SEPTA® 32

Solar Array Drive Assembly

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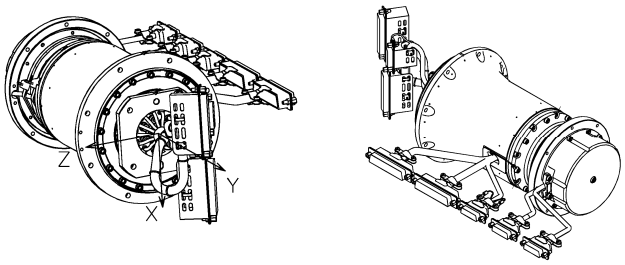
GENERAL DESCRIPTION

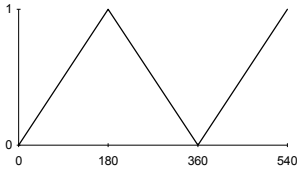
The SEPTA 32 Solar Array Drive Assembly (SADA) is designed to fulfill a large range of applications on satellites with a mass of approximately 1000 kg in LEO and MEO orbit that are used for scientific or telecommunications purposes by using a standard product to minimize costs on system level. The SADA is full 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 campaign of SEPTA 32 a total of 102 490 sweeps of ±41° were performed during the life time test. The SADA has flight heritage since 2007 and over 120 years of accumulated component flight heritage (C.F.H.).



The main functions of the SEPTA 32 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 32 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 54 current transfer rings made from gold plated brass, rated for the following currents: 40 power tracks at 3 A_{RMS} (32TK @ 3.4 A_{RMS}); 2 ground tracks at 3.4 A_{RMS}; 12 signal tracks at 0.25 A_{RMS}. Molding of rings and contacts wires, together with wires and soldering points, within a charged space qualified epoxy gives a very high electrical insulation.

Position measurement is achieved using main and redundant potentiometers, which feedback an analogue 0 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 4.7kΩ ±10%.



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 32-E/R and –E/S incorporate fully space qualified electronics integrated at the rear of the SEPTA 32 on two separate PCB's. The SEPTA 32-E/R version can be fed using 21 V to 36 V regulated power bus; the SEPTA 32-E/S version is powered using an unregulated 50 V ±1 V power bus.

The SEPTA 32-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 32-M/RR).

The following SEPTA 32 Models are available:

	Drive Electronics 21V to 36V	**Drive Electronics** 50V ±1V	**Potentiometer**	**Reset Switch**
SEPTA®32-E/R	x	-	x	-
SEPTA®32-E/S*	-	x	x	-
SEPTA®32-M*	-	-	x	-
SEPTA®32-M/RR*	-	-	x	x

* **A PFM approach is requested for this model**

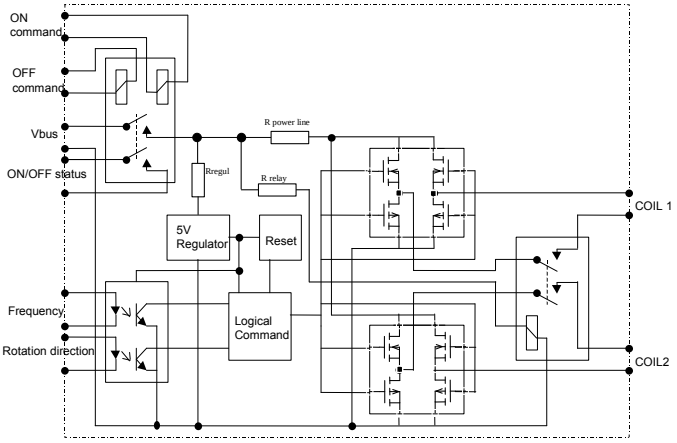


Figure 2: SADE Block Diagram SEPTA®32-E/R

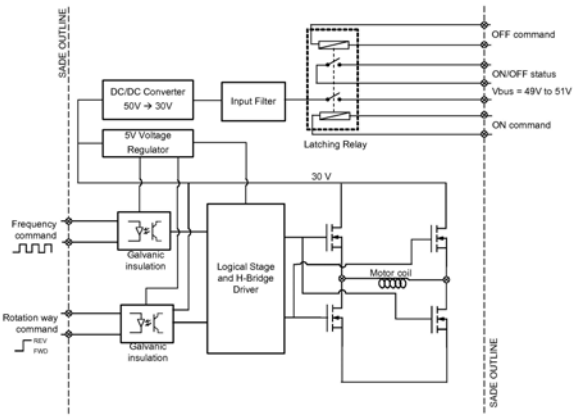
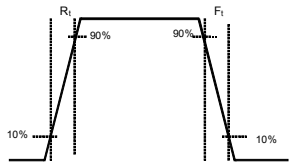


Figure 2: SADE Block Diagram SEPTA®32-E/S

COMMAND SIGNALS ON-OFF TIMING

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



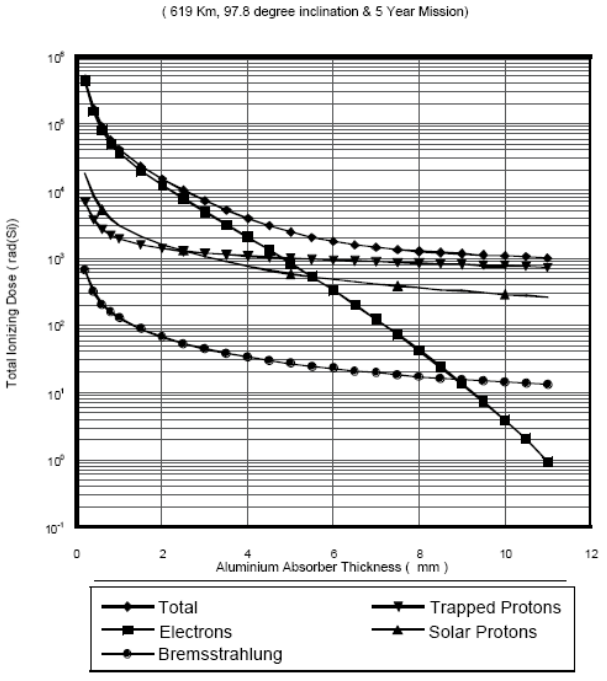
High level:	2.4-5 V
Low level:	<0.4 V
R_t	<0.5 ms
F_t	<0.5 ms
Duration	>1 ms

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 for SEPTA 32 qualification. Higher radiation tolerance may be achieved by increasing the thickness of the SADE housing in order to fulfil the required environment conditions.

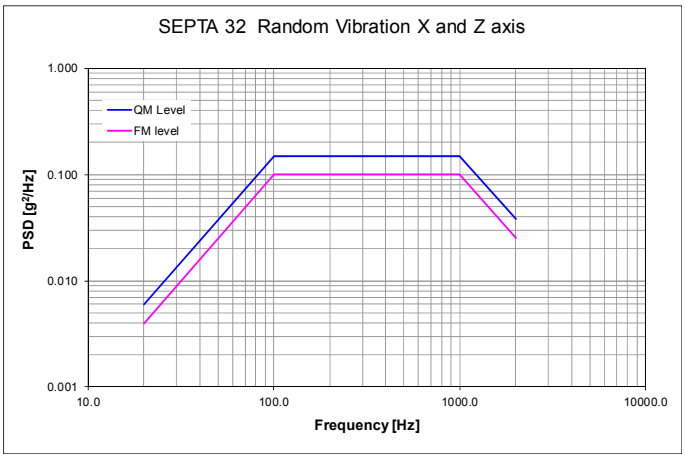


ESD

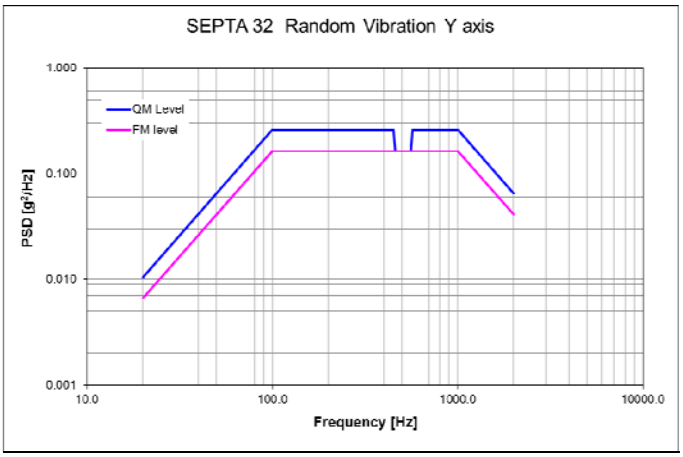
SEPTA 32-E/R and –E/S are ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulates on the human body and test equipment and can discharge without detection. Although the SEPTA 32 features proprietary ESD protection circuitry, permanent damage may occur 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 SEPTA®32 acceleration levels for X- and Z-axis, parallel to mounting plate, for random vibration levels is given as follows:



Random vibration levels for acceleration in Y axis correspond to the following diagram:



PACKAGING AND STORAGE

As delivered by RUAG SPACE the SEPTA®32 is mounted on a handling tool equipped with shock detectors.

The SEPTA®32 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	36 000 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 35 000 orbital rotation
Qualification sequence	500 complete rotations 102 490 sweeps of ± 41°

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 return line)	
Number of power transfers	40 (20 fwd + 20 return)
Current	3 A_{RMS} @ 40 Tracks (3.4 A_{RMS} on model 32 TK)
Voltage	Nom. 55 V
Power transfer	Max. 3,3 kW
Insulation	≥ 10 MΩ
Noise	10 mV_{RMS}/A

Signal Transfer (forward or return line)	
Signal transfer number	12
Current	0.25 A
Voltage	55 V
Insulation	≥ 10 MΩ
Noise	10 mV_{RMS}/A

Position Measurement	
Potentiometer resistance	4.7 kΩ ± 10%
Potentiometer accuracy	±0.5°
Potentiometer linearity	±0.15%

Dimension	
External diameter	120 mm
Fixation flange diameter	140 mm
Total length (from SA interface flange to rear part)	240 mm
Mass without external leads and connectors	M ≤ 3.7 kg
Mass with external leads and connectors	M ≤ 4.4 kg

Mechanical Interface	*PF interface*	*SA interface*
	See Figure 3 to 6	See Figure 3 to 6

Power Consumption (worst case)	**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

Qualified Temperatures	**T_{min}**	**$T_{Ambient}$**	**T_{max}**
Ground Storage	+ 10°C	+22°C	+ 40°C
In orbit non operational	- 22°C		+ 72°C
Cold start-up limit	- 22°C		
In orbit operational	- 8°C	+22°C	+ 67°C

Environment conditions during operation			
Orbits	LEO	MEO	GEO
Radiation Total Dose (Shielding 2.5mm Al)	15 krad (Additional shielding can be applied)		

SADM Connectors		
J1	SA Signals	DDMA50S
J2	SA & Potentiometer Signal	DBMA25P
J3	SADE Main	DAMA15P
J4	SADE Redundant	DAMA15P
J5	SA Power & Signals	DDMA50S
J6	SA Signals & Signals	DBMA50S
J7	SA Signals & Signals	DBMA50P
J8	SA Signals & Signals	DBMA50P

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

Torsion 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 19	± 10.3 mm	± 6.9 mm
19 to 80	15 g	10 g
80 to 100	8 g	6 g

sweep rate	2oct / min

Random vibration:

Frequency (Hz)	⊥ *MOUNTING PLANE*	// *MOUNTING PLANE*
20-100	+6 dB/oct	+6 dB/oct
100-450	0.260 g²/Hz	0.150 g²/Hz
450-460	-63.11 dB/oct	0.150 g²/Hz
460 -560	0.164 g²/Hz	0.150 g²/Hz
560 - 570	+78.37 dB/oct	0.150 g²/Hz
570 - 1000	0.260 g²/Hz	0.150 g²/Hz
1000-2000	-6 dB/oct	-6 dB/oct
Global	19.03 g_{rms}	14.7 g_{rms}

Shock levels for each axes (X, Y, Z):

Frequency (Hz)	Shock input levels
200	150 g
2’000	750 g
10’000	750 g

FLIGHT MODEL (FM) ACCEPTANCE PROGRAMME

The flight model acceptance programme includes the following tests:

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

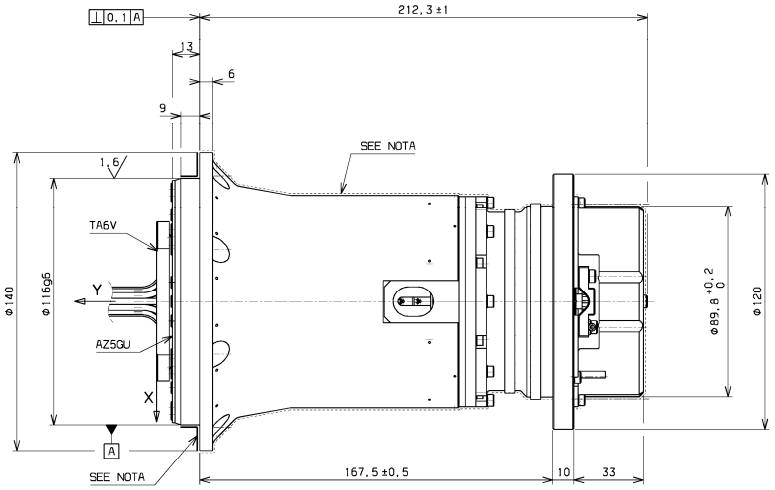


Figure 3: SEPTA 32-E/R plan view

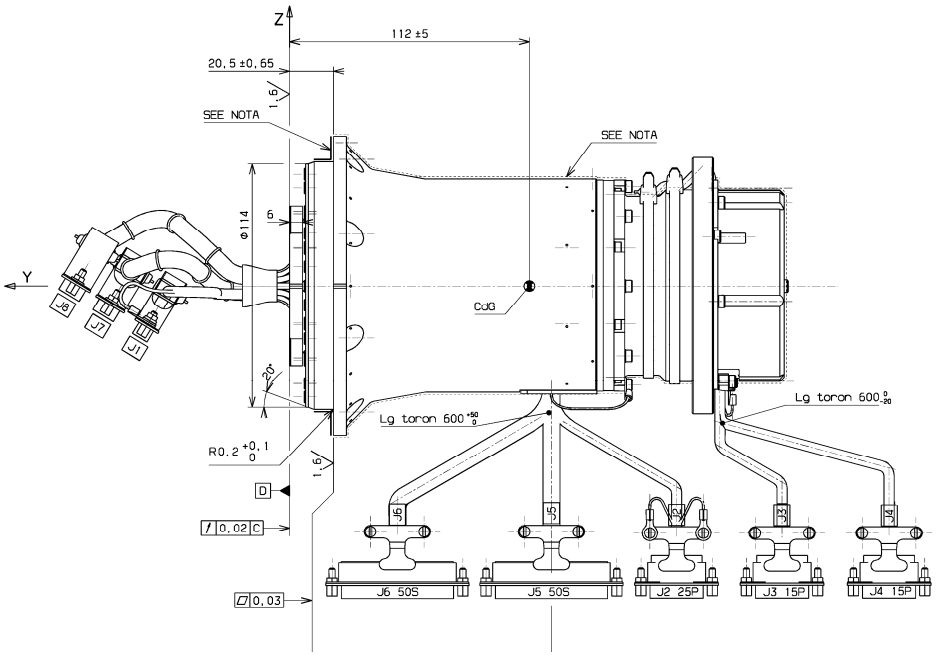


Figure 4: SEPTA 32-E/R plan view with connectors

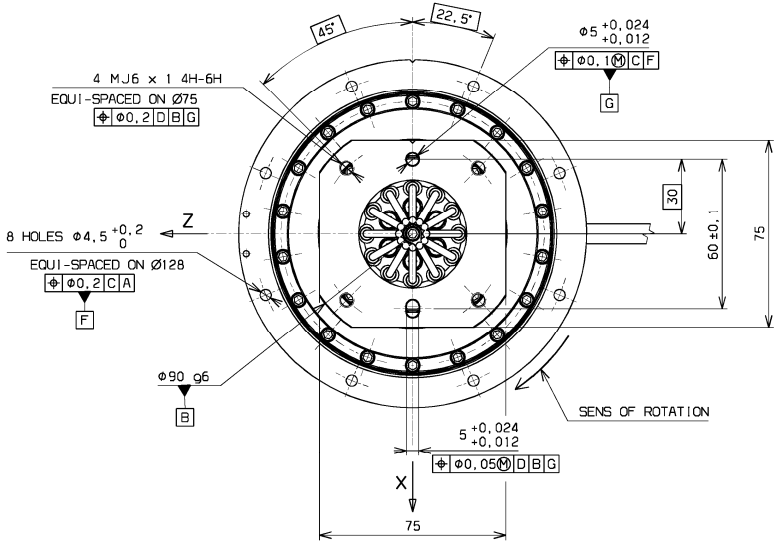


Figure 5: SEPTA 32-E/R Solar Panel Interface side view

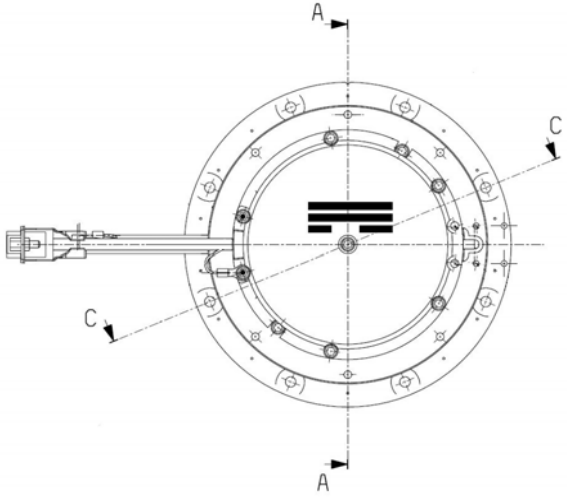


Figure 6: SEPTA 32-E/R rear view

ELECTRICAL INTERFACES FOR SEPTA 32-E/R

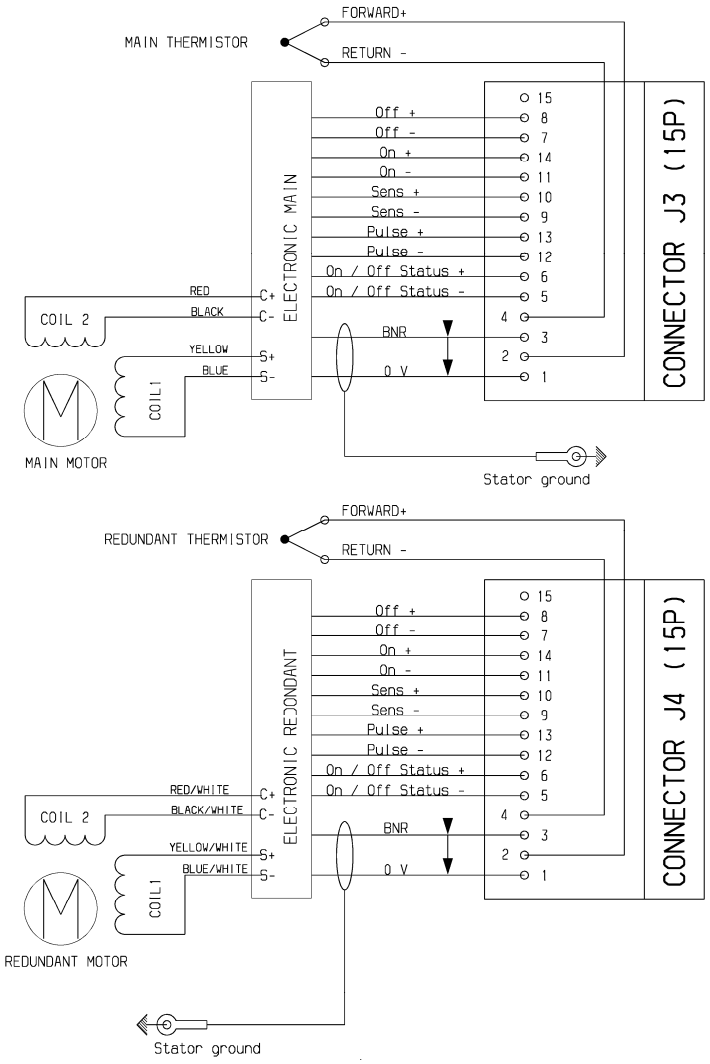


Figure 7: SEPTA 32-E/R SADE electrical interface

Figure 8: SEPTA 32-E/R power transfer and position sensor's electrical interface