

D3.1 SEA module – design description

This documentation gives a detailed description of the mechanical design including all its components. This document must be treated confidentially.

Design and tools

During the design process we put emphasis on a tight integration of motor (incl. electronics), gear, gear encoder, custom titanium spiral spring, and joint encoder (Fig 1) into a single encapsulated unit with a hollow shaft.

- All parts were designed using Siemens UGS NX and dimensioned with Ansis.
- A hollow output shaft holds large loads (100Nm bending, 1000N radial/axial load) and enables proper cabling
- Sealed bearings on both sides ensure high IP grade
- The spring characteristics is optimized using FEM (Fig 2)
- IP67 rated cable glands are used for power and bus



Figure 2 Main components motor, gear, gear encoder, spring, joint encoder

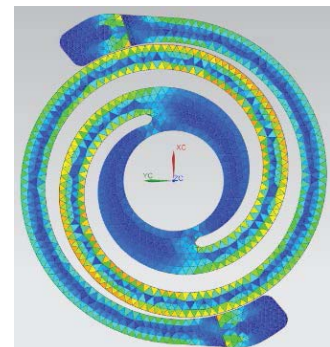


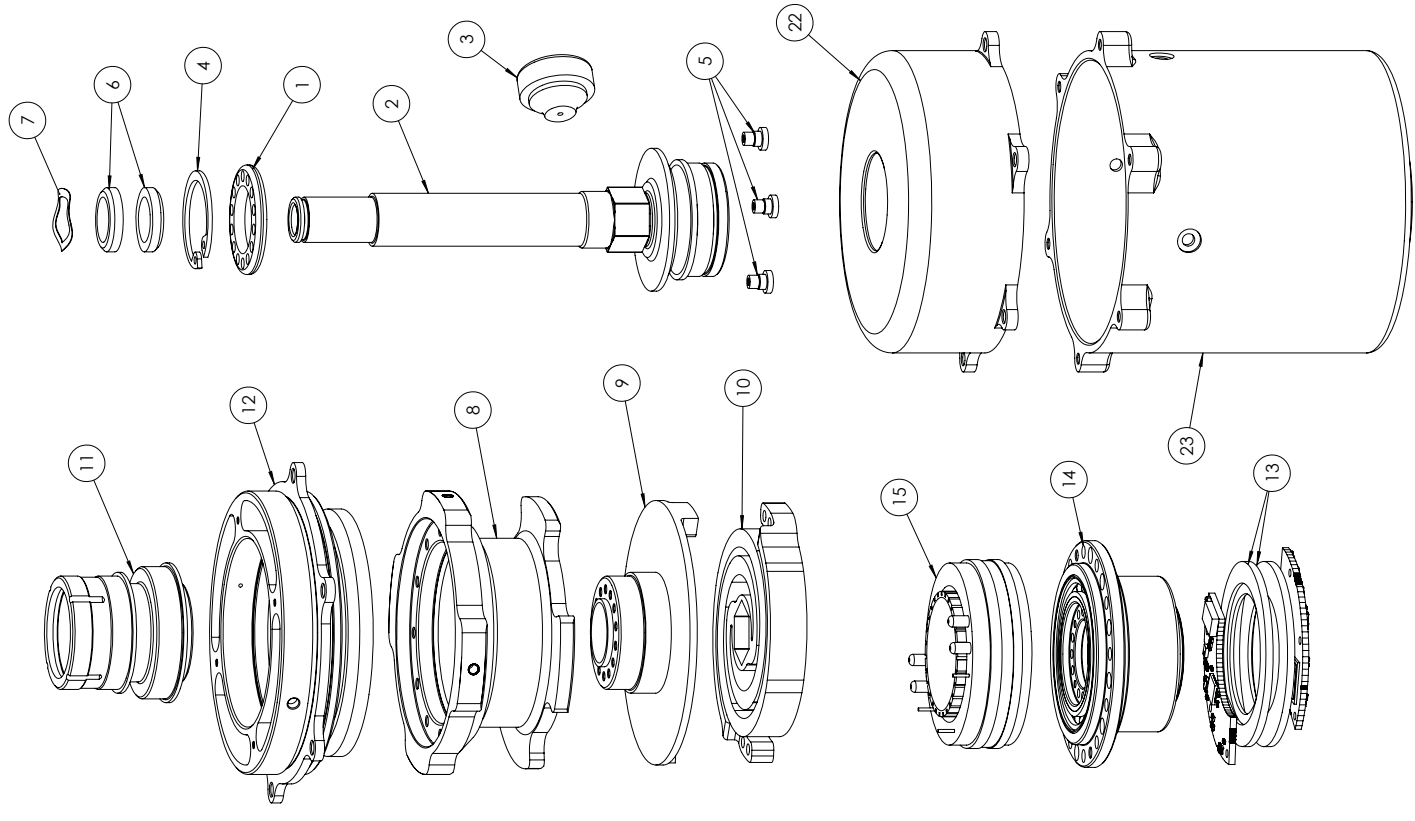
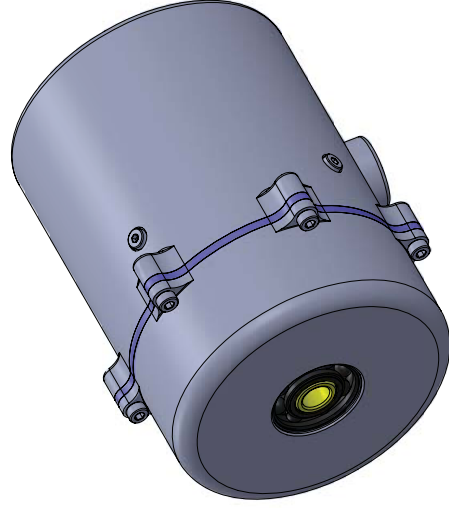
Figure 1 FEM optimized spring

Detailed assembly structure

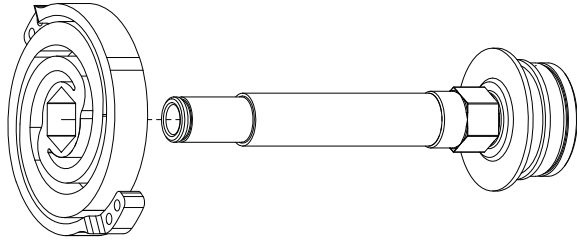
The following PDF provides details about

SEA UNIT ASSEMBLY

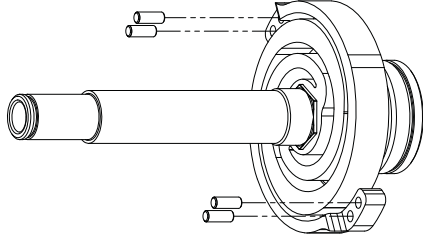
ITEM NO.	PART NUMBER	DESCRIPTION	Default/ QTY.
1	031541_00	HD Clamping Ring	1
2	031552_00	Output Shaft	1
3	031563_00	Cable Grommet	1
4	031567_00	Retaining Ring	1
5	031569_00	Encoder Standoff	3
6	031588_00	Extension Washer	2
7	031589_00	Compensation Disc	1
8	031544_00	Harmonic Drive Mount	1
9	031560_00	Gear-Spring Transmission	1
10	031527_01	Torsional Spring	1
11	031540_01	Input Shaft	1
12	031547_01	Motor Mount	1
13	031546_00	RLS Absolute Encoder	2
14	031554_00	Harmonic Drive CPL-2A 17	1
15	031561_00	TQ Torque Motor	1
16	031582_00	SKF 61806-2RS1	1
17	031550_00	SKF 61902-2Z	1
18	031551_00	SKF 61806-2Z	1
19	031553_00	SKF 61901-2Z	1
20	031559_00	SKF 6001-2RSH	1
21	031556_00	SKF 61807-2Z	1
22	031543_01	Housing Cap	1
23	031545_01	Main Housing	1
24	031591_00	Input O-ring	1
25	031592_00	Output O-ring	1
26	031593_00	Housing O-ring	2
27	031564_00	Dowel Pin $\varnothing 3 \times 8$	4
28	031579_00	SHCS M3-0.5 x 10	6
29	031573_00	SHCS M3-0.5 x 8	12
30	031575_00	SHCS M2-0.4 x 6	4
31	031581_00	SHCS M2.5-0.45 x 10	14
32	031574_00	SHCS M2-0.4 x 4	6
33	031578_00	SHCS M3-0.5 x 6 low profile	4



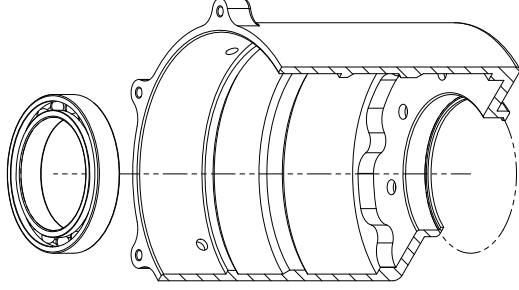
PRESSED COMPONENTS



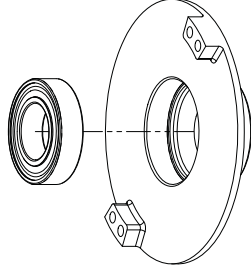
PRESS SPRING ONTO PIN
(SHRINK FIT)



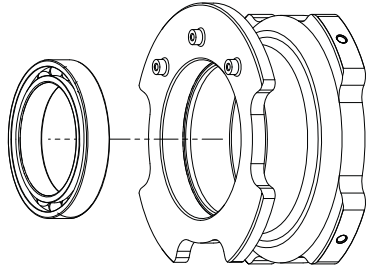
PRESS PINS INTO SPRING



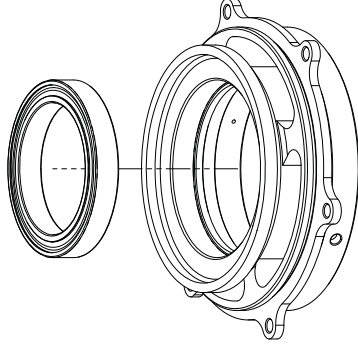
PRESS 61806-2RS1 BEARING
INTO MAIN HOUSING



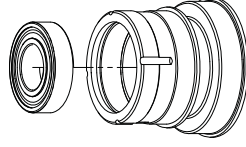
PRESS 61902-2Z BEARING
INTO GEAR-SPRING TRANSMISSION



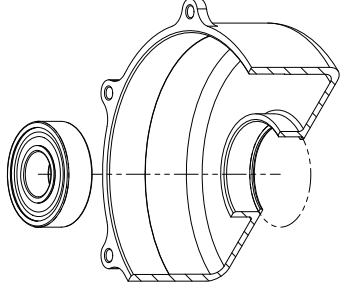
PRESS 61806-2Z BEARING
INTO HARMONIC DRIVE MOUNT



PRESS 61807-2Z BEARING
INTO MOTOR MOUNT

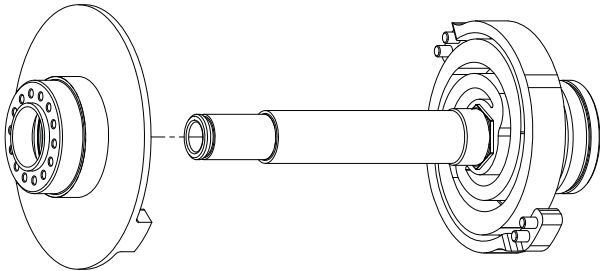


PRESS 61901-2Z BEARING
INTO INPUT SHAFT

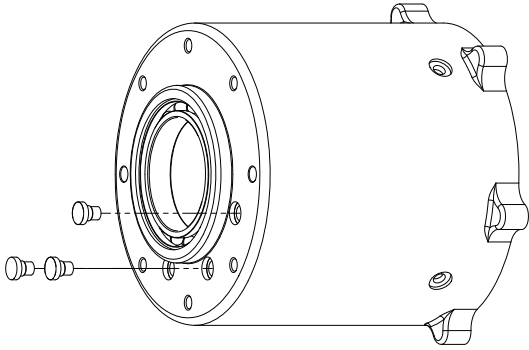


PRESS 6001-2RSH BEARING
INTO HOUSING CAP

PRESSED COMPONENTS

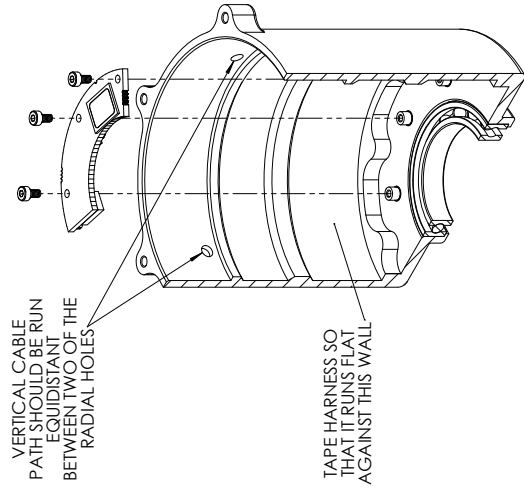


PRESS GEAR-SPRING TRANSMISSION ONTO
PINS IN THE SPRING-OUTPUT SHAFT ASSEMBLY

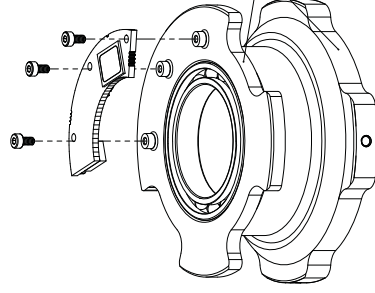


PRESS ENCODER STANDOFFS
INTO MAIN HOUSING

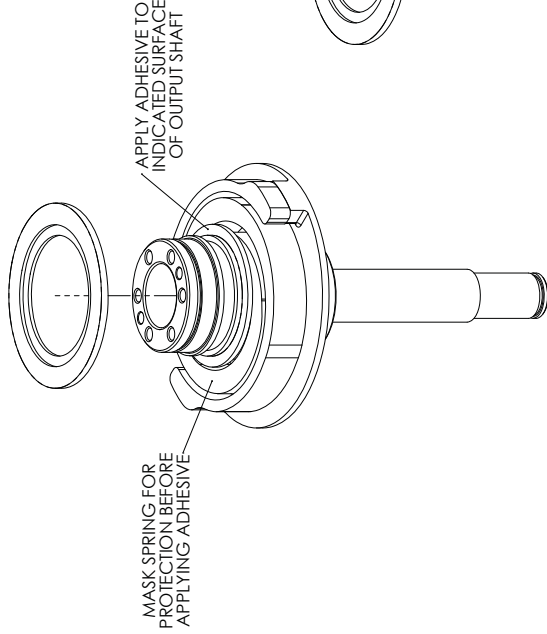
INSTALL ENCODERS



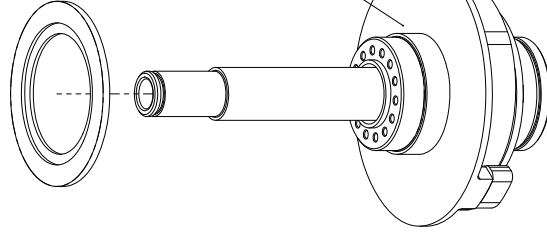
ATTACH CABLE TO FIRST ENCODER READER,
AND INSTALL IN MAIN HOUSING ENCODER
STANDOFFS WITH 3X M2-0.4 x 4 FASTENERS.



ATTACH CABLE TO SECOND ENCODER
READER, AND INSTALL ON HD MOUNT
BOSSSES WITH 3X SHCS M2-0.4 x 4

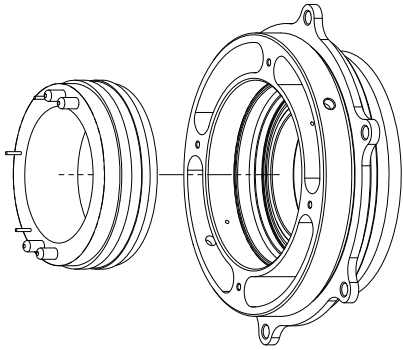


INSTALL FIRST MAGNETIC ENCODER
WHEEL ON OUTPUT SHAFT

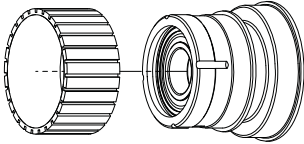


INSTALL SECOND MAGNETIC ENCODER WHEEL
ON GEAR-SPRING TRANSMISSION

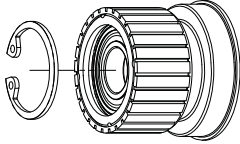
PREPARE COMPONENTS FOR ASSEMBLY



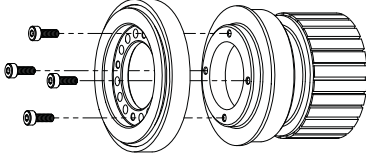
INSTALL STATOR OF TQ TORQUE MOTOR INTO MOTOR MOUNT



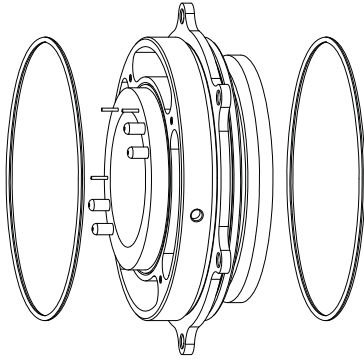
INSTALL ROTOR OF TQ TORQUE MOTOR ONTO INPUT SHAFT



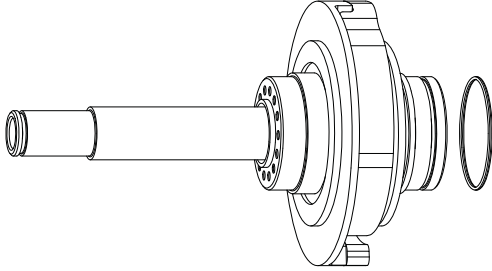
INSTALL CIRCLIP IN INPUT SHAFT TO SECURE BEARING



INSTALL WAVE GENERATOR ON INPUT SHAFT WITH 4X SHCS M2-0.4 x 6

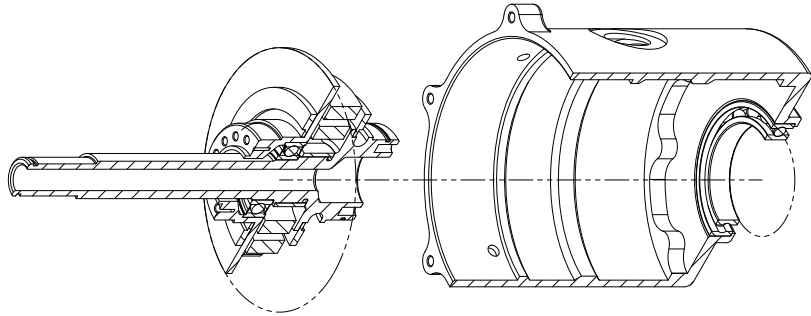


SEAT HOUSING O-RINGS INTO GROOVES ON MOTOR MOUNT

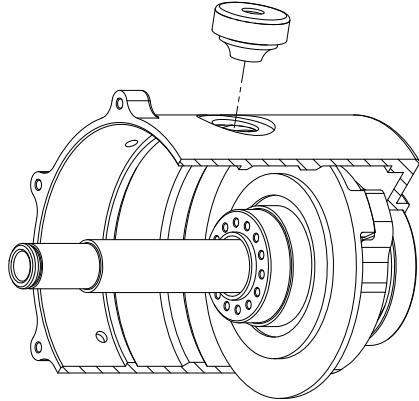


SEAT OUTPUT O-RING INTO GROOVES ON OUTPUT SHAFT

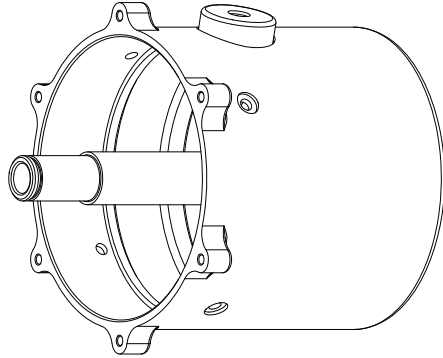
ASSEMBLE OUTPUT SHAFT AND INSTALL MAIN CABLE



INSERT OUTPUT SHAFT ASSEMBLY
INTO MAIN HOUSING

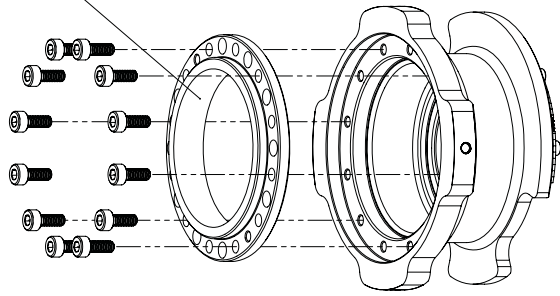


RUN CABLE THROUGH GROMMET,
THEN PULL INTO MAIN HOUSING
THROUGH OPENING



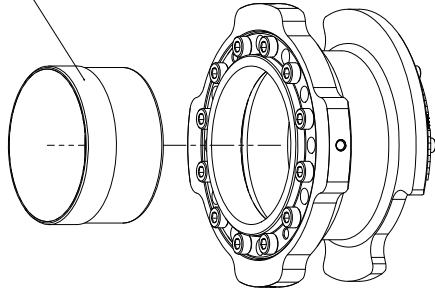
ENSURE THE GROMMET IS FULLY
SEATED IN OPENING

ASSEMBLE HARMONIC DRIVE

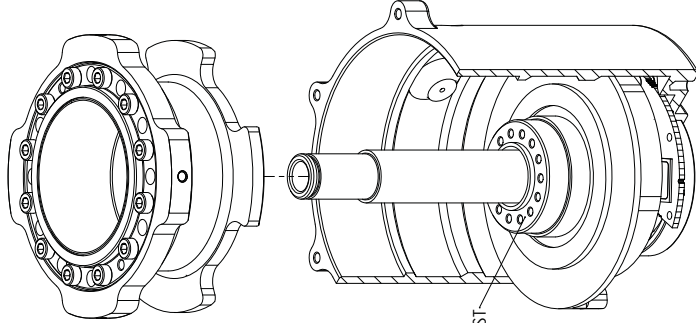


LUBRICATE CIRCULAR SPLINE TEETH
ACCORDING TO HARMONIC DRIVE
CPL-2A OPERATING MANUAL

LUBRICATE FLEXSPLINE
ACCORDING TO HARMONIC DRIVE
CPL-2A OPERATING MANUAL

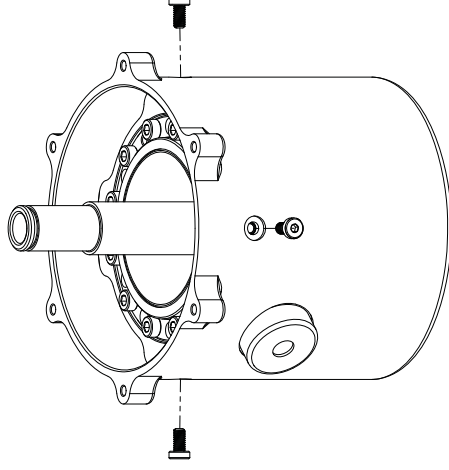


INSTALL CPL-2A 17 CIRCULAR SPLINE
IN HARMONIC DRIVE MOUNT WITH
12X SHCS M3-0.5 X 8



PLACE HARMONIC DRIVE
"Ekagrip gasket" IN PLACE FIRST

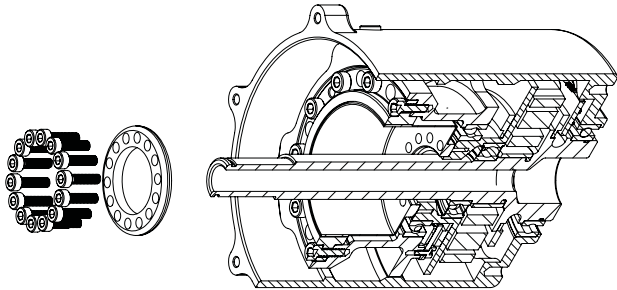
PLACE FLEXSPLINE IN CIRCULAR
SPLINE SO THAT TEETH ENGAGE
PROPERLY (SYMMETRIC GAPS ON
EITHER SIDE OF ENGAGED TEETH)



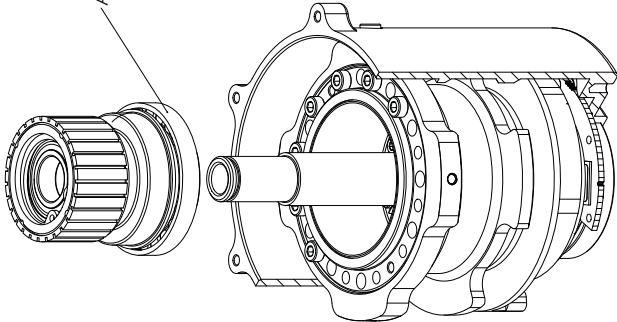
INSERT HARMONIC DRIVE MOUNT
INTO MAIN HOUSING ASSEMBLY

INSERT 4X low profile SHCS M3-0.5 X 6 LOOSELY
(TIGHTEN AFTER ASSEMBLY COMPLETE)

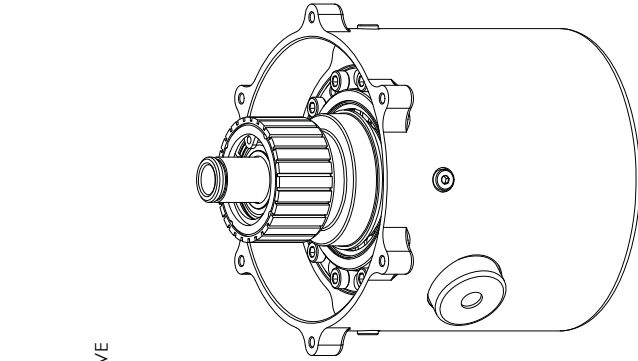
ASSEMBLE HARMONIC DRIVE



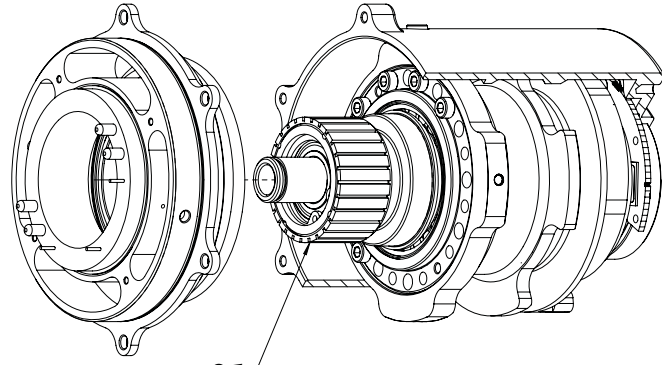
ATTACH FLEXSPLINE WITH CLAMPING RING
AND 14X SHCS M2.5-0.45 x 10



INSERT WAVE GENERATOR INTO FLEXSPLINE
MAINTAINING SYMMETRIC GAPS BETWEEN
FLEXSPLINE AND CIRCULAR SPLINE.

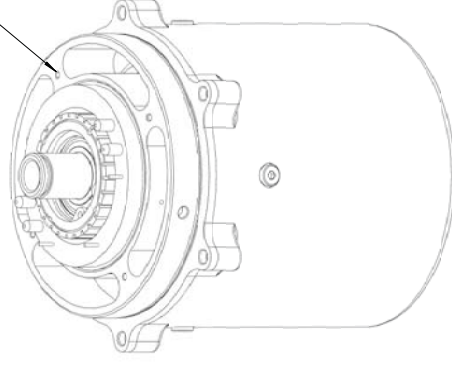


ASSEMBLE MOTOR



WRAP PROTECTIVE COVER AROUND
ROTOR TO PREVENT DAMAGE FROM
BEARING DURING INSTALLATION

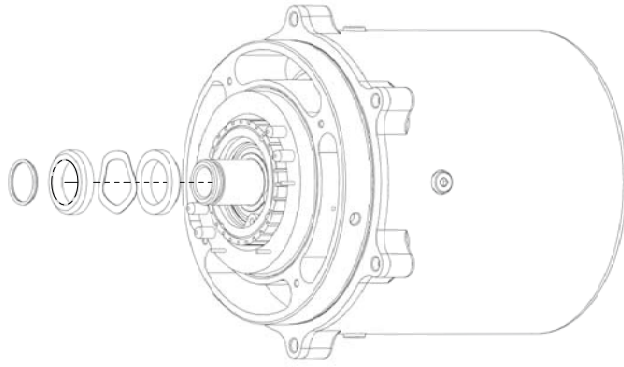
ELECTRONICS MOUNTING POINTS



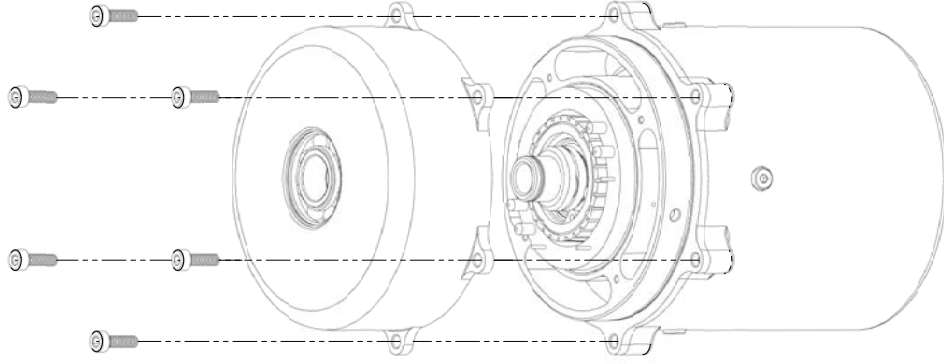
INSTALL ELECTRONICS ON MOTOR
MOUNT AND CONNECT ALL CABLES

INSERT MOTOR MOUNT WITH STATOR INTO MAIN
HOUSING, ALIGNING EXTERNAL MOUNTING HOLES

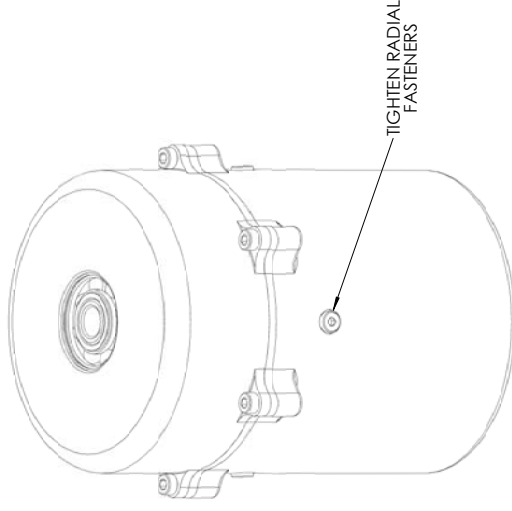
COMPLETE ASSEMBLY



INSTALL SPACERS, COMPENSATION DISC,
AND SHIMS IF NECESSARY. INSTALL O-RING
ON GROOVE ON OUTPUT SHAFT



INSTALL HOUSING CAP WITH 6X SHCS M3-0.5 x 8



TIGHTEN RADIAL
FASTENERS