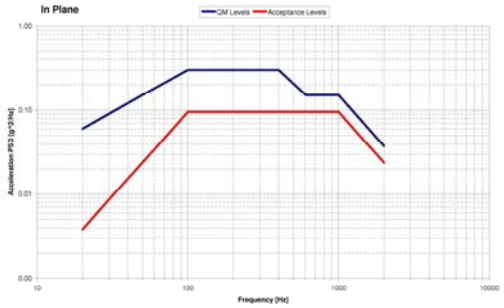


ESD

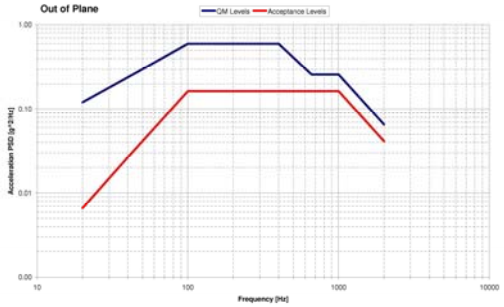
The SEPTA 31-E/R and –E/S are ESD (electrostatic discharge) sensitive devices. Electrostatic charge as high as 4'000V readily accumulate on the human body and can discharge through the test equipment without detection. Although the OP470 features proprietary ESD protection circuitry, permanent damage 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 ON FM

For SEPTA 31 acceptance tests the acceleration levels for X- and Z-axis, parallel to mounting plate, for random vibration high levels is given as follows:



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



PACKAGING AND STORAGE

The SEPTA 31 is delivered by RUAG SPACE mounted on a handling tool equipped with shock detectors.

The SEPTA 31 shall be kept in a 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 in antistatic protective foil (ESD) under dry nitrogen.

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 / 6 min
Maximum rotation speed	1°/s
1 revolution	36000 steps
1 step	0.01°
Qualified life span	8 years in orbit + 5 year storage (2 years integrated on Satellite)
Revolutions performance	500 on ground 35000 orbital rotation
Qualification sequence	84000 complete rotations

Motor	
Winding resistance	285 Ω ±5%
Number of steps per revolution of motor	360
Stabile positions (motor is unpowered)	360
SA holing torque (unpowered motor)	≥ 2.8 Nm
SA average torque(powered motor)	≥ 10.6 Nm
SA repeated peak torque (powered motor)	≥ 14.7 Nm (starting and stop)
SA momentary peak torque (powered motor)	≥ 19.6 Nm (exceptional peak torque)

Power Transfer (forward or reverse line)	
Number of power transfers	48 (24 each forward or reverse)
Current	1.65 A_{RMS}
Voltage	Nom. 55 V
Power transfer	< 2,2 kW
Insulation	≥ 10 MΩ
Noise	10 mV_{RMS}/A

Signal Transfer (forward or reverse line)	
Signal transfer number	10
Current	0.25 A_{RMS}
Voltage	55 V
Insulation	≥ 10 MΩ
Noise	10 mV_{RMS}/A

Position Measurement	
Potentiometer resistance	4.0 kΩ ± 5%
Potentiometer accuracy	±0.5° resp. (±8.73 x 10-3 rad)
Potentiometer linearity	±0.15%

Dimensions	
External diameter	99 mm
Fixation flange diameter	140 mm
Total length (from SA interface flange to rear part)	215 mm
Mass without external leads and connectors	M ≤ 3.0 kg
Mass with external leads and connectors	M ≤ 3.6 kg

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

Power Consumption	V_{BUS}	P_{motor}	P_{SADE}	Total Power
Maximum conditions (Type - E/R)	21 V - 36 V	2.34 W	3.28 W	< 7 W
Maximum conditions (Type - E/S)	50 V	2.34 W	3.18 W	< 7 W

Temperature Specification	T_{min}	$T_{Ambient}$	T_{max}
Ground Storage	+ 10°C	+20°C	+ 40°C
In orbit non operational	- 40°C		+ 75°C
Cold start-up limit	- 40°C		
In orbit operational	- 40°C	+20°C	+ 75°C

Environment conditions during operation			
Orbits	LEO	MEO	GEO
Radiation Total Dose (Shielding 6mm Al)	17.3 krad (depending on SADE housing and structure shielding)		

SADM Connectors		
J1	SA Power	DDMA50S
J2	SA & Position Signal	DBMA25P
J3	SADE Main	DAMA15P
J4	SADE Redundant	DAMA15P
J5	SA Power	DDMA50P
J6	SA Signals	DBMA25S

Radiative Interface	***Slip ring housing***	***Motor housing***	***Electronic housing***
External finish (nature)	Black anodizing	Black paint	Black anodizing
Emissivity (ε)	0.85	0.85	0.85
Absorption (α)	0.80		0.80

Interface load allowables	**Flight**	**Qualification**
Axial load (F_y)	200 N	300 N
Radial load (F_{xz})	333 N	500 N
Torsional moment (M_y)	6.7 Nm	10 Nm
Bending moment (M_{xz})	167 Nm	250 Nm

Stiffnesses

Axial stiffness (K_y)	> $10*10^6$ N/m
Shear stiffness (K_{xz})	> $50*10^6$ N/m
Torsion angular stiffnes ($K_{\theta y}$)	> 1500 Nm/rad
Bending angular stiffness ($K_{\theta xz}$)	> 5000 Nm/rad

Environment conditions during launch

High level sine vibration:	Frequency (Hz)	⊥ *MOUNTING PLANE*	// *MOUNTING PLANE*
	5 to 26	11 mm	11 mm
	26 to 100	30 g	18 g
	100 to 130	13.5 g	7.8 g
sweep rate		2 oct / min	
Random vibration:	Frequency (Hz)	⊥ *MOUNTING PLANE*	// *MOUNTING PLANE*
	20-100	+3 dB/oct	+3 dB/oct
	100-400	0.600 g²/Hz	0.300 g²/Hz
	400-606	-5 dB/oct	-5 dB/oct
	606-662	-5 dB/oct	0.150 g²/Hz
	662-1000	0.260 g²/Hz	0.150 g²/Hz
	1000-2000	-6 dB/oct	-6 dB/oct
	Global	23.0 g_{rms}	16.8 g_{rms}
Shock levels for each axes (X, Y, Z):	Frequency (Hz)	Shock input levels	
	200	300 g	
	2000	3000 g	
	10000	3000 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
- Inspection and Control

DIMENSIONS AND MECHANICAL INTERFACES FOR SEPTA 31-E/S

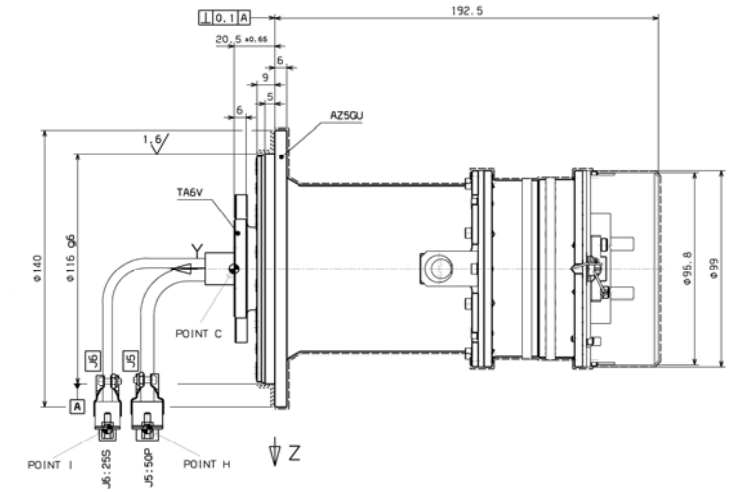


Figure 2: SEPTA 31-E/S & -E/R plan view

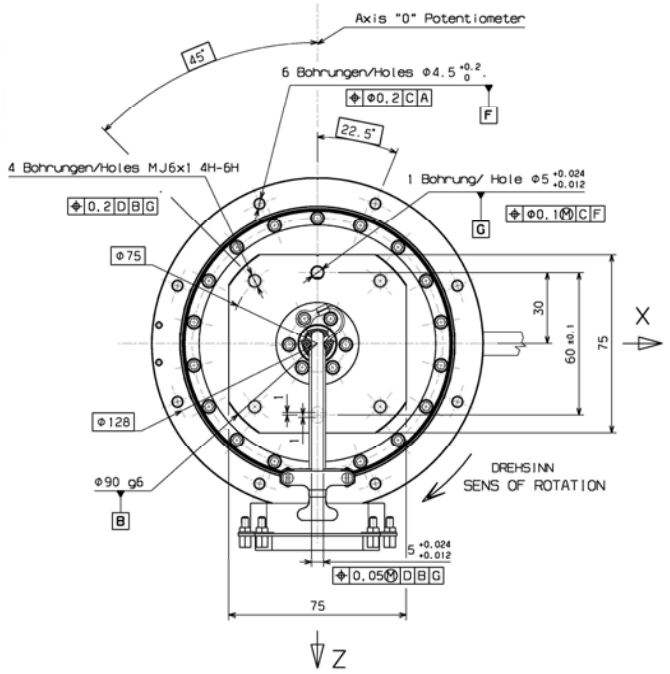


Figure 3: SEPTA 31-E/S & -E/R Solar Panel Interface side view

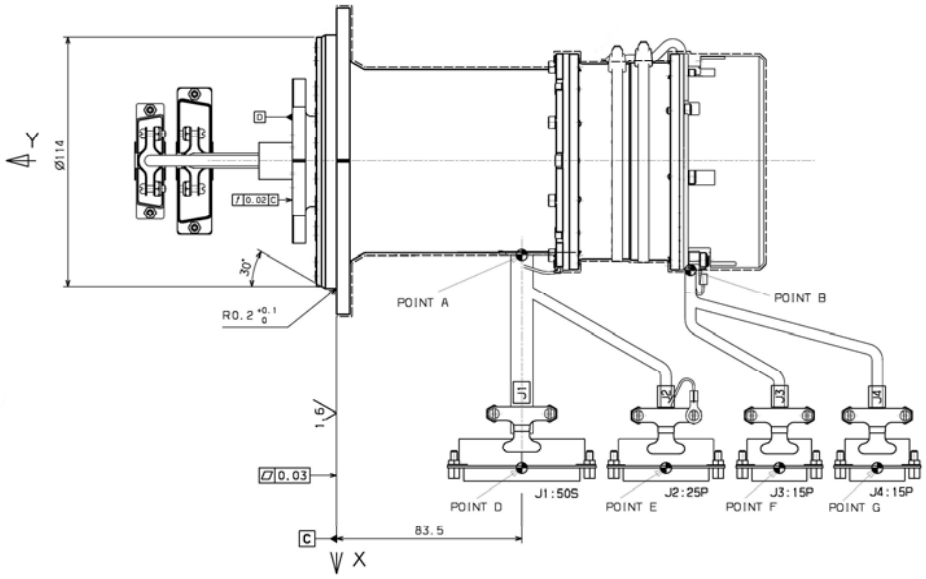


Figure 4: SEPTA 31-E/S & -E/R plan view with connectors

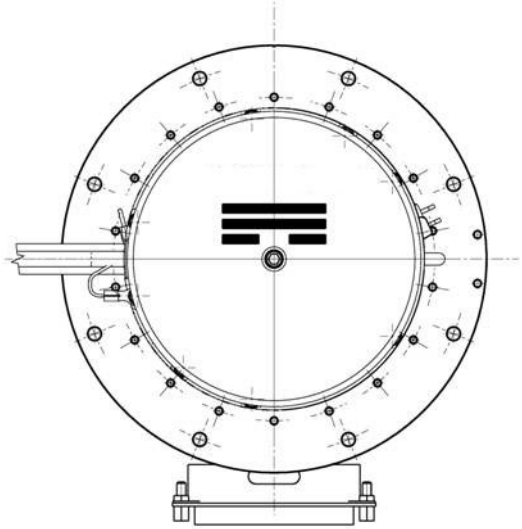


Figure 5: SEPTA 31-E/S & -E/R rear view

ELECTRICAL INTERFACES FOR SEPTA 31-E/S

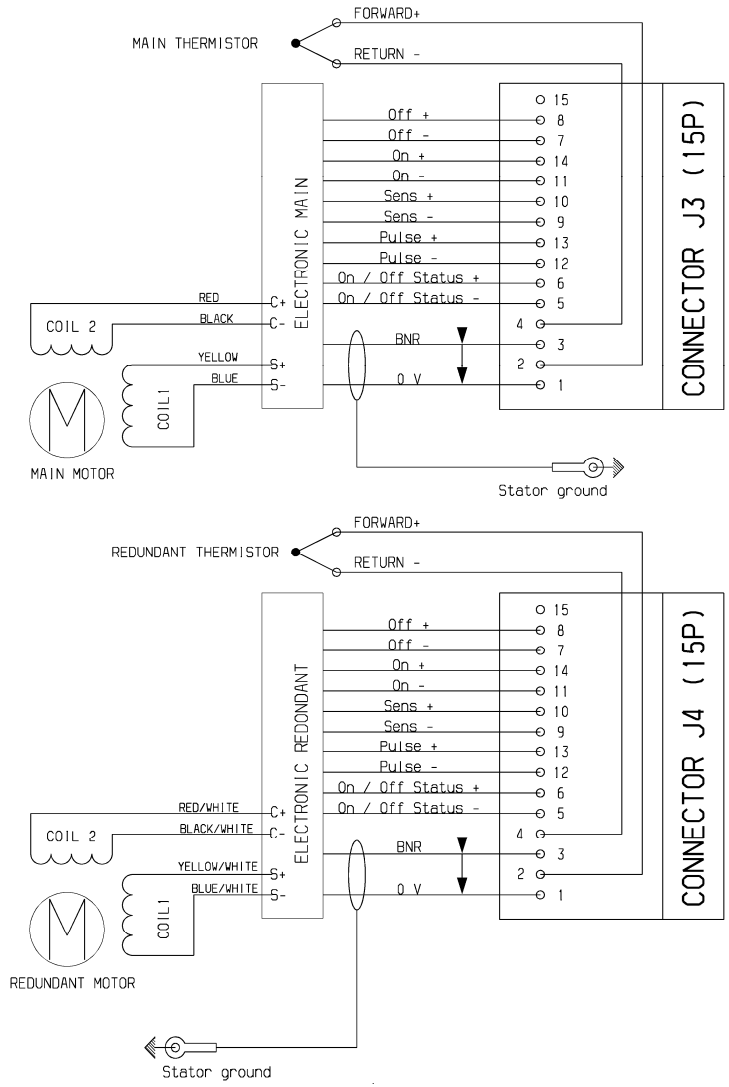


Figure 6: SEPTA 31-E/S & -E/R SADE electrical interface

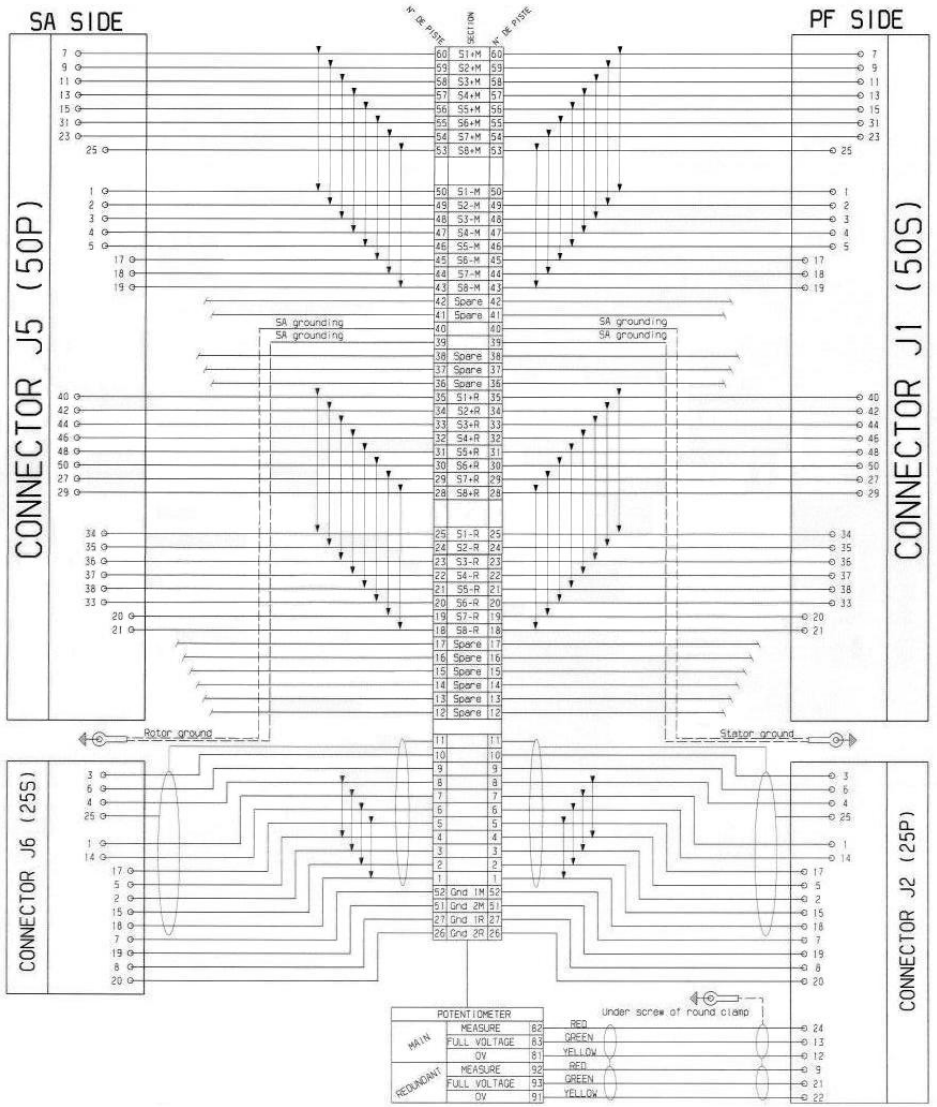


Figure 8: SEPTA 31 power transfer and position sensor's electrical interface