LIEBHERR-AEROSPACE

LINDENBERG

Airbus / A350
ATA 27 High-lift System
Level III Training Manual

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Liebherr-Aerospace Lindenberg GmbH

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LIST OF ABBREVIATIONS (LOA)

List of Abbreviations

A

A/C	Aircraft
ADGB	Active Differential Gearbox
AMS	Aerospace Material Specification
ASSY	Assembly
ASJ	Articulating Splined Joint

B

BGB	Bevel Gear Box
BRSV	Brake Solenoid Valve

C

CAN	Control Area Network
CU	Control Unit
CS	Compliant Shaft
C	Control

D

DFPPU	Differential Feedback Position Pickup Unit
DFS	Differential Flap Setting
D/F	Differential gear
DC	Direct Current
DNGRA	Droop Nose Geared Rotary Actuator

E

EPOB	Electric Power Off Brake
ESV	Enable Solenoid Valve
EHSV	Electro Hydraulic Servo Valve
EM	Electrical Motor

F

FPPU	Feedback Position Pickup Unit

G

GRA	Geared Rotary Actuator

H

HPOB	Hydraulic Power Off Brake

I

I/B	Inboard
ISV	Isolation Valve

K

KGB	Kink Gear Box

L

LLI	Liebherr-Aerospace Lindenberg GmbH
LH	Left Hand
LRU	Line Replaceable Unit
LVDT	Linear Variable Differential Transducer
LEP	List of Effective Pages
LOA	List of Abbreviation
LSDS	Load Sensing Drive Strut

M

MCE	Motor Control Electronic
MD	Moving Damper
MAPS	Motor Angular Position Sensor

O

O/B	Outboard

P

PCU	Power Control Unit
PPU	Position Pickup Unit
PSU	Power Supply Unit
PCE	Power Control Electronic
P/N	Part Number
POB	Power Off Brake
PT	Pressure Transducer
P	Pressure

Q

QPA	Quantity Per Aircraft

R

RH	Right Hand
RG	Reduction Gear
R	Return

S

SAPS	Swash Plate Angular Position Sensor
SAE	Society of Automotive Engineers
SEPOB	Standby Electric Power Off Brake
SB	Steady Bearing
SFCC	Slat Flap Control Computer

STL	System Torque Limiter

T

TOC	Table of Contents
TBGB	Tee Bevel Gear Box
TSU	Torque Sensor Unit

U

UJ	Universal Joint

V

VB	Valve Block
VDC	Volts Direct Current
VDHM	Variable Displacement Hydraulic Motor

W

WTB	Wing Tip Brake

Introduction

INTRODUCTION SLAT SYSTEM

The purpose of the equipment is to move the slat surfaces of the Airbus A350 aircraft to its pre-defined positions. Each wing is equipped with 1 leading edge droop nose panel, 6 leading edge slat panels and 2 trailing edge flap surfaces.

The droop nose devices are moved with levers into which a droop nose actuator interface with a spline output is plugged in. The droop nose actuator includes a torque limiter to limit the torque transmitted in case of a jam or overload.

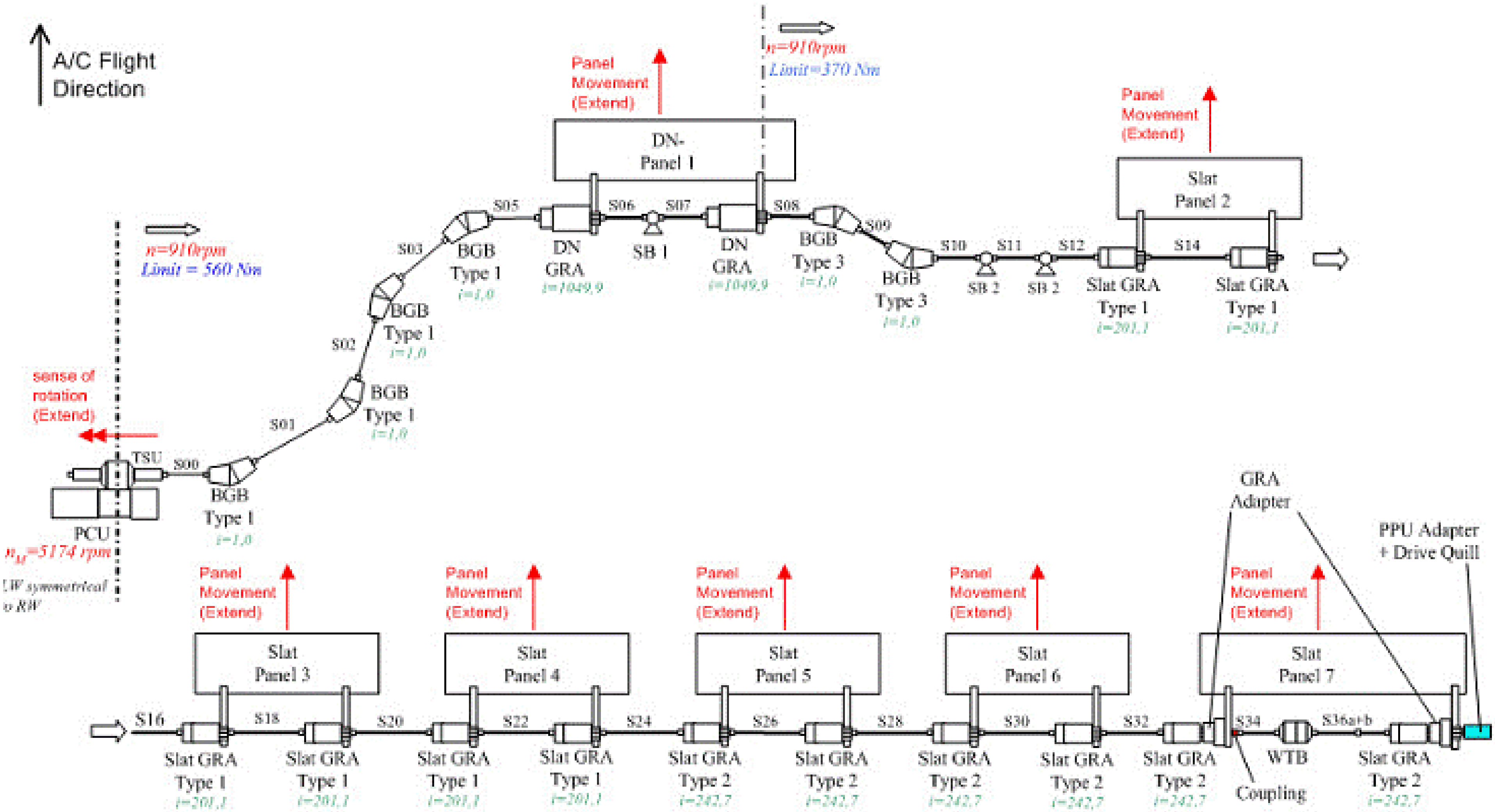
The slat panels are driven to their positions by curved racks which are actuated by plug-in type rotary actuators which move a pinion each through a spline interface. The midboard and outboard panels (3 each per wing) require different actuator sizes due to the loading difference. The midboard and outboard actuators also include a torque limiter in case of a jam or overload.

All leading edge devices are each connected with rigid shaft transmission systems including flexible joints where necessary. Major changes in drive shaft direction are accomplished with angle gearboxes. The droop nose actuator section runs additionally with higher loads.

Each wing for the slat system is protected from extreme loads with an electronic torque sensing unit which is part of the PCU. By that the system torque limiters can be avoided.

In the slat system a Wing Tip Brake of the Power-Off type is installed between the 2 outer most actuators.

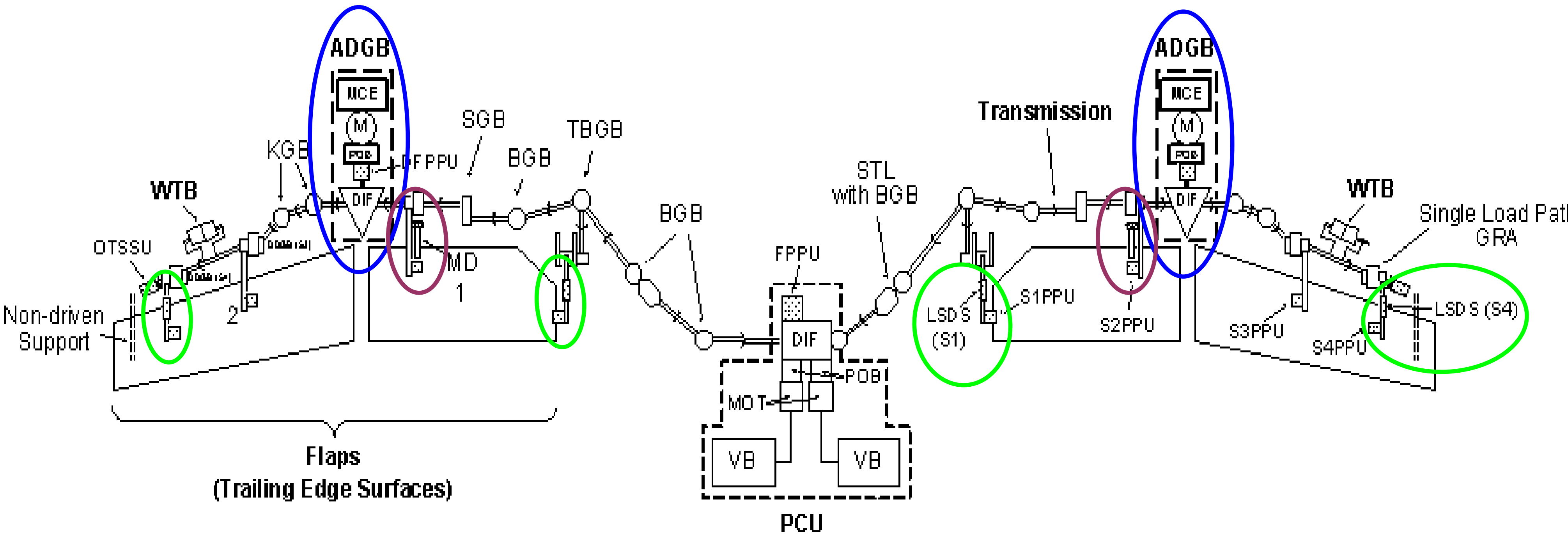
The complete system is controlled and monitored through Control Computers and various sensors.



A/C Flight Direction
Panel Movement (Extend)
DN-Panel 1
n=910rpm
Limit=370 Nm
Slat Panel 2
n=910rpm
Limit = 560 Nm
S03
BGB Type 1
i=1,0
S05
DN GRA
i=1049,9
S06
SB 1
S07
DN GRA
i=1049,9
S08
BGB Type 3
i=1,0
S09
BGB Type 3
i=1,0
S10
S11
SB 2
SB 2
S12
Slat GRA Type 1
i=201,1
S14
BGB Type 1
i=1,0
S02
sense of rotation (Extend)
BGB Type 1
i=1,0
S01
TSU
S00
BGB Type 1
i=1,0
PCU
n_M=5174 rpm
GRA Adapter
PPU Adapter + Drive Quill
Slat Panel 3
Slat Panel 4
Slat Panel 5
Slat Panel 6
Slat Panel 7
S16
S18
S20
S22
S24
S26
S28
S30
S32
S34
S36a+b
Slat GRA Type 1
i=201,1
Slat GRA Type 2
i=242,7
WTB
Coupling

INTRODUCTION FLAP SYSTEM

The flap panels are moved to the defined positions through struts which are actuated by lever outputs of rotary actuators. These are not part of the LLI work share. In the Flap System only the active differential gearbox, the Moving Damper and the Load Sensing Drive Struts are part of the LLI-workshare. The differential gearbox allows the movement of the outboard flap independently from the inboard flap. The Load Sensing Drive Strut transfers the necessary loads from the rotary actuator to the panel and provides the SFCC with a load signal on support station 1 and 4. A moving damper has been installed in parallel to the drive strut at support station 2 in order to reduce high dynamic peak loads in case of special failure scenarios (e.g. rupture of drive strut at support station 2).


ADGB
MCE
M
POB
DIF
FPPU
SGB
TBGB
BGB
KGB
WTB
OTSSU
MD
1
2
Non-driven Support
BGB
STL
with BGB
FPPU
DIF
POB
MOT
VB
VB
PCU
Transmission
ADGB
WTB
Single Load Path GRA
LSDS (S1)
S1PPU
S2PPU
S3PPU
S4PPU
LSDS (S4)
Flaps
(Trailing Edge Surfaces)

ATA 27 Component Listing

The following tables show information concerning Liebherr-Aerospace components used in the High Lift System of the Airbus A350.

- Liebherr partnumber
- code (abbreviation) used in the training manual
- QPA, quantity per aircraft
- description
- remarks

P/N	CODE	DESCRIPTION	QPA	REMARKS
4773A0000		**Slat System**		
4785A0000	PCU	Power Control Unit	1	LLI provides only Slat PCU
5425A0000	MCE	Motor Control Electronic	1	Slat PCU
4785A4100		Harness	1	Slat MCE
4785A4200		Harness	1	Slat MCE
4785A4300		Harness	1	Slat MCE
4774A0000	GRA	Geared Rotary Actuator	12	Slat Panel 2-4
4775A0000	GRA	Geared Rotary Actuator	12	Slat Panel 5-7
4776A0000	DNGRA	Droop Nose Geared Rotary Actuator	4	Slat Panel 1
4778A0000	BGB	Bevel Gearbox Type 1	8	Slat
4781A0000	BGB	Bevel Gearbox Type 3	4	Slat
4786A0000	WTB	Wing Tip Brake	2	Slat
5434A0000		Adapter	4	GRA Adapter on Slat Panel 7
4784A0000		Transmission Set Complete	1	Slat
4784A7100		Steady Bearing	2	Slat 370 Nm
4784A7300		Steady Bearing	4	Slat 560 Nm

P/N	CODE	DESCRIPTION	QPA	REMARKS
4784A0100	S01	Shaft Assy	2	Slat
4784A0200	S02	Shaft Assy	2	Slat
4784A0300	S03	Shaft Assy	2	Slat
4784A0400	S04	Shaft Assy	2	Slat
4784A0600	S06	Shaft Assy	2	Slat
4784A0700	S07	Shaft Assy	2	Slat
4784A0800	S08	Shaft Assy	2	Slat
4784A0900	S09	Shaft Assy	2	Slat
4784A1000	S10	Shaft Assy	2	Slat
4784A1100	S11	Shaft Assy	2	Slat
4784A1200	S12	Shaft Assy	2	Slat
4784A1400	S14	Shaft Assy	2	Slat
4784A1600	S16	Shaft Assy	2	Slat
4784A1800	S18	Shaft Assy	2	Slat
4784A2000	S20	Shaft Assy	2	Slat
4784A2200	S22	Shaft Assy	2	Slat

P/N	CODE	DESCRIPTION	QPA	REMARKS
4784A2400	S24	Shaft Assy	2	Slat
4784A2600	S26	Shaft Assy	2	Slat
4784A2800	S28	Shaft Assy	2	Slat
4784A3000	S30	Shaft Assy	2	Slat
4784A3200	S32	Shaft Assy	2	Slat
4784A3400	S34	Shaft Assy	2	Slat
4784A3600	S36	Shaft Assy	2	Slat
4784A3700	S00	Shaft Assy	2	Slat

4762A0000		**Flap System**		
6343B0000	MD	Moving Damper	2	Including Harness 6343B4100
6341A0000	LSDS 1	Load Sensing Drive Strut 1	2	Flap
6341A4100		Harness for LSDS 1	2	Flap
6341A4200		Harness for LSDS 1	2	Flap
6342A0000	LSDS 4	Load Sensing Drive Strut 4	2	Flap
6342A4100		Harness for LSDS 4	2	Flap
6342A4200		Harness for LSDS 4	2	Flap

P/N	CODE	DESCRIPTION	QPA	REMARKS
4784A0000	ADGB	Active Differential Gear Box	2	Flap
5427A0000	MCE	Motor Control Electronic for ADGB	2	Flap
4787A4400		Harness	1	Flap
4787A4500		Harness	1	Flap
4787A4600		Harness	1	Flap
4787A4700		Harness	1	Flap
4787A4800		Harness	1	Flap
4787A4900		Harness	1	Flap

Slat System

EFFECTIVITY:

ALL

02 Dec 2014

Power Control Unit

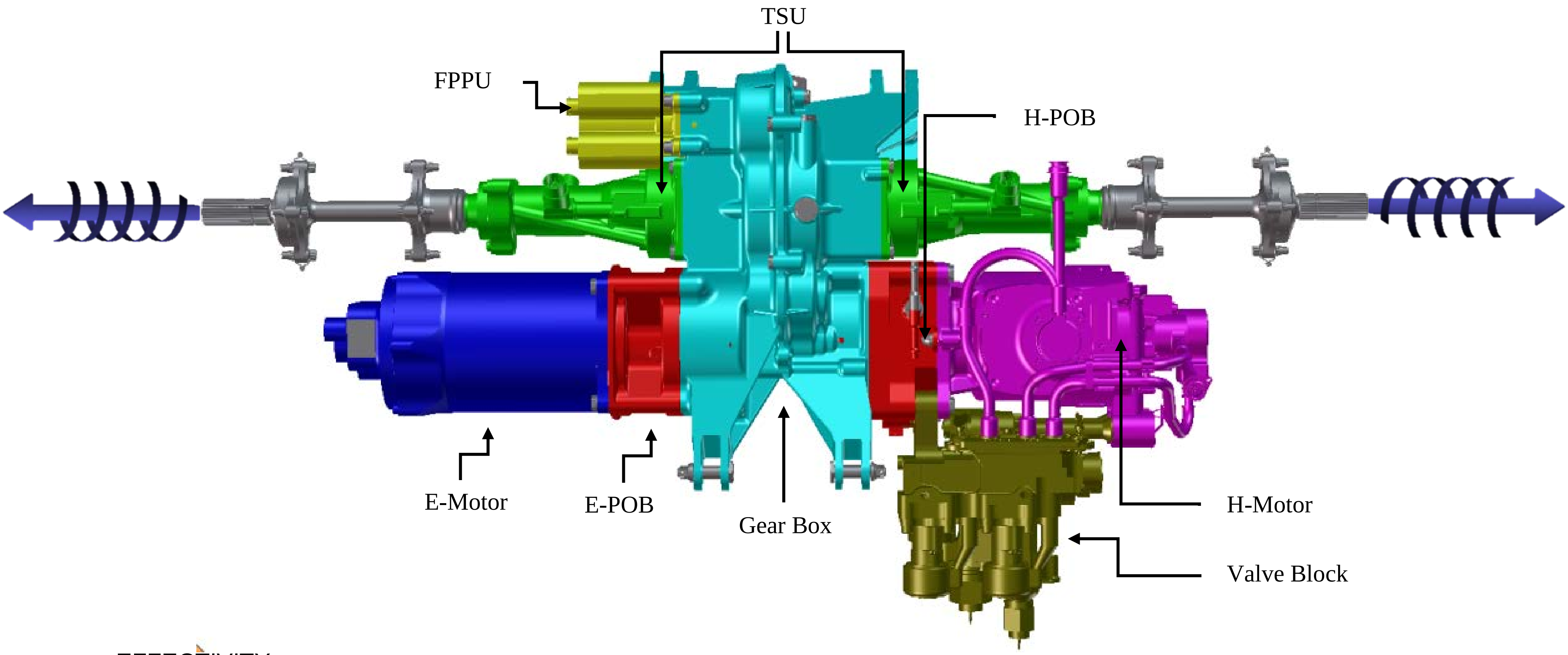
Functions of the PCU:

- Drive the actuation system to the commanded position and maintain it
- Provide position and speed feedback
- Interface to SFCCs and mechanical actuation

The PCU contains several LRUs, which are mounted to the gearbox assembly housing:

- Hydraulic Motor
- Pressure Off Brake
- Motor Angular Position Sensor
- Servo Valve
- Manifold Block Assy
- Pressure Transducer
- Electro Hydraulic Solenoid Valve
- Electric Power Off Brake
- Electric Motor

PCU Installation Position (LH Shown)



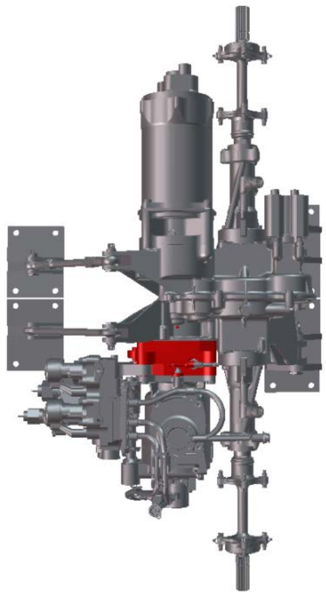
Hydraulic Power-Off Brake

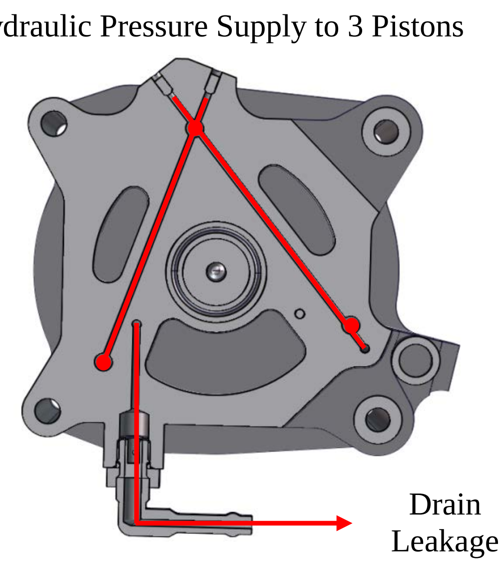
The H-POB, located on the PCU between the drive motor and the gearbox, is normally locked due to spring pressure. Only when energized by high pressure hydraulic fluid does the brake release to allow movement of the motor shaft.

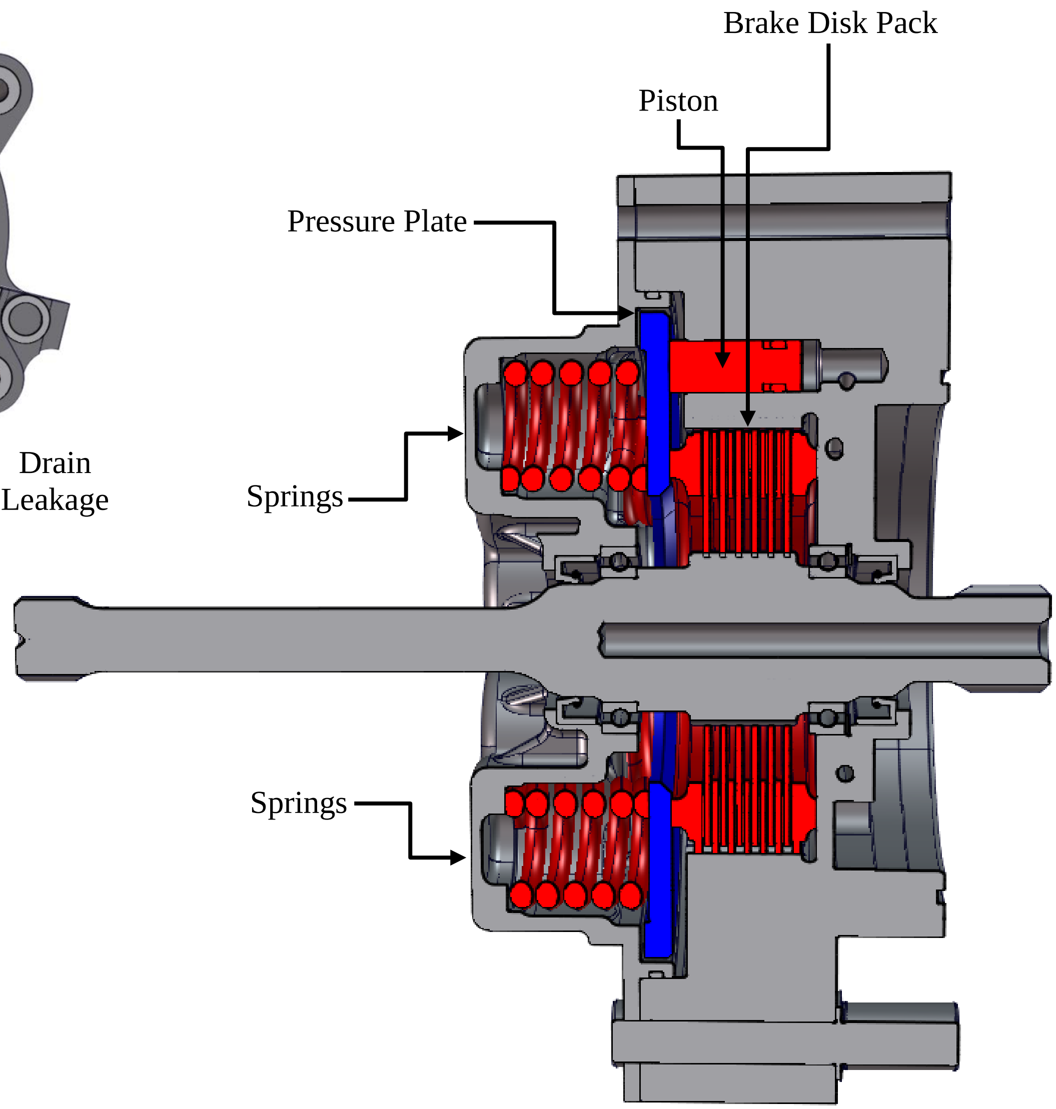
The H-POB has three functions:

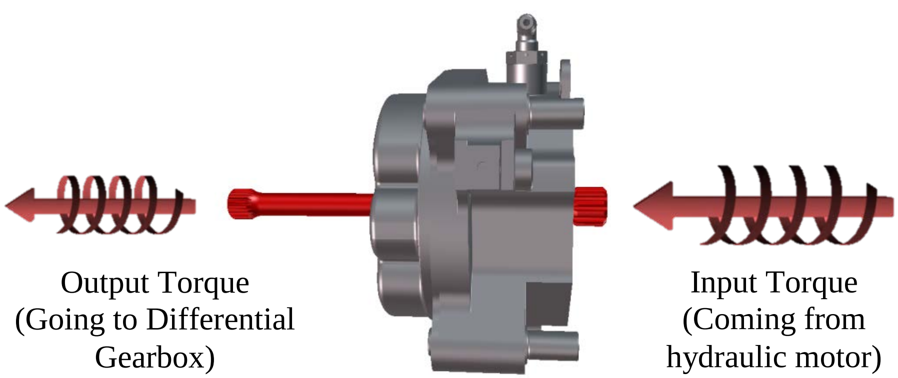
- To hold the system in the last commanded position against all outside forces
- To block the system in case of a major system failure
- To provide a grounding point for the differntial gearing in case of loss of one hydraulic system or motor

The H-POB operates as a semi-sealed unit, lubricated by a bath of hydraulic fluid.




Hydraulic Pressure Supply to 3 Pistons
Drain Leakage


Brake Disk Pack
Piston
Pressure Plate
Springs
Springs


Output Torque (Going to Differential Gearbox)
Input Torque (Coming from hydraulic motor)

Variable Displacement Hydraulic Motor

The VDHM is an axial piston, variable displacement hydraulic motor. The VDHM converts hydraulic pressure into mechanical rotational motion.

The housing contains the following parts:

- drive shaft
- control plate
- cylinder barrel
- pistons and slipper pads
- swash plate

In addition the VDHM has the following components:

- motor angular postion sensor (MAPS)
- swash plate angular postion sensor (SAPS)
- electro hydraulic servo valve (EHSV)

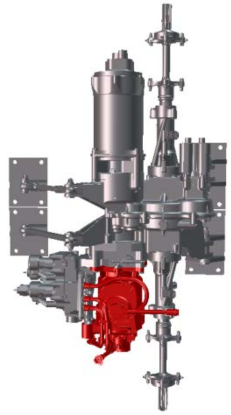
The motor has supply & return ports. A case drain feeds directly into the motor return. The swash plate is balanced by pressure loads only, allowing directional change of the output shaft by moving through the 0° angle of the swash plate.

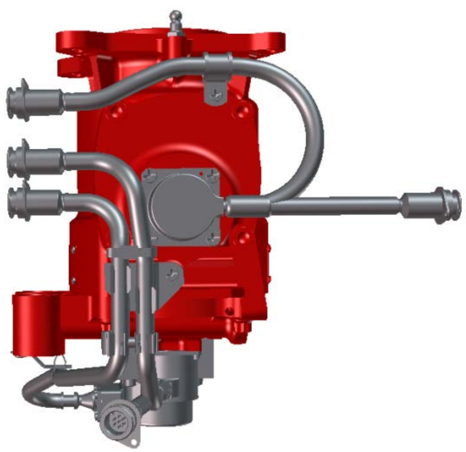
The Slat Flap Control Computer (SFCC) signals the EHSV as required to modulate swash plate angle. Changes in swash plate angle affect:

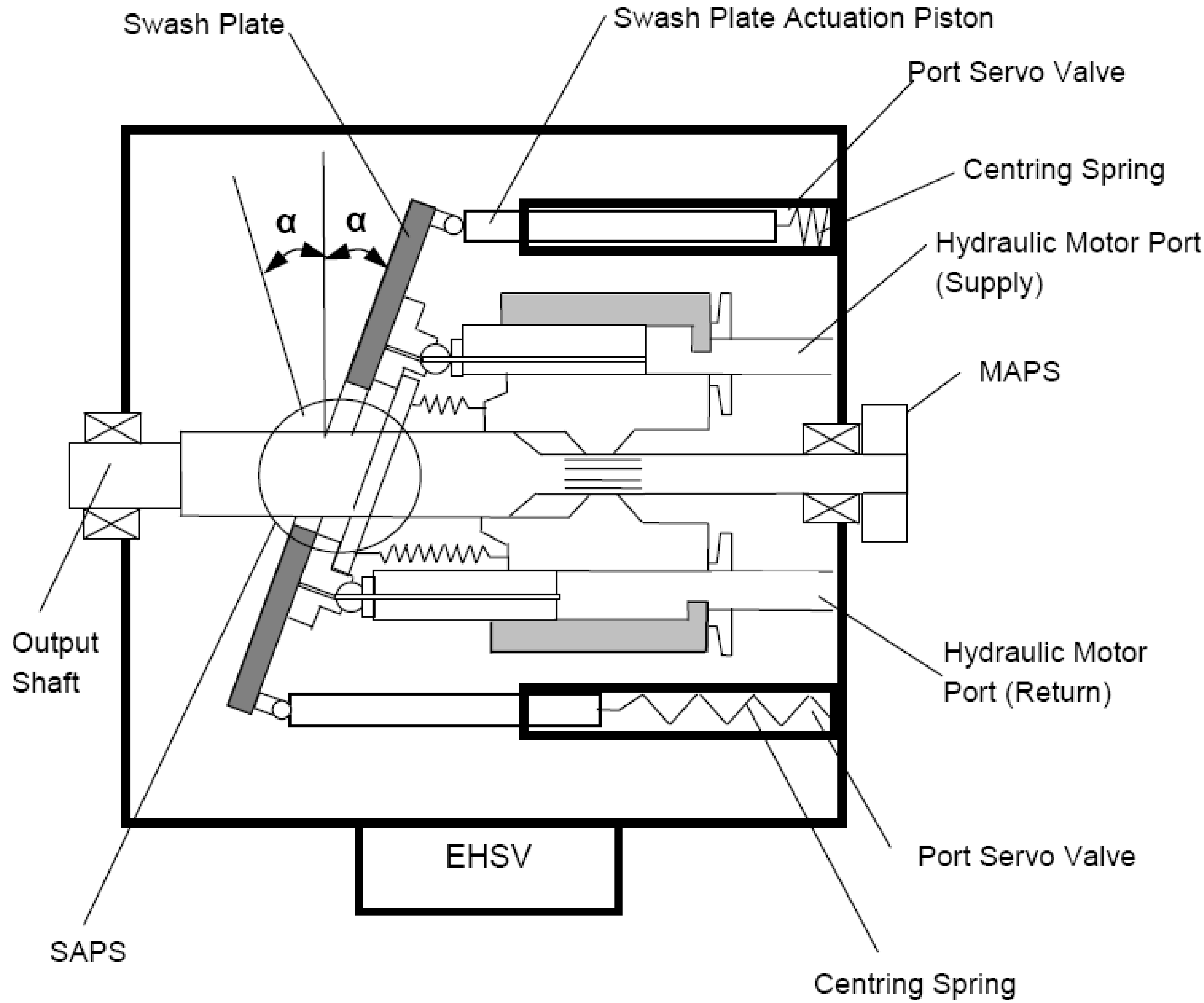
- motor direction of rotation (extend or retract)
- motor displacement
- motor speed and flow requirements

The required angle is determined by comparison to the commanded speed from SFCC and three variables:

- system pressure from the manifold PT
- actual VDHM speed from the MAPS
- actual swash plate angle from the SAPS

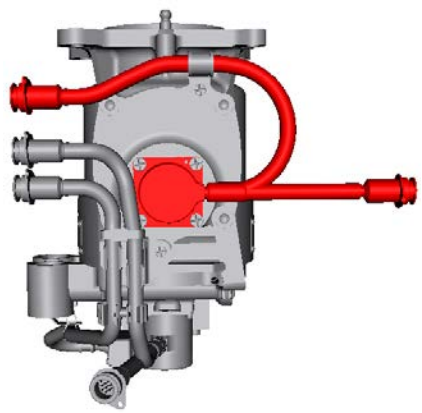


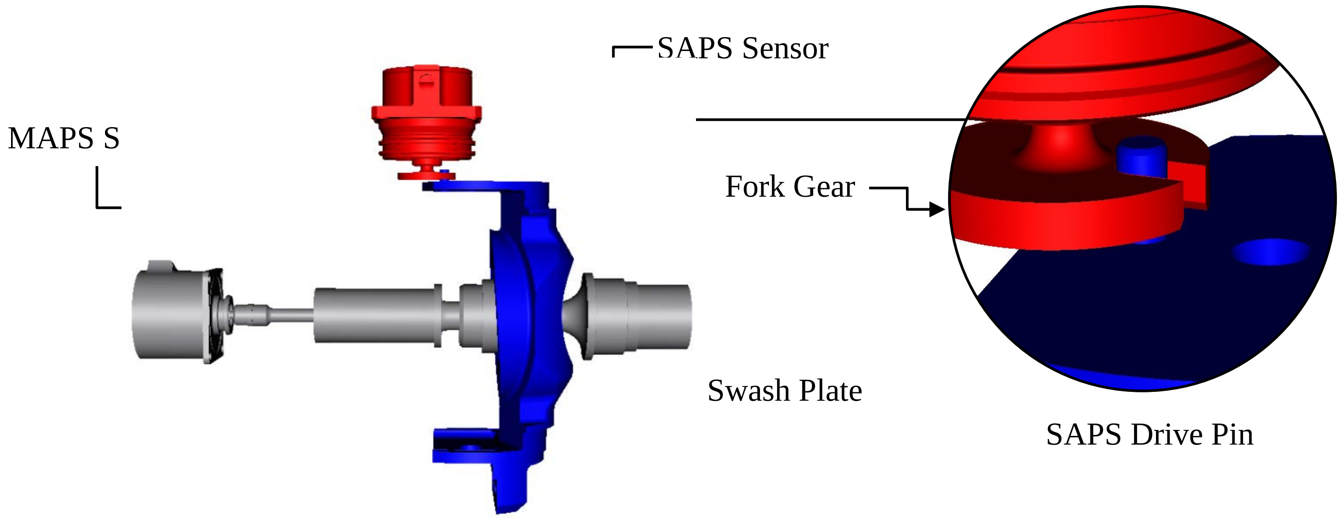



Swash Plate
Swash Plate Actuation Piston
Port Servo Valve
Centring Spring
α
α
Hydraulic Motor Port (Supply)
MAPS
Output Shaft
Hydraulic Motor Port (Return)
EHSV
Port Servo Valve
SAPS
Centring Spring

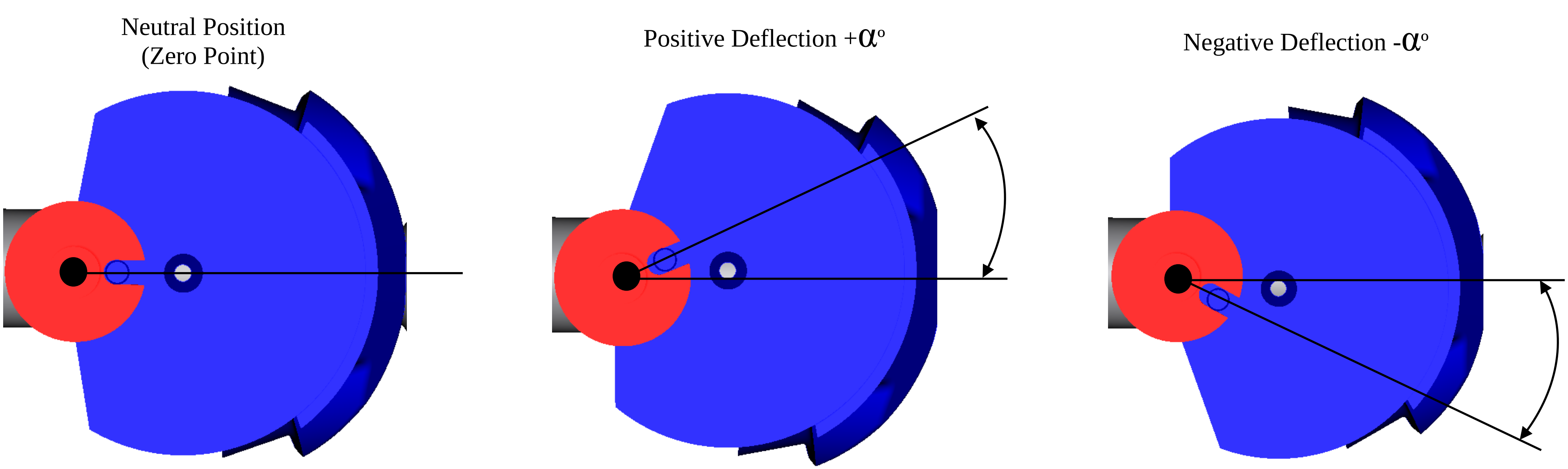
Swash Plate Angle Position Sensor

The Swahplate Angle Position Sensor (SAPS) determines the angle position of the swash plate. SAPS signal is used for the control loop for motor torque.




SAPS Sensor
MAPS S
Fork Gear
Swash Plate
SAPS Drive Pin

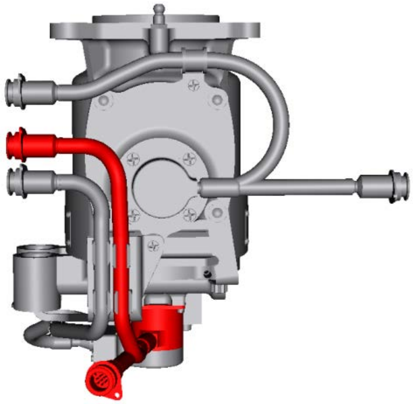
Top-View

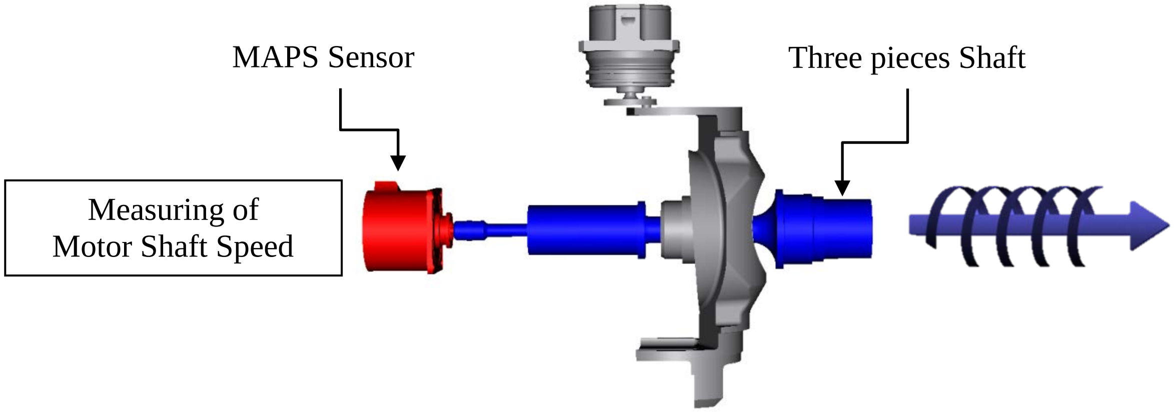

Neutral Position
(Zero Point)
Positive Deflection +α°
Negative Deflection -α°

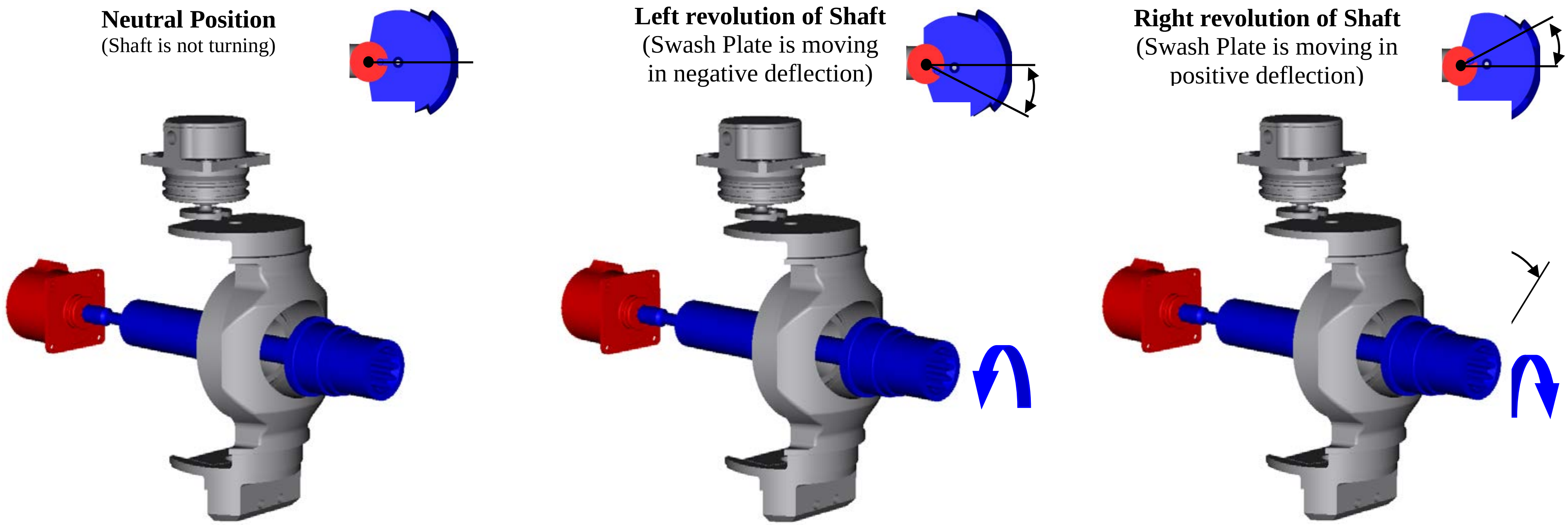
MOTOR ANGULAR POSITION SENSOR

MAPS signal is used to determine the motor speed.

To reverse the motor shaft rotation, the swash plate angle needs to be adjusted beyond the zero point.

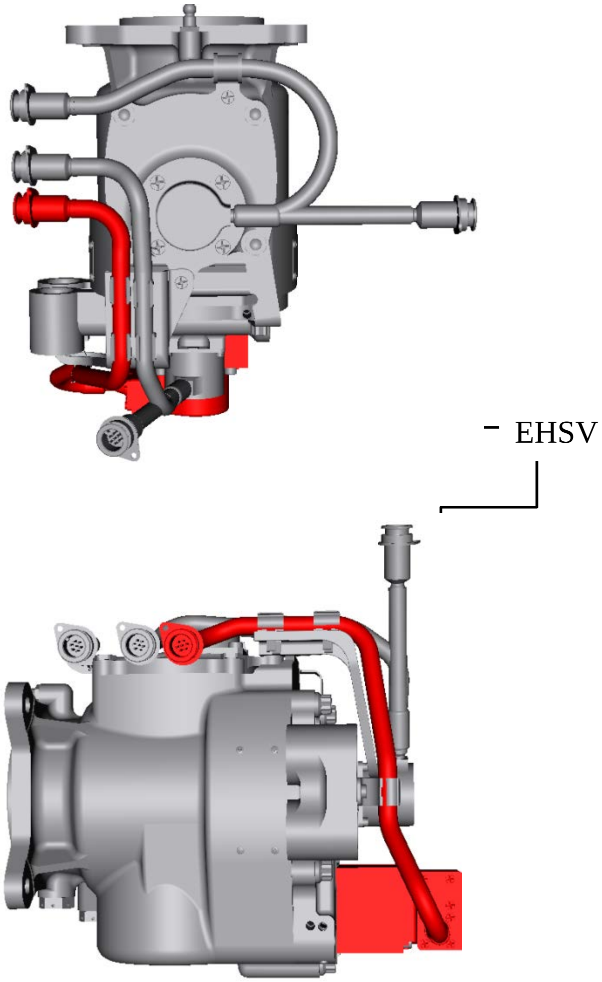


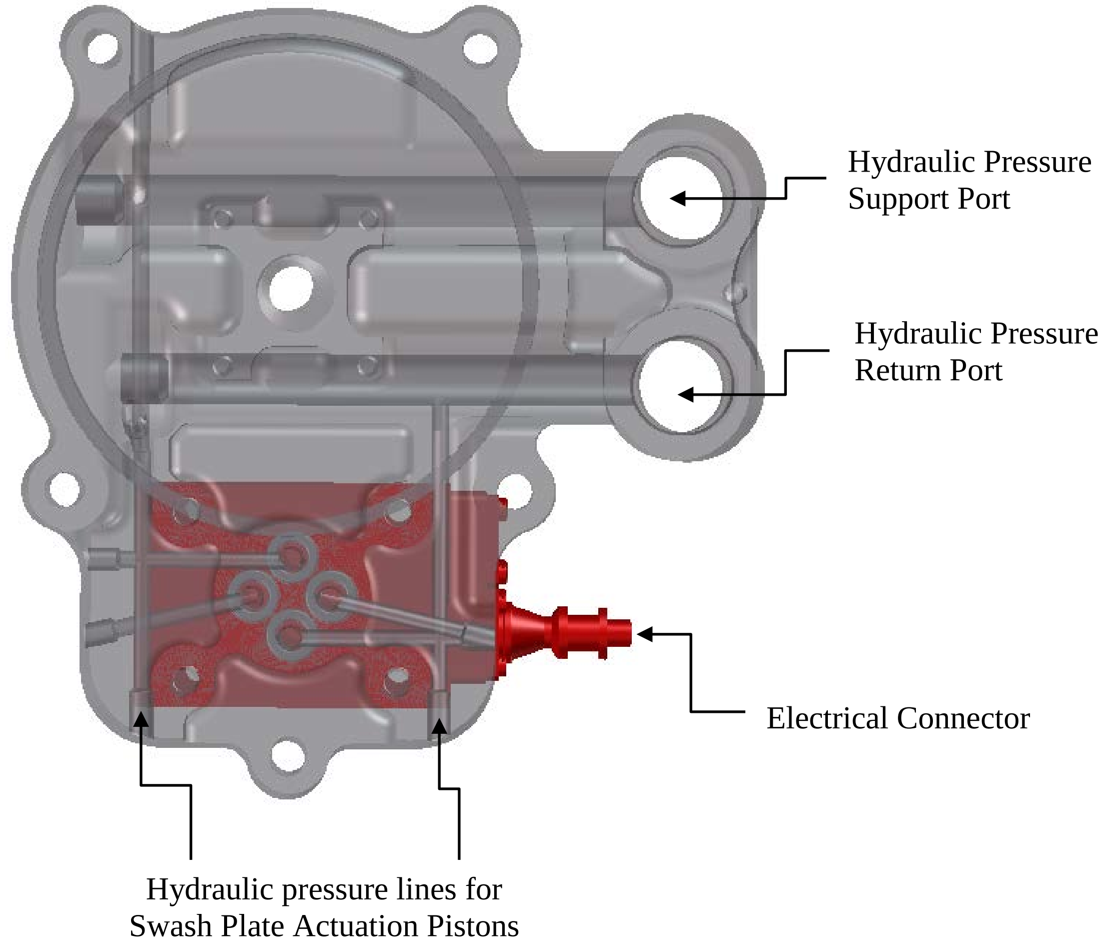

MAPS Sensor
Three pieces Shaft
Measuring of
Motor Shaft Speed


Neutral Position
(Shaft is not turning)
Left revolution of Shaft
(Swash Plate is moving
in negative deflection)
Right revolution of Shaft
(Swash Plate is moving in
positive deflection)

ELECTRO HYDRAULIC SERVO VALVE

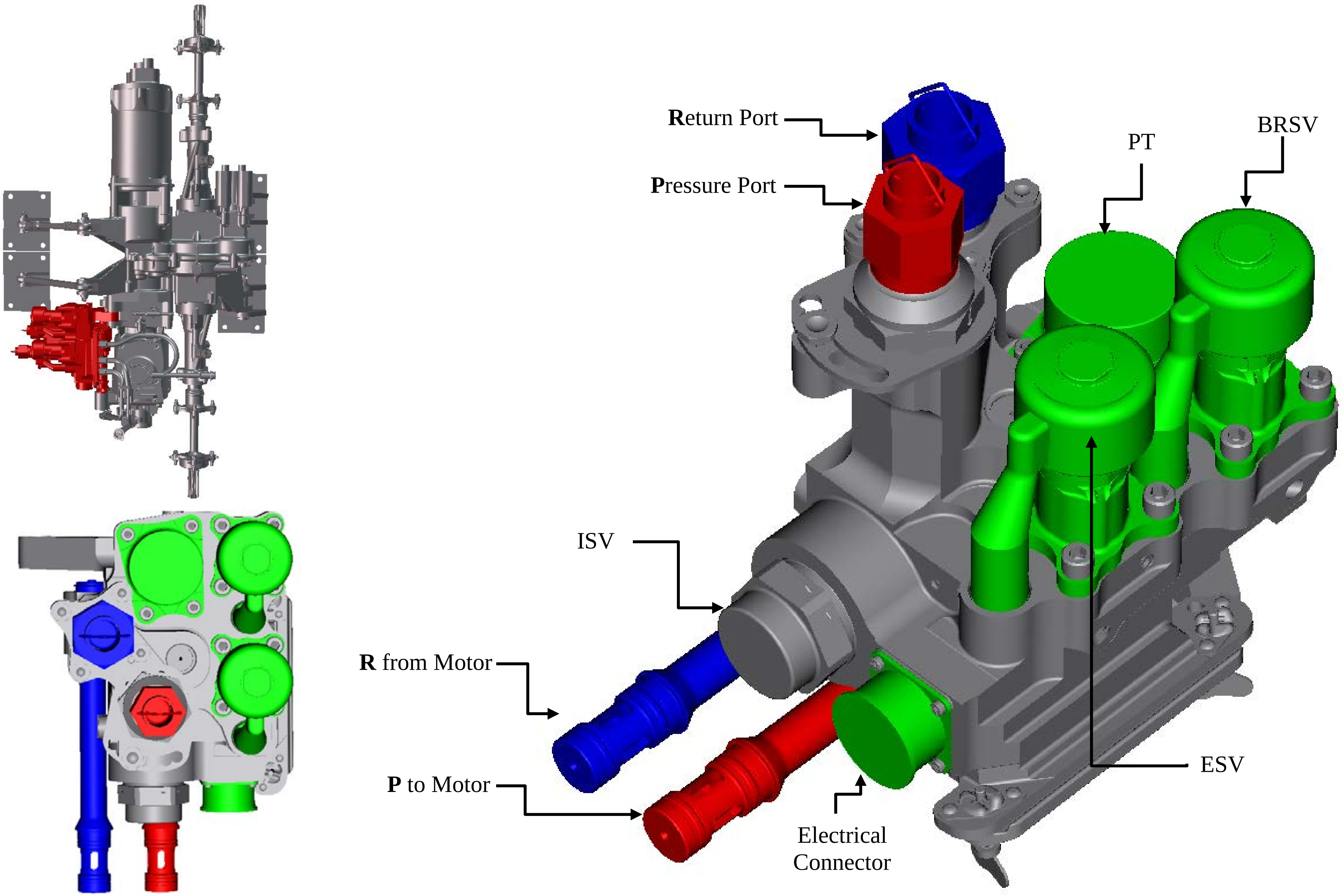
The Electro Hydraulic Servo Valve (EHSV) regulated the slipper pads which run on a wear resistant glide plate, attached by dowels to the face of the swash plate, which can be positioned by two hydraulic pistons.


EHSV


Hydraulic Pressure
Support Port
Hydraulic Pressure
Return Port
Electrical Connector
Hydraulic pressure lines for
Swash Plate Actuation Pistons

VALVE BLOCK ASSY

The Valve Block (VB) guides the hydraulic fluid to its associated VDHM and HPOB.



Return Port
Pressure Port
PT
BRSV
ISV
R from Motor
P to Motor
Electrical Connector
ESV

ENABLE SOLENOID VALVE

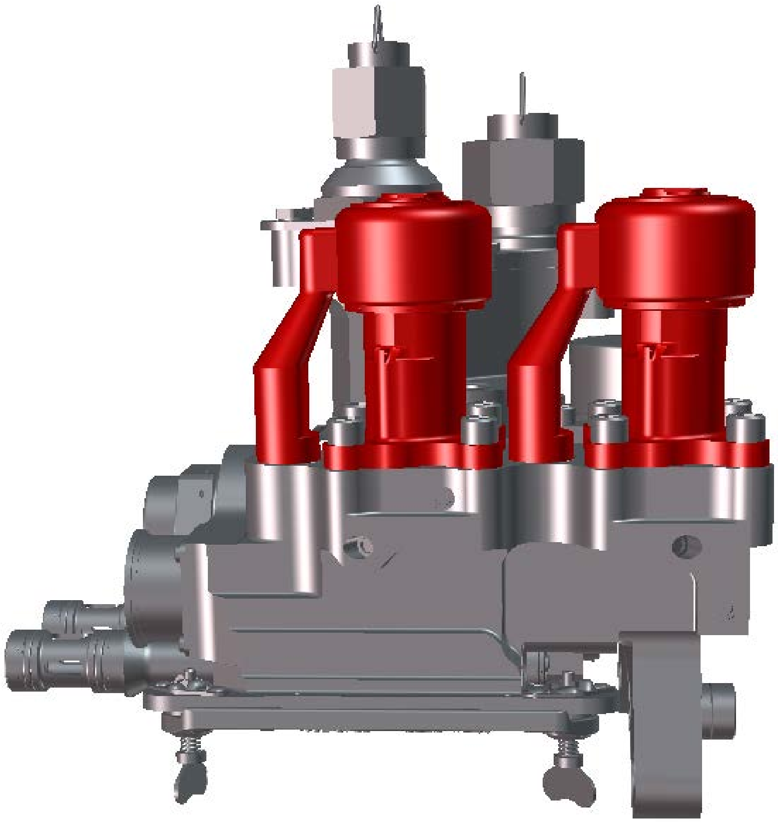
The enable solenoid valve (ESV) is a 3/2 way, normally closed, hydraulic valve. It is the interface between the electrical control of the SFCC and the hydraulic operation of the PCU.

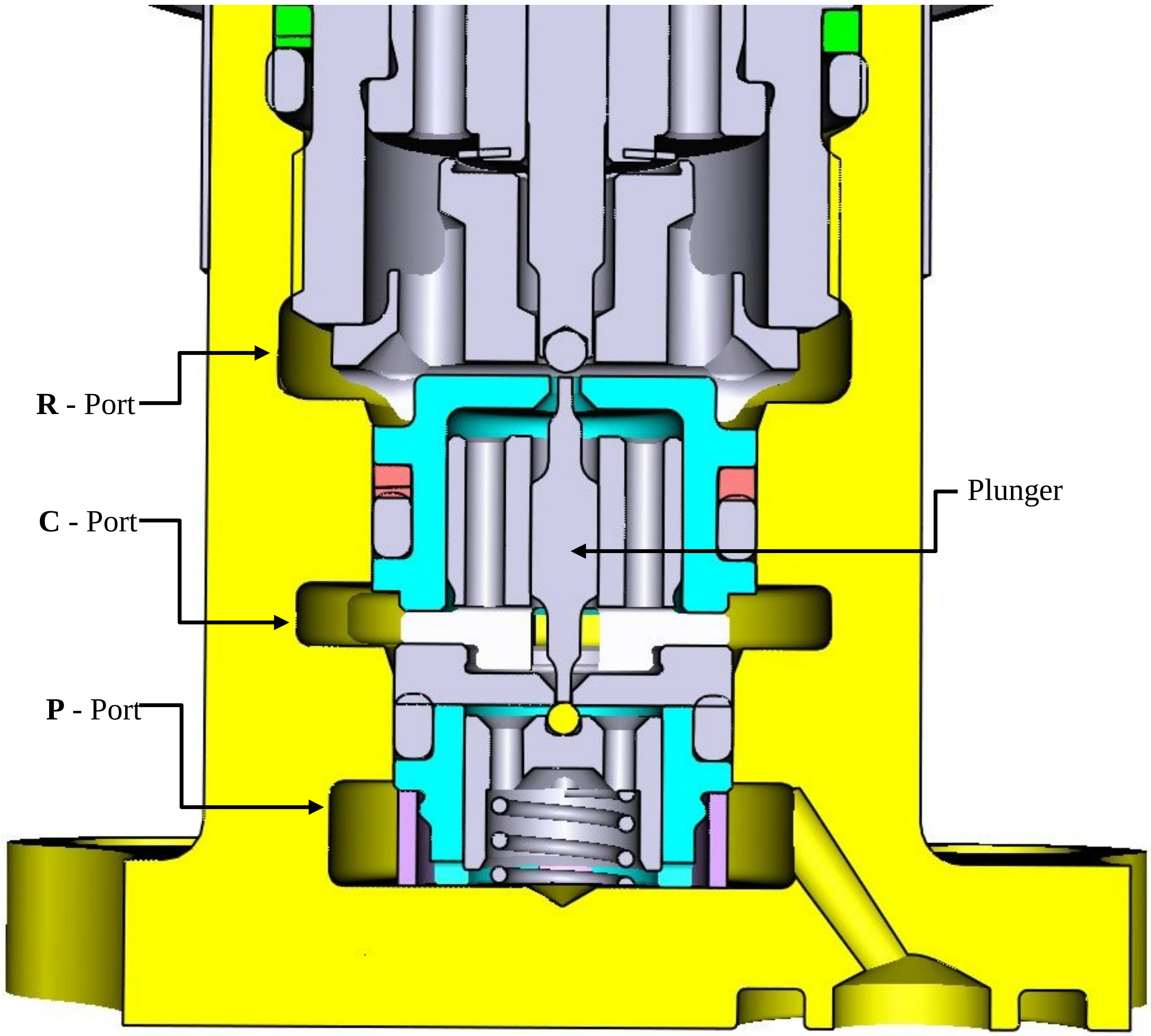
The ESV has:

- duplex electrical connectors
- duplex electromagnetics solenoids
- a twin ball-seat hydraulic valve

If the ESV is de-energized, the lower spring pushes the lower ball onto the P-valve seat. the lower plunger lifts the upper ball from the R-seat. Port C is connected with port R.

If the ESV is energized, the upper ball is pushed by the solenoid plunger to the R-seat and the lower plunger lifts the lower ball from the P-seat. Port P connected with Port C.




R - Port
C - Port
P - Port
Plunger

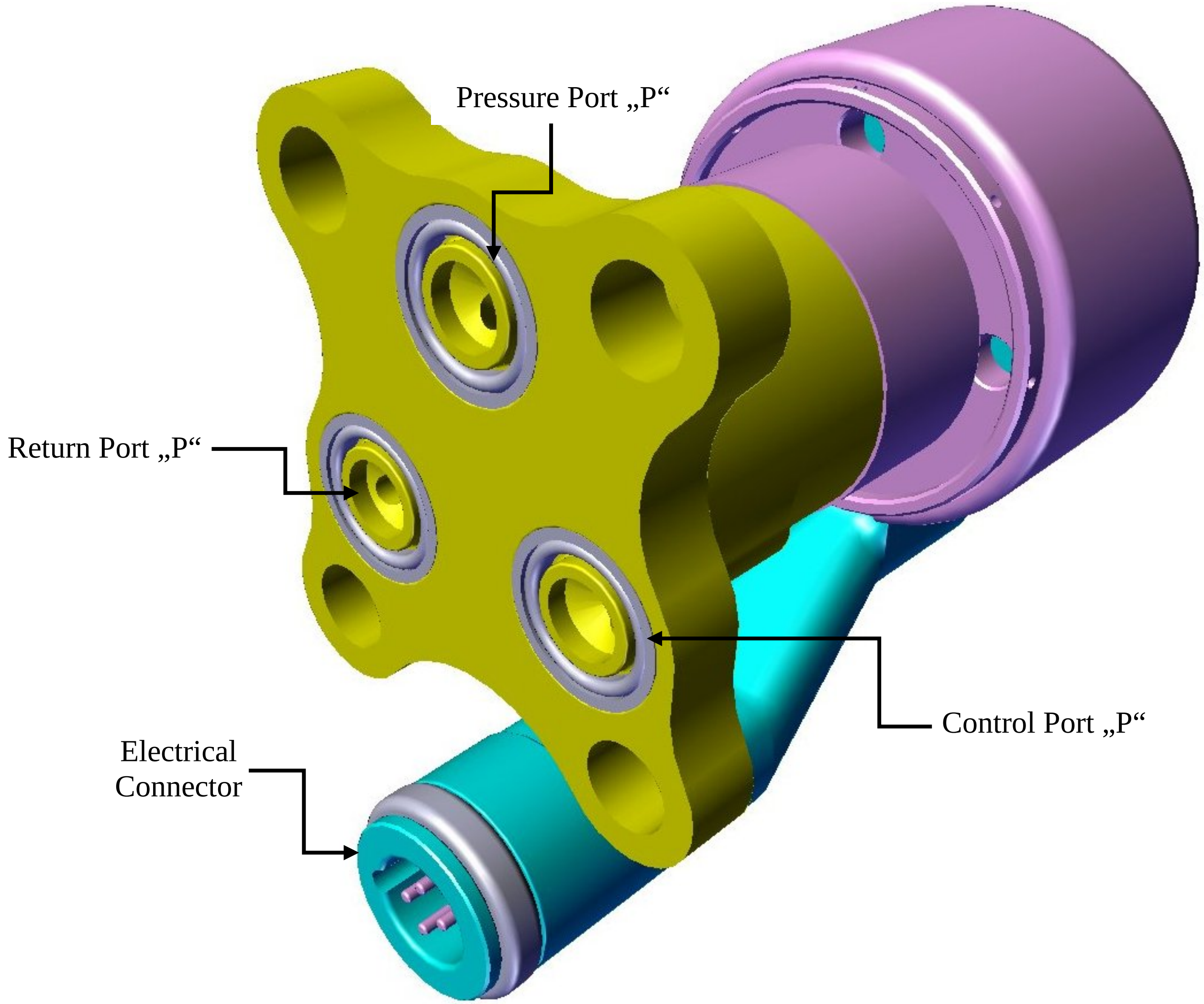
ESV

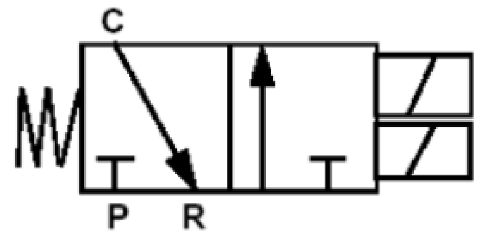
Each ESV has three hydraulic ports:

- Pressure (P)
- Control (C)
- Return (R)

De-energized, the passage from P to C is closed and from C to R is open.

Energized, the passage from P to C is open and from C to R is closed.


Pressure Port „P“
Return Port „P“
Control Port „P“
Electrical
Connector

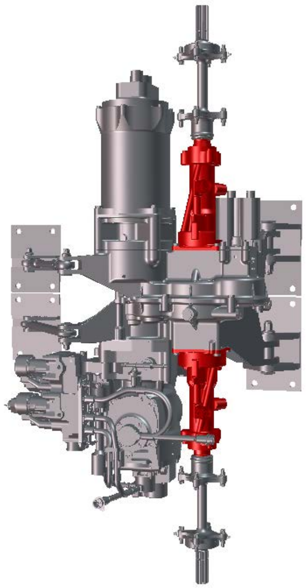

C
P
R

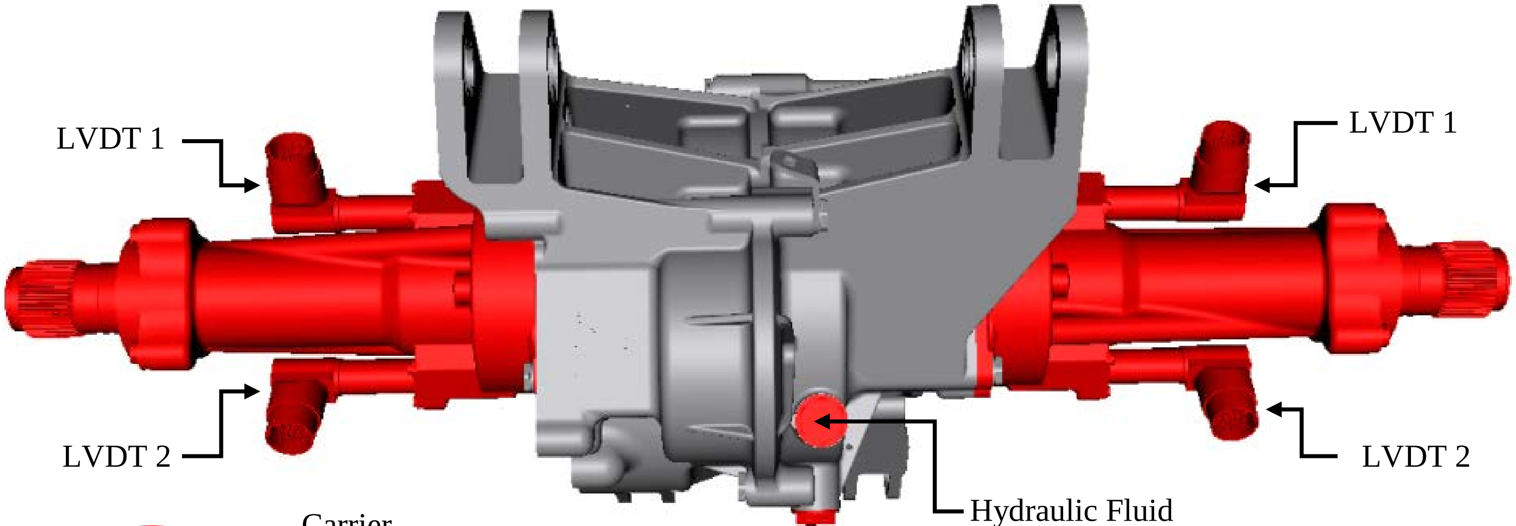
TORQUE SENSOR UNIT

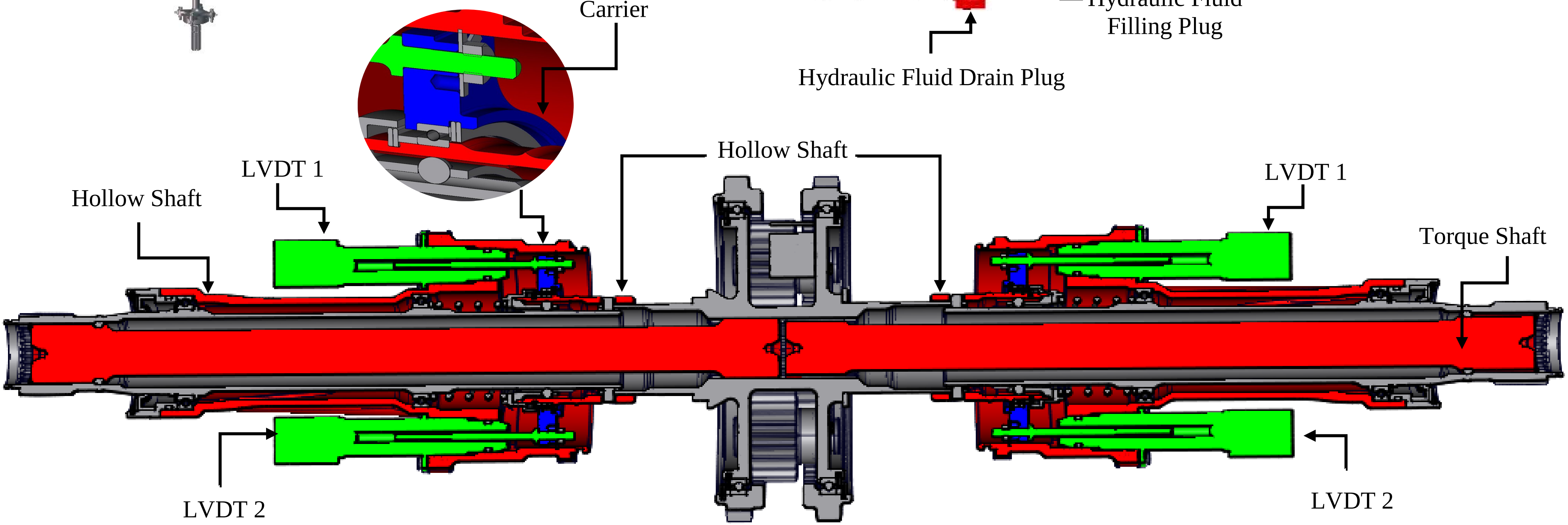
The PCU includes two torque sensing units (TSU) in order to shut down the PCU in case of a jam event.

The TSU is able to detect transmission overtorque by transforming the shaft torsion in a linear displacement which is detected by two integrated Line Variable Displacement Transducer (LVDT). One LVDT is connected to SFCC1, the other one is connected to SFCC2. This configuration ensures that the E-Motor and the VDHM of the PCU can be fully turned off to avoid any Slat System damage induced by overtorque.

When the torque shaft is applied with torque, it will be stressed by torsion which leads to a torsion angle between the shaft ends. The torsion angle is also shwon by the distortion of the hollow shafts to each other due to their coupling connection to the torque shaft ends. This distortion is transferred into a linear displacement by a pin guide mechanism which is fitted between the hollow shafts. The pins are moved in its ball guide whereby the guide will be displaced on hollow shaft 2. The LVDTs are mechanically connected with the ball guide thus the displacement in axial direction detected by the LVDTs.

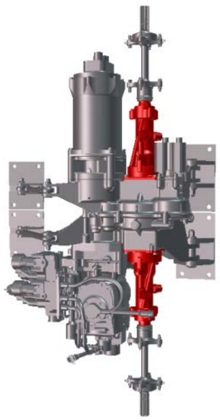


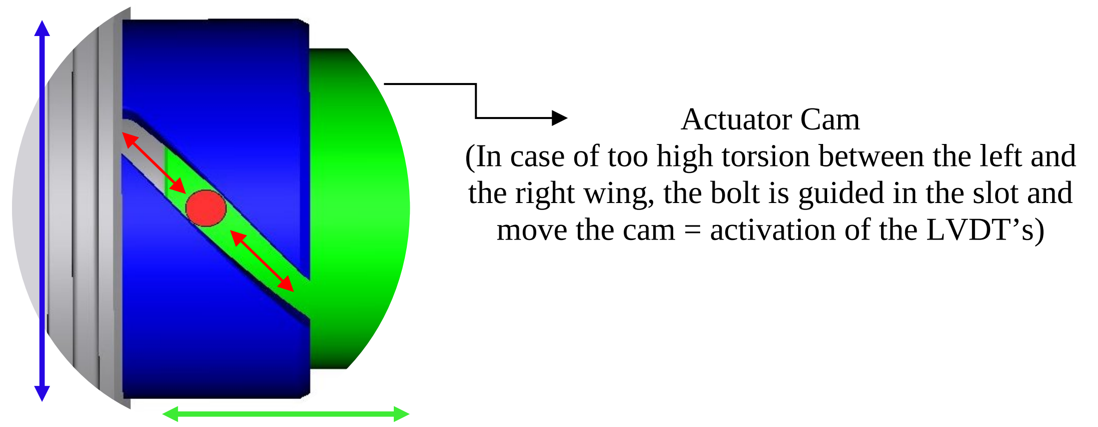

LVDT 1
LVDT 1
LVDT 2
LVDT 2
Hydraulic Fluid Filling Plug
Hydraulic Fluid Drain Plug

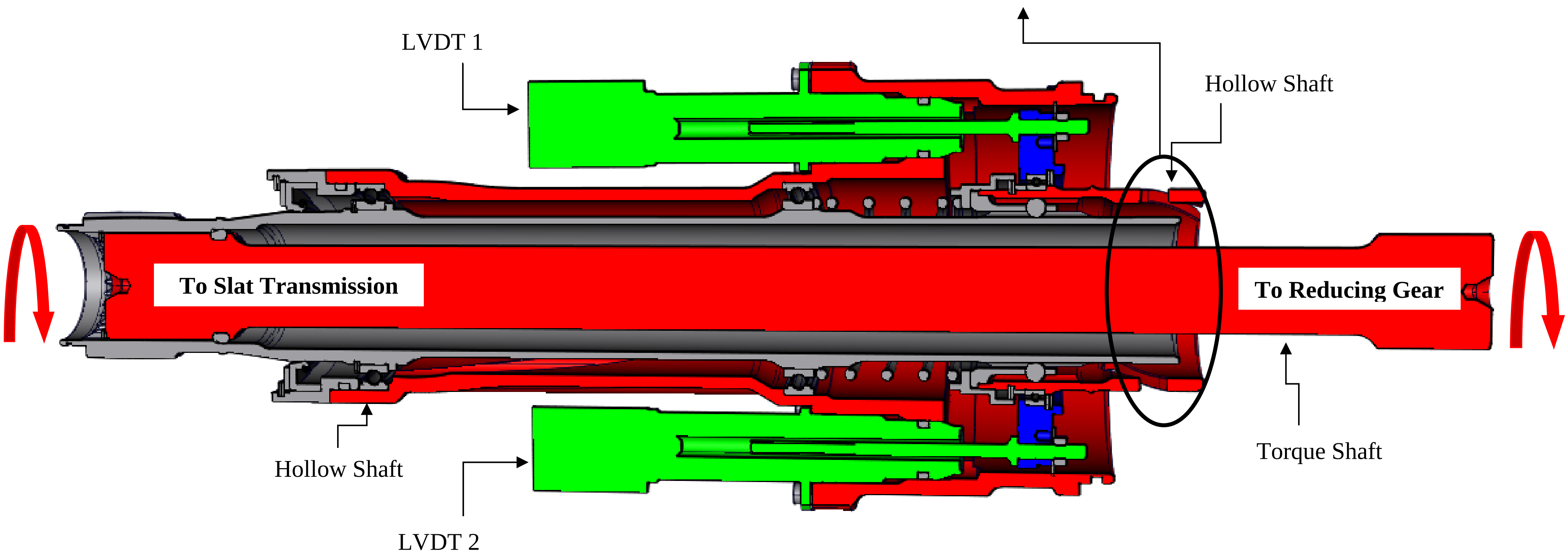

Carrier
Hollow Shaft
LVDT 1
Hollow Shaft
LVDT 1
Torque Shaft
LVDT 2
LVDT 2

TSU

The TSU installed in the PCU is fitted between the reducing gear output and the transmission set. In contrast to the foregoing example, the axial displacement of the LVDT is realized by Ball Ramp Mechanism.




Actuator Cam
(In case of too high torsion between the left and the right wing, the bolt is guided in the slot and move the cam = activation of the LVDT's)

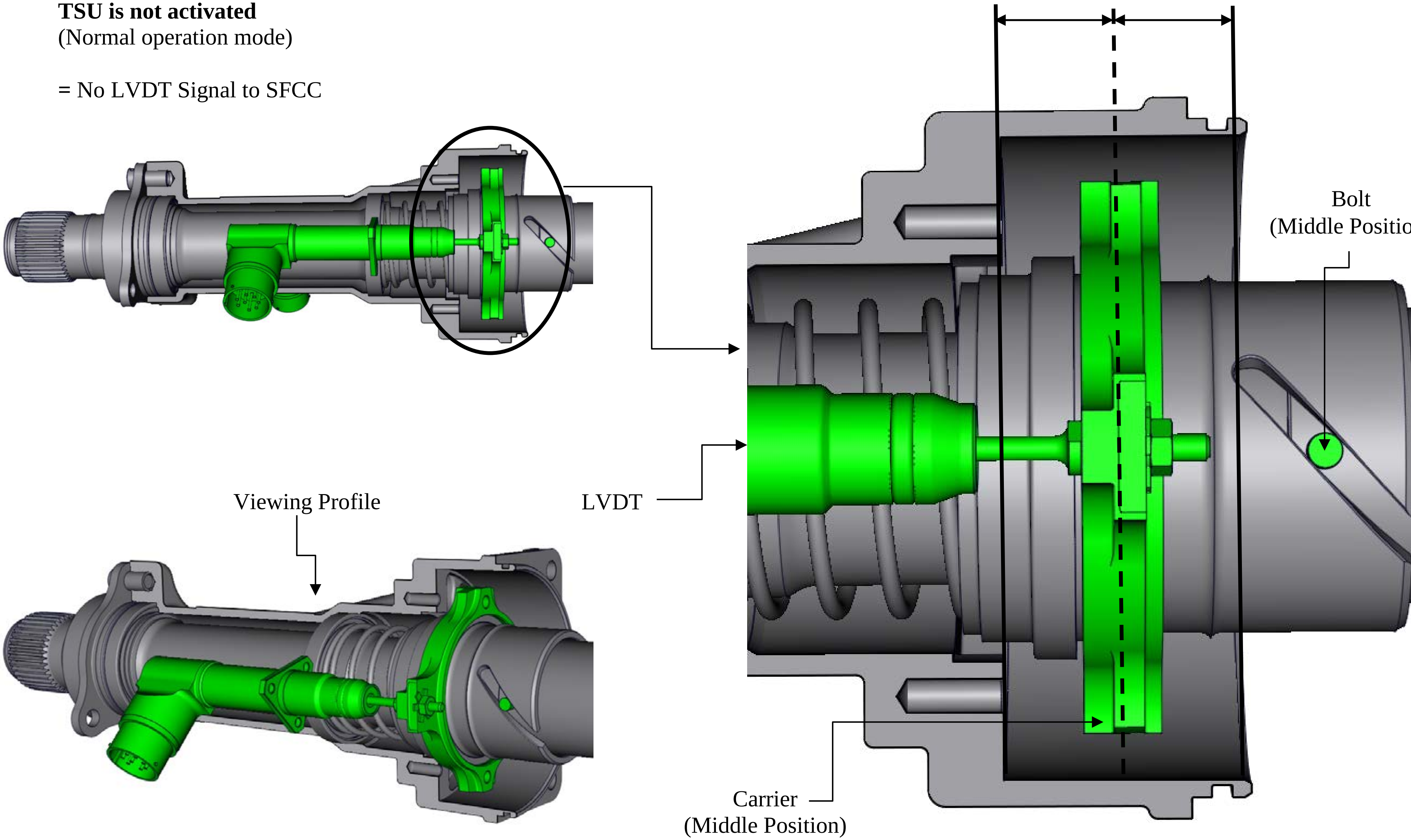

LVDT 1
Hollow Shaft
To Slat Transmission
To Reducing Gear
Hollow Shaft
Torque Shaft
LVDT 2

ACTIVATION OF THE TSU LVDT‘S

Following picture will shown the normal postion of TSU.

TSU is not activated
(Normal operation mode)

= No LVDT Signal to SFCC

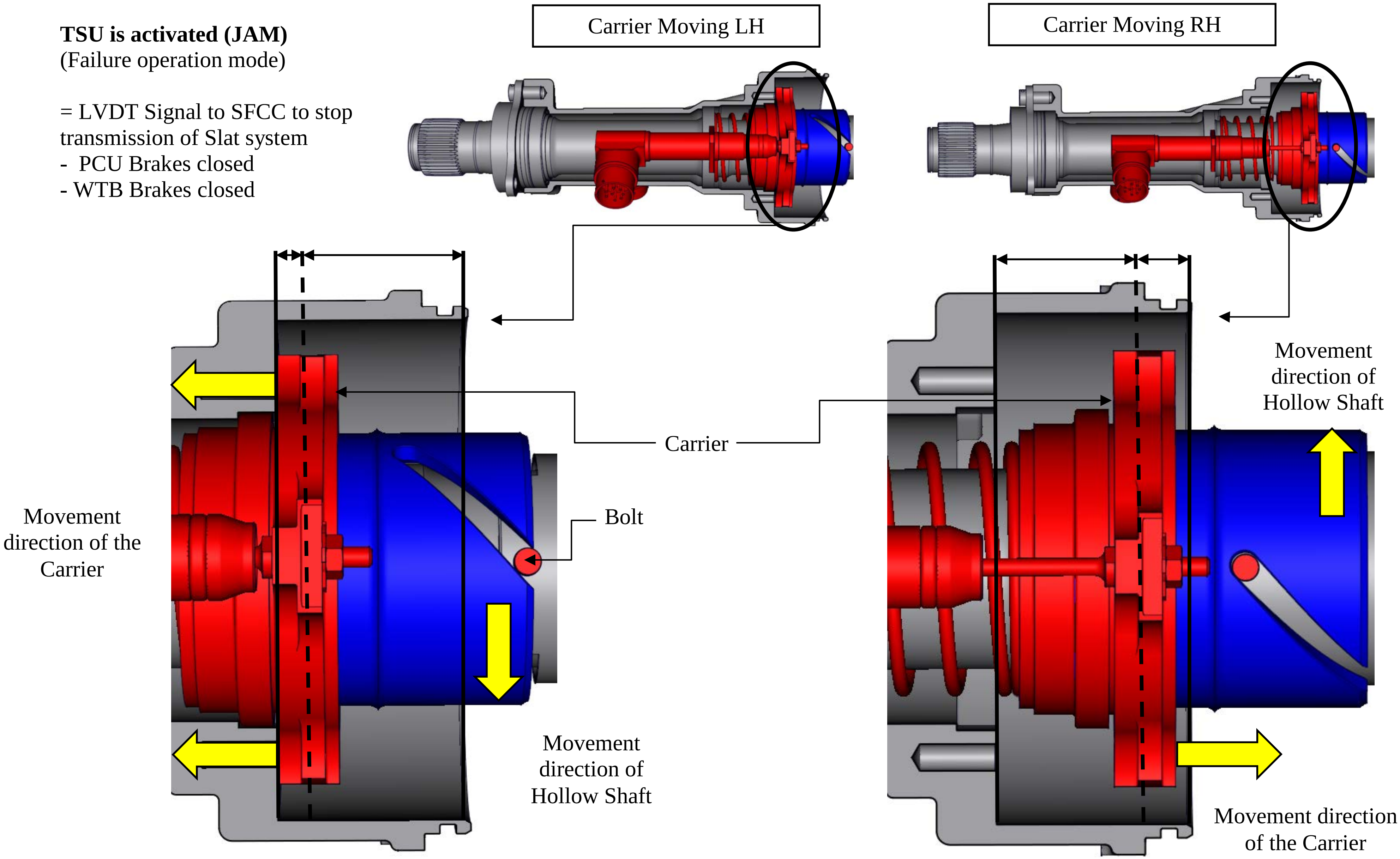


TSU IS ACTIVATED

Following pictures will shown the different postions of TSU cams to provide electronical feedback to SFCC’s in case of too high torsion between the left and the right wing.

TSU is activated (JAM)
(Failure operation mode)

= LVDT Signal to SFCC to stop transmission of Slat system
- PCU Brakes closed
- WTB Brakes closed



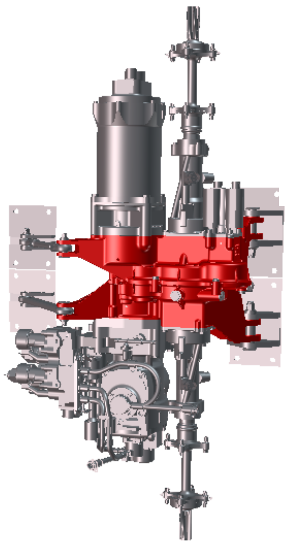
DIFFERENTIAL GEARBOX

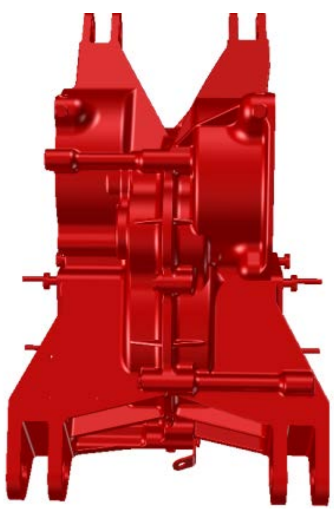
The function of the differntial gearbox is to provide a speed summation of the input torques from the hydraulic and electric motor and to enable the PCU to operate at half spede operation with full torque in case of any motor failure. It provides also reduction gearing to drive the FPPU.

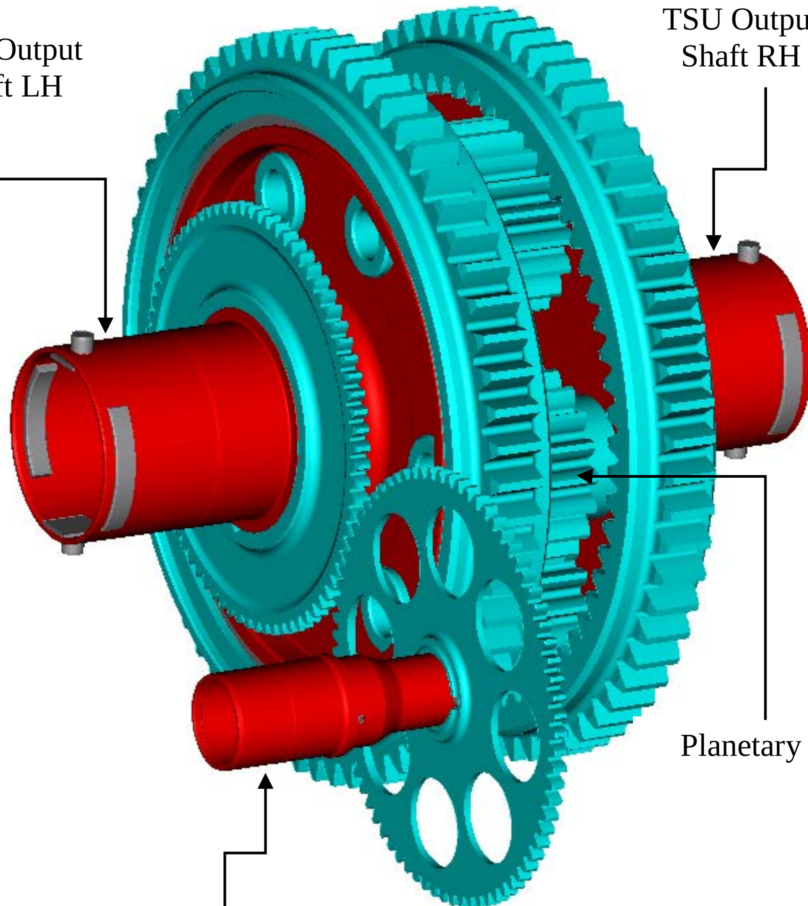
On energization of both motors and release of their respective POBs and provided that both motors deliver the same speed at their outputs, the input ring gears rotate at a common speed. The sets of planets/carrier rotate at a speed directly related to the input ring gears. In the event of unequal input speeds, the ring gears rotate at different speeds. This is translated into a contra – rotation of the paired planets and a progressive movement of the planet carrier. The rotational speed of the planet carrier is the average speed of the ring gears. In the event of half-speed operation, with normal input speed and one POB providing an earth reaction for the differential gear train, the output speed of the PCU will be halved, whilst maintaining full torque.

In the event of a failure within the gearbox causing a loss of motor input torque and POB braking, there is no means of providing an earth reaction to the defective input. In this case it is possible for the output shaft to be backdriven, as a result of blow-back, causing system runaway. Prevention is by detection of positional error and application of the WTB.

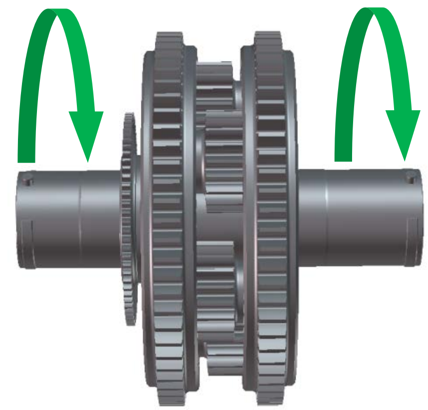
In order to detect any overtorque between the PCU output shafts and the slat system transmission shafts, the PCU is equipped with two TSUs. One unit is fixed on the LH PCU output torque shaft, the other one on the RH PCUoutput torque shaft. The principle TSU fucntion is based on the torque shaft torsion which is converted into an axial displacement. The displacement is detected by two LVDTs on each side. LVDT1 LH_1 sends the signal to SFCC1, LVDT LH_2 sends the signal to SFCC2. LVDT RH_1 sends the signal to SFCC1, LVDT RH_2 sends the signal to SFCC2. With respect of this configuration, the VDHM and the E-Motor can be turned off by SFCC1 or SFCC2 in order to avoid any damage due to overtorque.



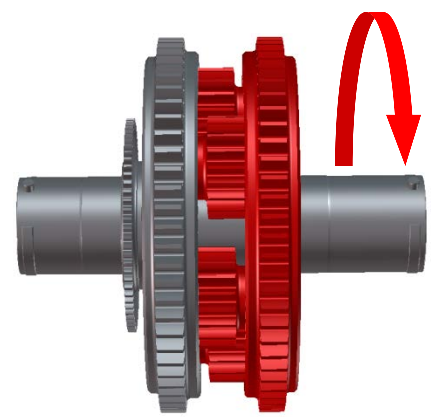




Normal Operation Mode
(Planetary Gear not active)
= Full Speed Slat Extension/Retraction
= Full Torque Slat Extension/Retraction



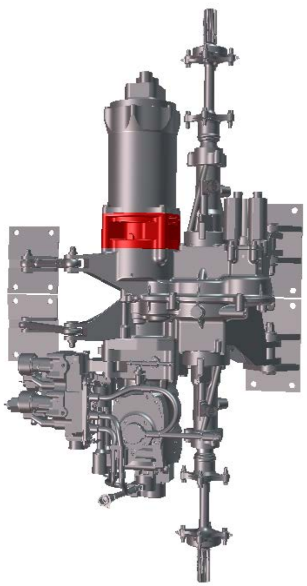
Failure Operation Mode
(Planetary Gear are active)
= Half Speed Slat Extension/Retraction
= Full Torque Slat Extension/Retraction

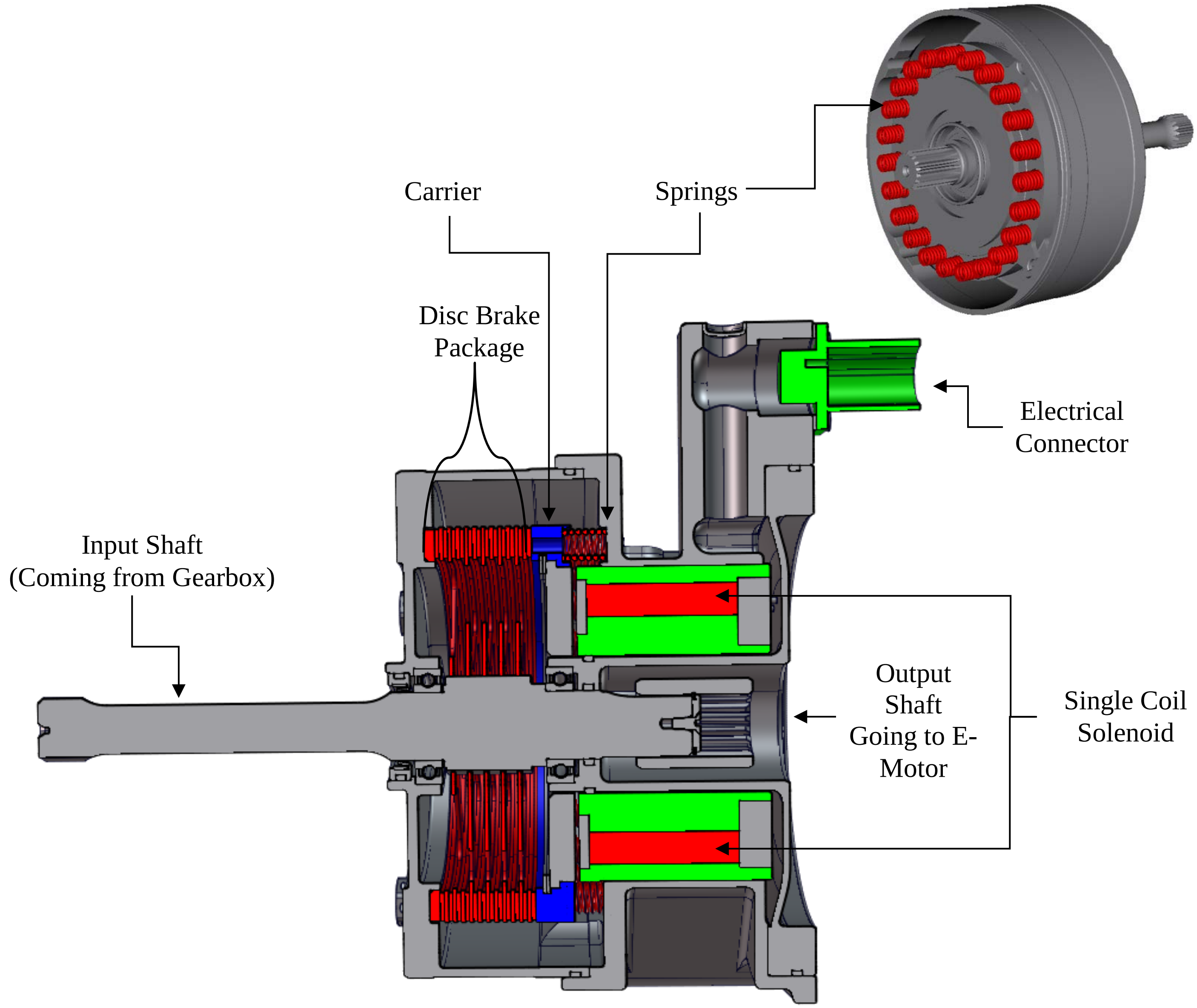


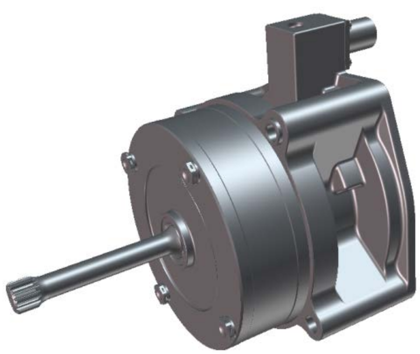
Electric Power Off Brake

The EPOB comprises a friction disk pack which is splined to the torque shaft. One torque shaft end fits into the E-Motor shaft, the other end fits to the reducing gear input shaft. A single coil solenoid is installed which is positioned in a housing with dry environment to achieve a high brake torque at a moderate size. The compression springs are placed radial in the spring housing.

The solenoid is energized by the MCE internal DC link with a controller output voltage range of 0 to 230 VDC driven by a regulated output current.

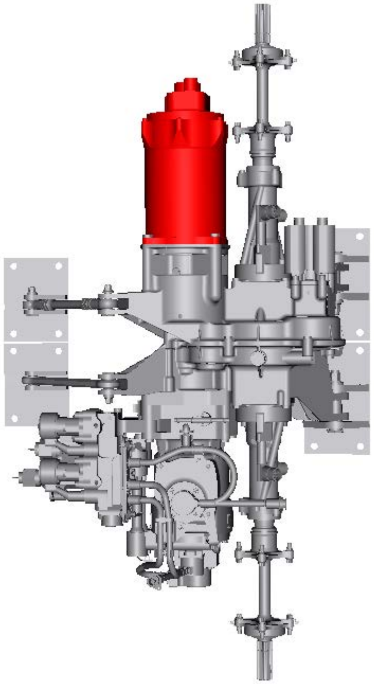


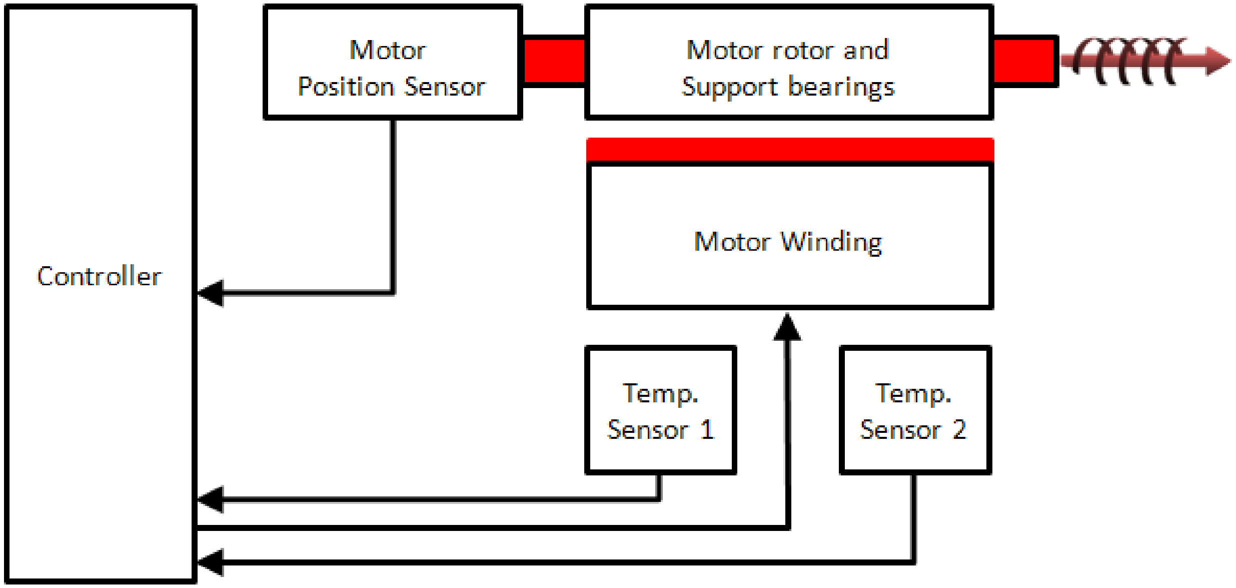

Carrier
Springs
Disc Brake Package
Electrical Connector
Input Shaft (Coming from Gearbox)
Output Shaft Going to E-Motor
Single Coil Solenoid

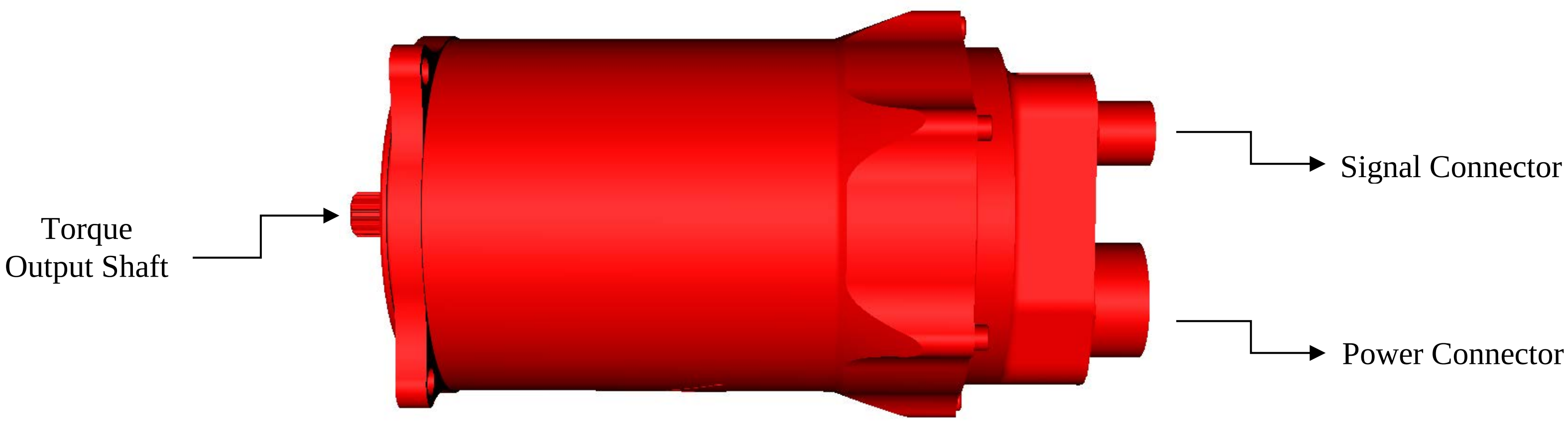


ELECTRIC MOTOR

The motor is a three phase brushless DC motor with high efficiency rare earth magnets on the rotor. The assembly of the magnets on the rotor is secured with an external ring in order to reduce the risk of jamming due to deteriorated magnets or small parts of magnet that would brake during over the time due to an undetected initial shock during assembly. A resolver, fitted on the motor shaft, provides position feedback to the communication system. The motor winding insulation is capable of withstanding up to 180°C winding temperature without deterioration. Two temperature sensors are attached to the stator windings to control motor temperature in order to avoid overheating.




Controller
Motor
Position Sensor
Motor rotor and
Support bearings
Motor Winding
Temp.
Sensor 1
Temp.
Sensor 2


Torque
Output Shaft
Signal Connector
Power Connector

MOTOR CONTROL ELECTRONIC

The slats of the A350 are operated by the output of a differential gear with two input drives. One of these inputs is a hydraulic drive and the other one is an electric drive. In normal operation (when no fault signal is issued) both units are active and operate the slats. In abnormal mode when the one of the drives is not operational the remaining drive provides the operation of the slats with reduced performance.

The electric drive is controlled by the Motor Control Electronic (MCE). Two independent SFCC provide overall control and monitoring for the complete leading edge system, only one SFCC provides overall control and monitoring for the slat MCE.

The electric drive is composed of the e-motor, the rotor position sensor (resolver) and the EPOB. The EPOB has to stop or release the shaft position of the e-motor. Only in operational mode of the electric drive the EPOB is powered and releases the shaft. In all other modes (e.g. standby mode, fault of e-motor, etc.) the EPOB stops the shaft. The EPOB is in principle activated by the MCE. But for safety reasons the EPOB control must be enabled by two control signals from the SFCC (Enable, EPOB, Enable), which are additionally fed directly to the EPOB control module, which is partv of the MCE.

The MCE additionally provides status and temperature information of MCE and e-motor to the SFCC via ARINC. This information is used for monitoring purposes. For maintenance purpose a CAN interface and a RS232 interafec are available. The MCE is powered by the aircraft supply. A discrete signal (230 V Available) indicates the SFCC a valid supply voltage.

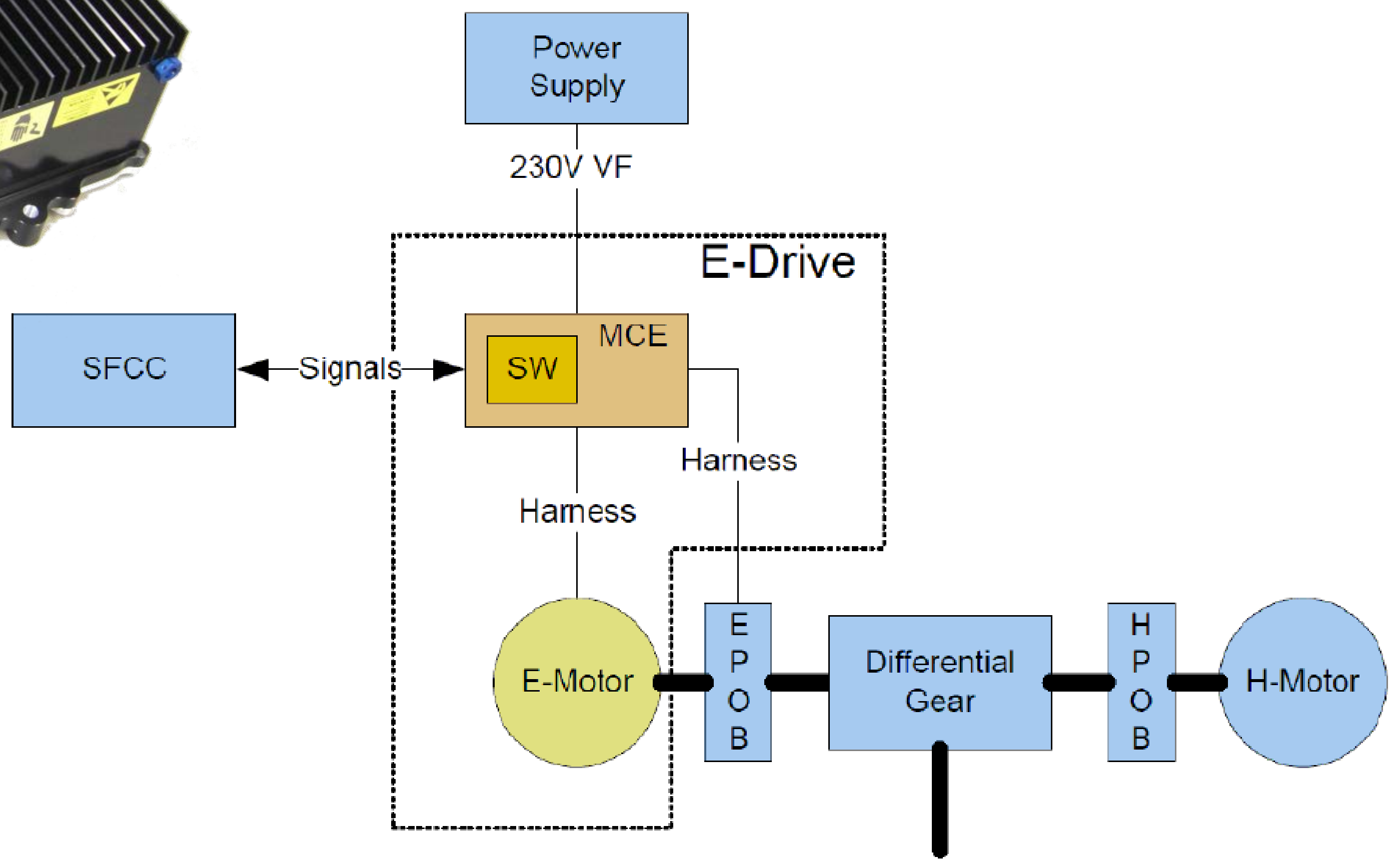
The MCE is fitted to the System as a LRU (Line Replacement Unit).

The Motor Control Electronic (MCE) comprises four modules:

1) PSU
2) PCE
3) CU
4) EPOB control

All modules are installed in one MCE housing. Communication and power supply between SFCC_MCE_LRUs is realized by electric cables and ARINC 429.


CAUTION!
Heavy load


Power Supply
230V VF
E-Drive
MCE
SW
SFCC
Signals
Harness
Harness
E-Motor
E
P
O
B
Differential Gear
H
P
O
B
H-Motor

SLAT GEARED ROTARY ACTUATOR

Two types of Geared Rotary Actuator (GRA) are utilised in the slat midboard and outboard drive system. Due to the different loading and gear ratio requirements between the inner and outer slat surfaces and the fact that in the outboard area less space is availabledue to thin wing section.

The slat GRA have three functions:

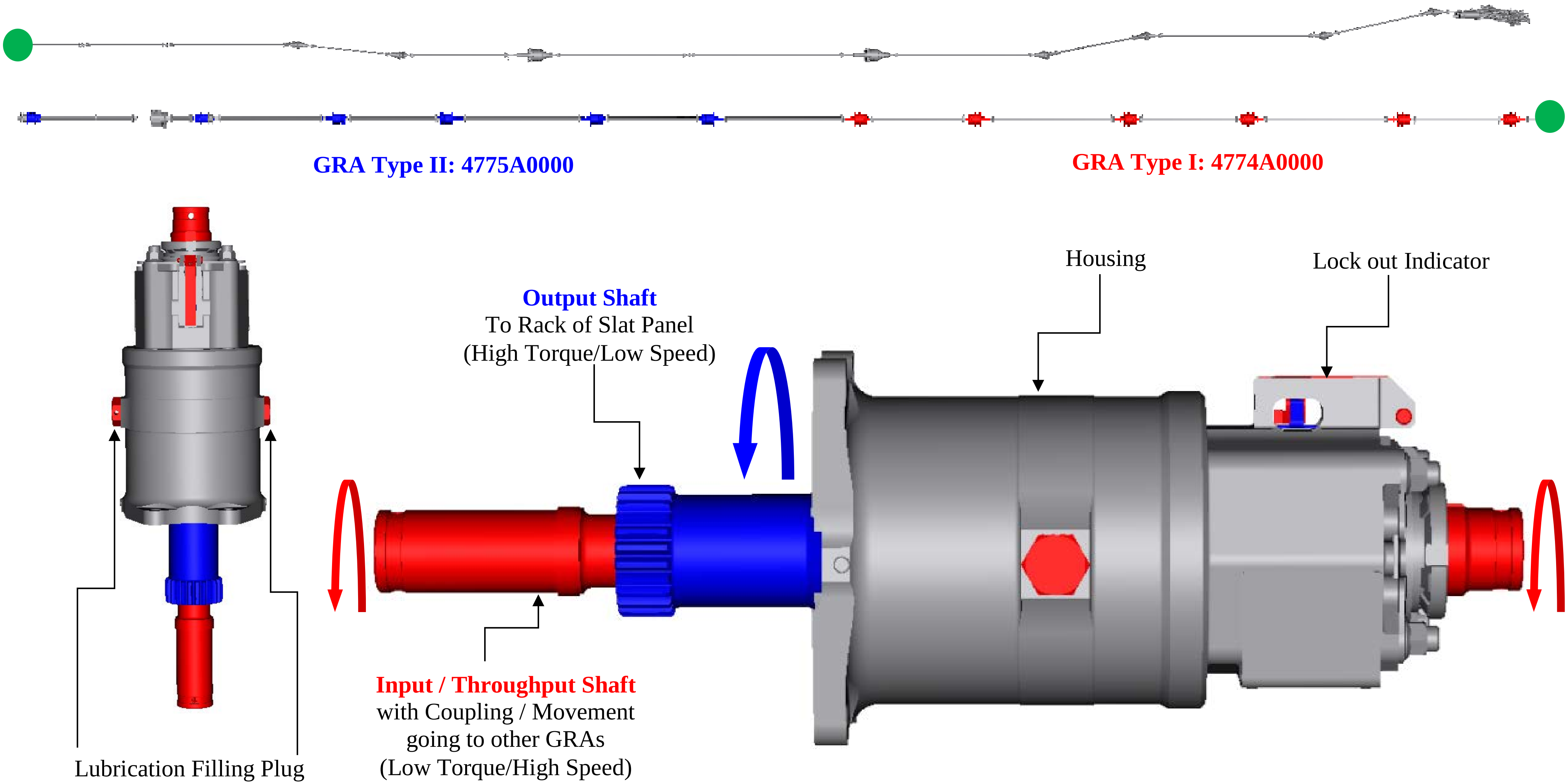
- Conversion of transmission shaft rotation into drive pinion rotation
- Limiting the torque available to downstream components
- Pass transmission rotation on to the next unit in line

Each actuator contains an integral torque limiting device and lock-out indicator. The output shaft, which drives the slat drive pinion, is concentric to the input shaft.

Ratio GRA type I: 201:1

Ratio GRA type II: 242,7:1

The actuator is mounted to the wing structure with a four bolt mounting flange. The output shaft is splined to the slat drive pinion.



NOTE: Spare delivery is for LH configuration! (DRAIN PLUG INSTALLATION)

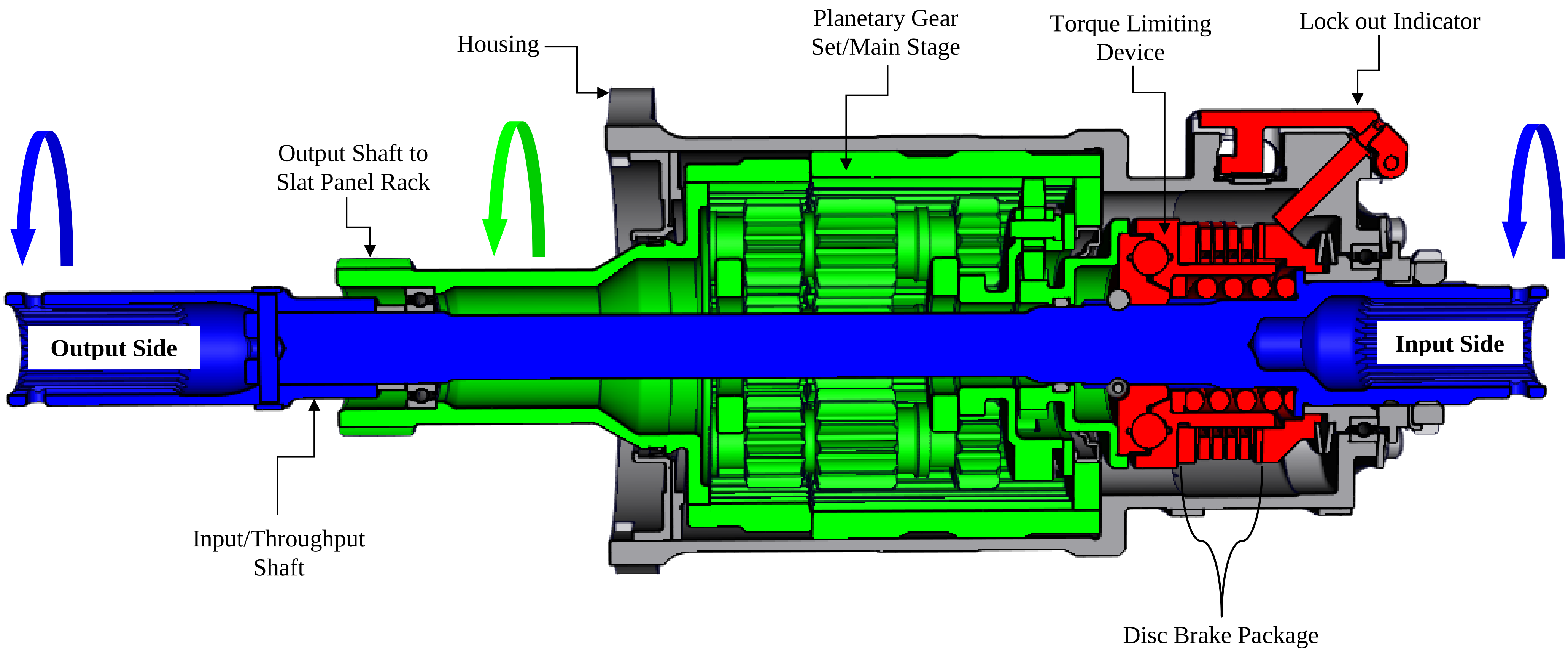
Normal Operation:

Input shaft rotation is transferred to the torque limiting device and is transmitted to the input sun gear. The input sun gear then drives the planet gear assembly providing the desired output shaft rotation.

Lock Out Operation:

The torque limiter normally rotates as a single unit with the input shaft due to action of the pre-load spring on the ball and detent plates. If the load difference between input and output exceeds the pre-load value, these plates separate and compress the friction disc pack, thereby transferring excess torque into the actutor housing.

If sufficient movement of the plates is present, the lock-out indicator will be activated. Once the overload condition disappears, the torque limiter returns to normal conditions and operation, but the indicator remains activated until reset by hand.

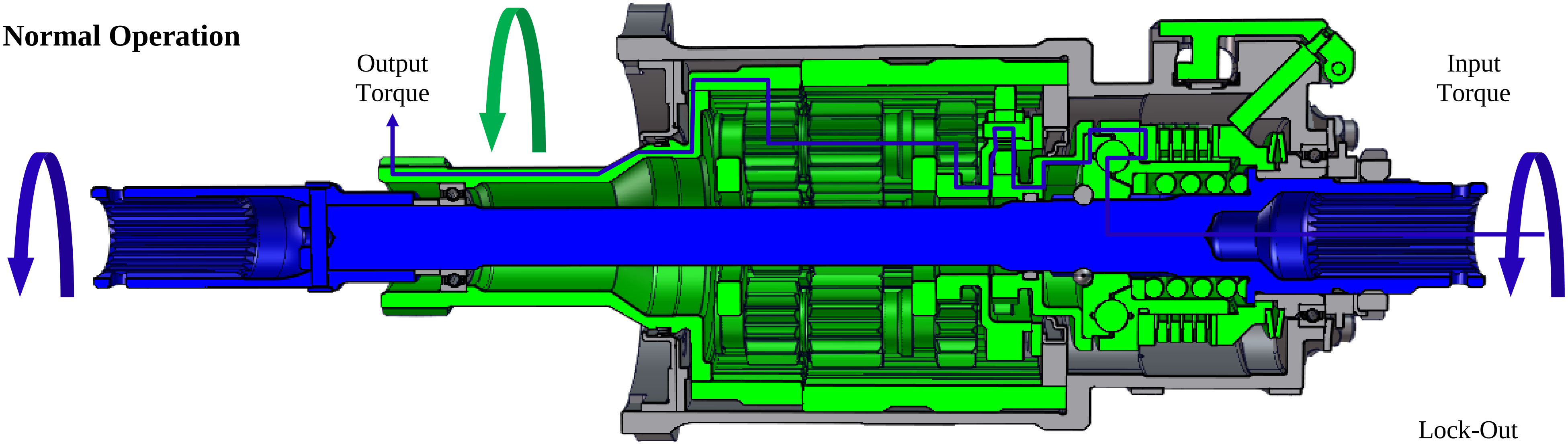

Housing
Planetary Gear
Set/Main Stage
Torque Limiting
Device
Lock out Indicator
Output Shaft to
Slat Panel Rack
Output Side
Input Side
Input/Throughput
Shaft
Disc Brake Package

SLAT GEARED ROTARY ACTUATOR LOAD PATH

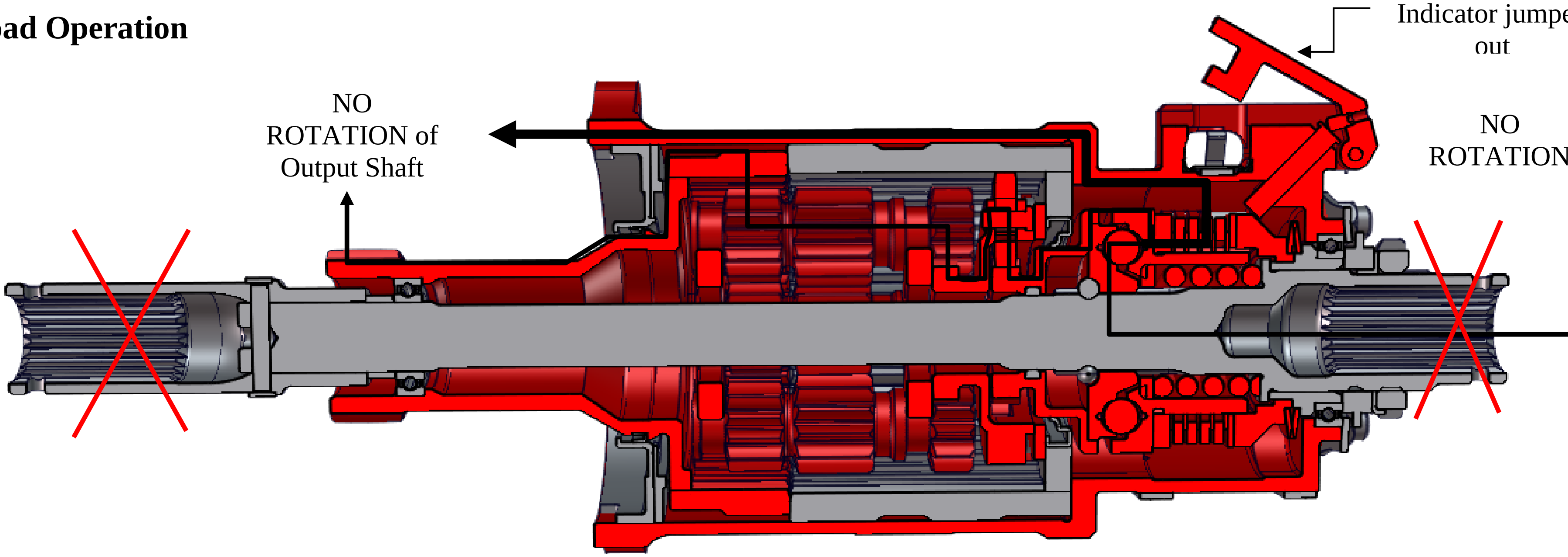
In normal operation the input torque is transferred through the torque limiter assembly into the planetary reduction gears and then finally to the output shaft.

Under overload conditions, the torque limiter will lock-out and excess torque will be transferred to the actuator housing and on to the wing structure. The torque transmitted to the output shaft will remain fixed at the lock-out value.

Normal Operation



Overload Operation



SLAT GRA TORQUE LIMITER OPERATION

In case of a Jam, the lockout indicator will extend out and provide a visible feedback to the maintenance personal to carry out a deeper trouble shooting.

Torque Limiter Deactivated:

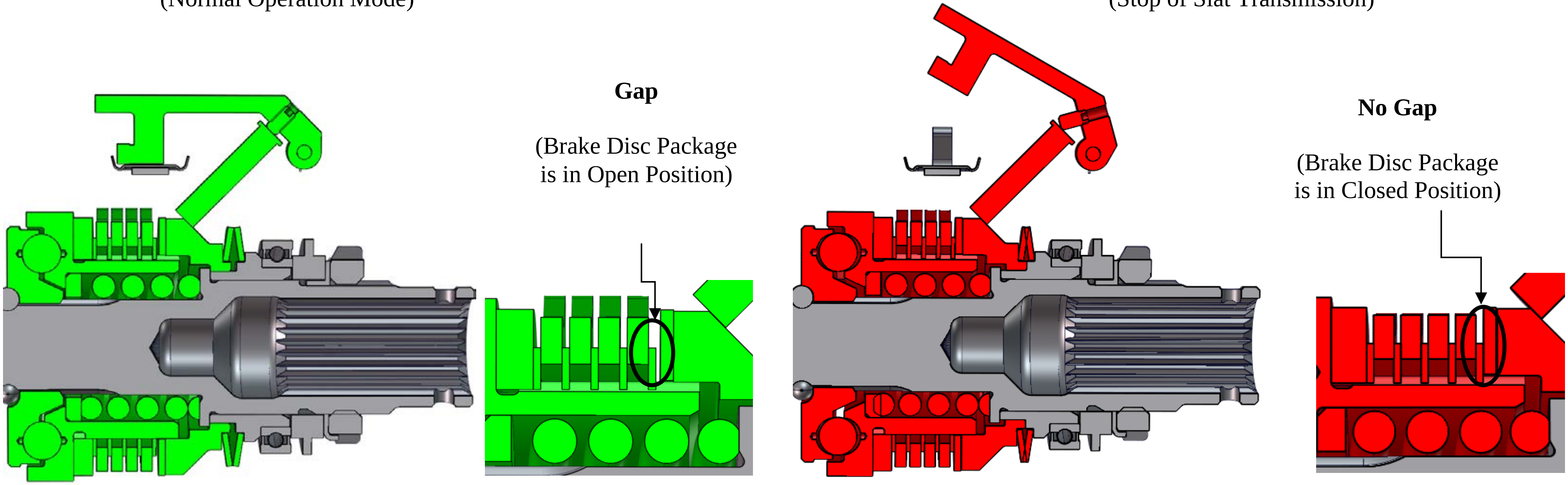
- Brake Disc Package is in open position
- Lock-out Indicator retracted
- Shaft of the GRA can rotate freely

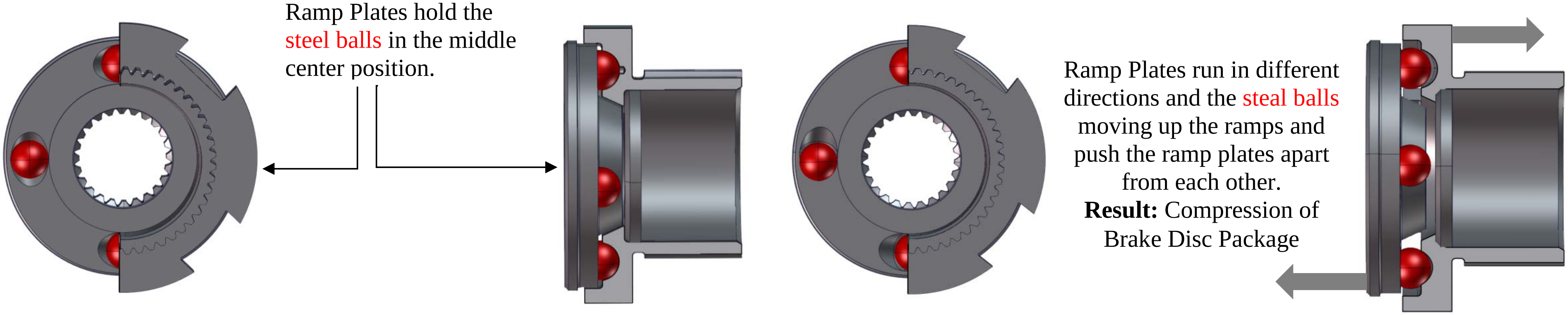
Torquer Limiter Activated:

- Brake Disc Package is in closed position
- Lock-out Indicator extended
- Shaft of the GRA is stopped (complete Slat system is fixed)

Torque Limiter Deactivated
(Normal Operation Mode)

Torque Limiter Activated
(Stop of Slat Transmission)





DROOP NOSE ACTUATOR

The Slat Actuation System contains two Droop Nose Geared Rotary Actuators per wing on the droop nose panel.

The actuator consists of two input and one output planetary gear stages.

Drive torque is transmitted from the input sun gear via the input planetary gear stage, second planetary gear stage, output planetary gear stage to the output shaft.

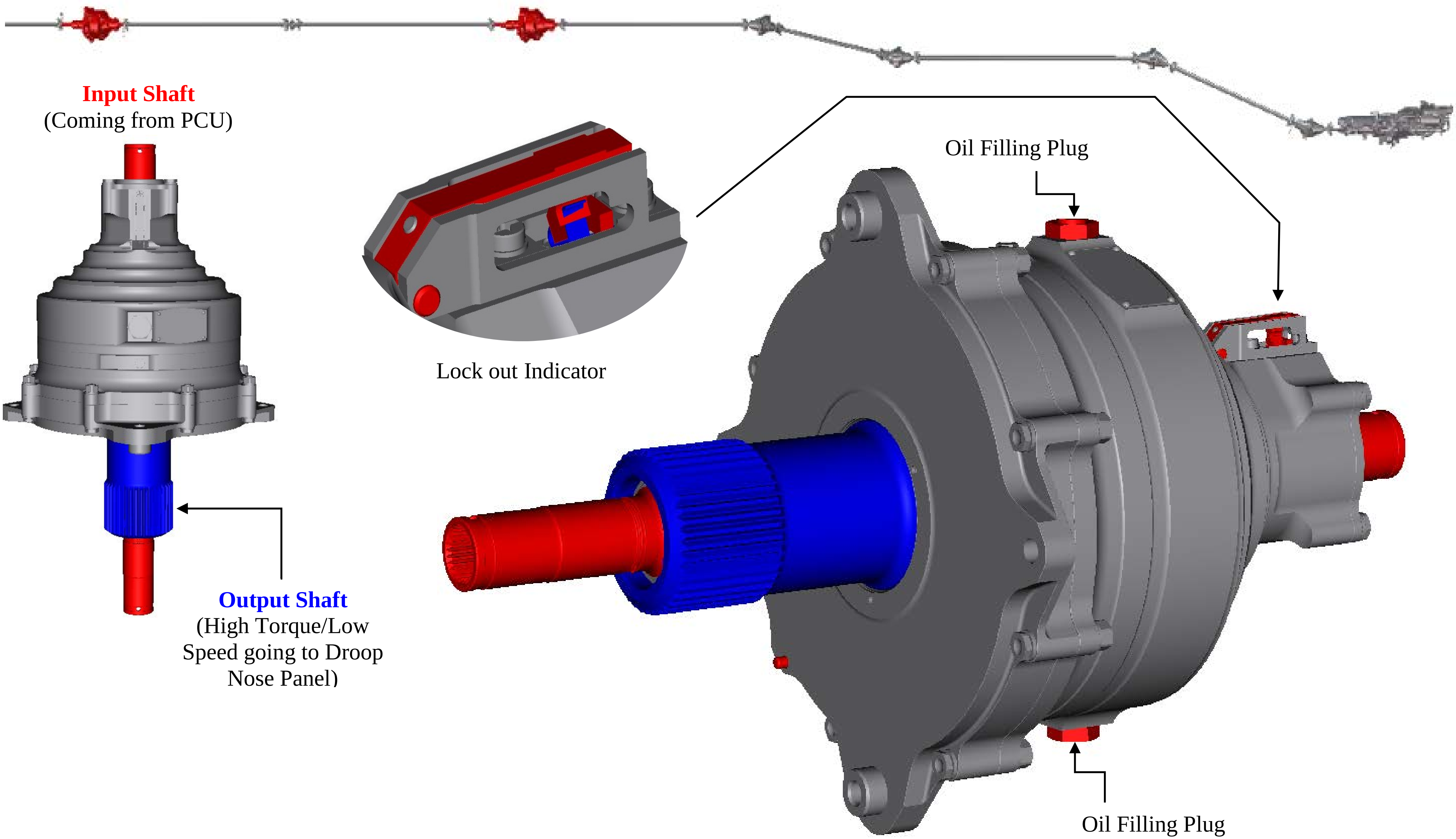
The torque limiter is based on the ball ramp and clamp roller principle.

These units have three functions:

- Conversion of transmission shaft rotation into drive arm motion
- Limiting the torque available to downstream components
- Transfer transmission rotation to the next unit in line

The actuator is mounted to the wing structure with a four bolt mounting flange.

The droop nose actuators are lubricated with red oil (MIL-PRF5606).


Input Shaft
(Coming from PCU)
Lock out Indicator
Oil Filling Plug
Output Shaft
(High Torque/Low Speed going to Droop Nose Panel)
Oil Filling Plug

DROOP NOSE ACTUATOR

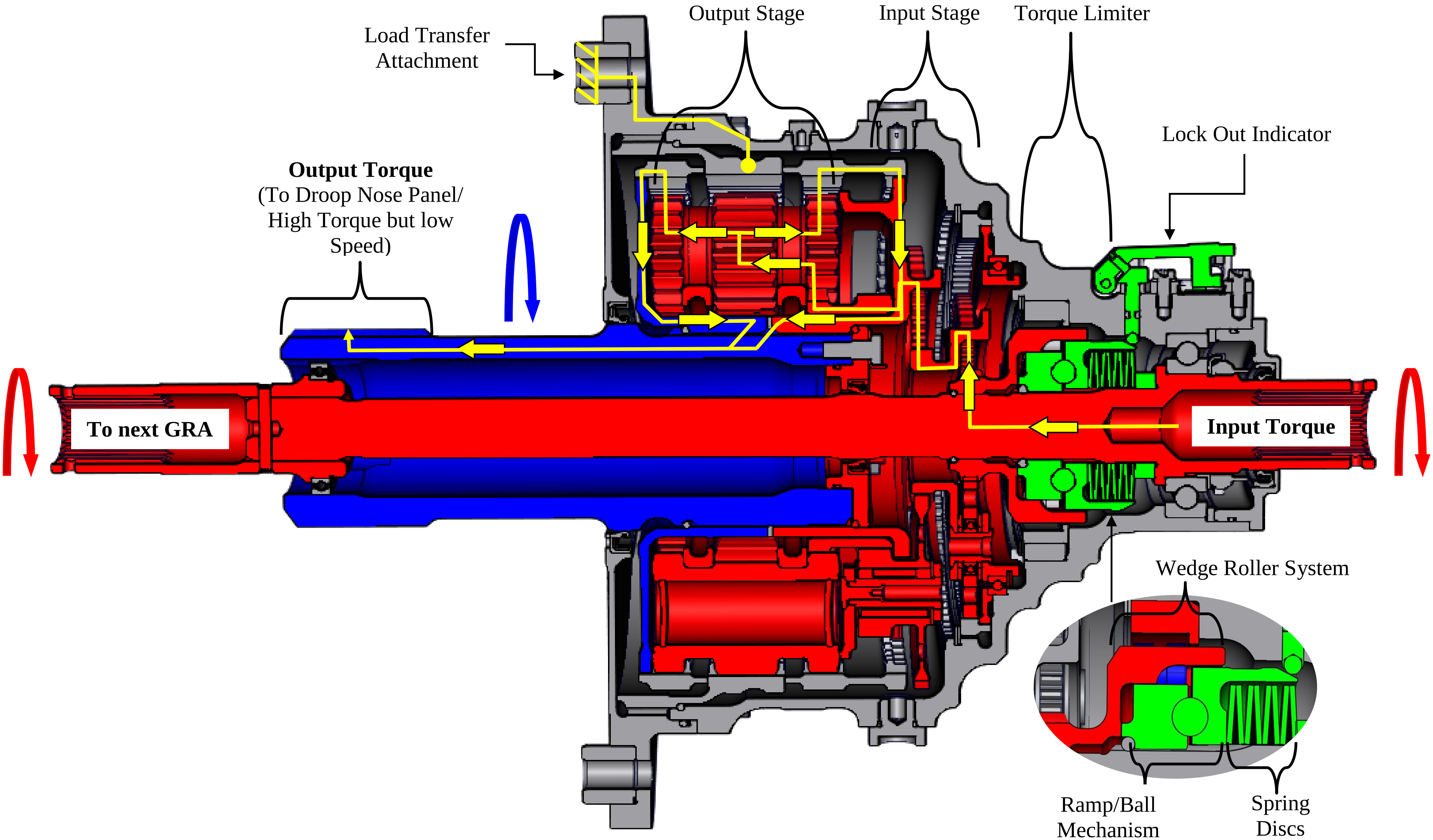
Normal Operation:

Input shaft rotation is transferred to the torque limiting device and is transmitted to the first stage input sun gear. The first stage reduction gearing then drives the power stage reduction gear assembly providing the desired output shaft rotation.

Lock Out Operation:

The torque limiter normally rotates as a single unit with the input shaft due to action of the pre-load spring on the ball and ramp plates. If the load difference between input and output exceeds the pre-load value, these plates separate and compress the clamp roller, thereby transferring excess torque into the actuator housing.

If sufficient movement of these ball and ramp is present, the lock-out indicator will be activated. Once the overload condition disappears, the torque limiter returns to normal conditions and operation, but the indicator remains activated until reset by hand.


Load Transfer Attachment
Output Stage
Input Stage
Torque Limiter
Lock Out Indicator
Output Torque
(To Droop Nose Panel/
High Torque but low
Speed)
To next GRA
Input Torque
Wedge Roller System
Ramp/Ball
Mechanism
Spring
Discs

DROOP NOSE GRA TORQUE LIMITER OPERATION

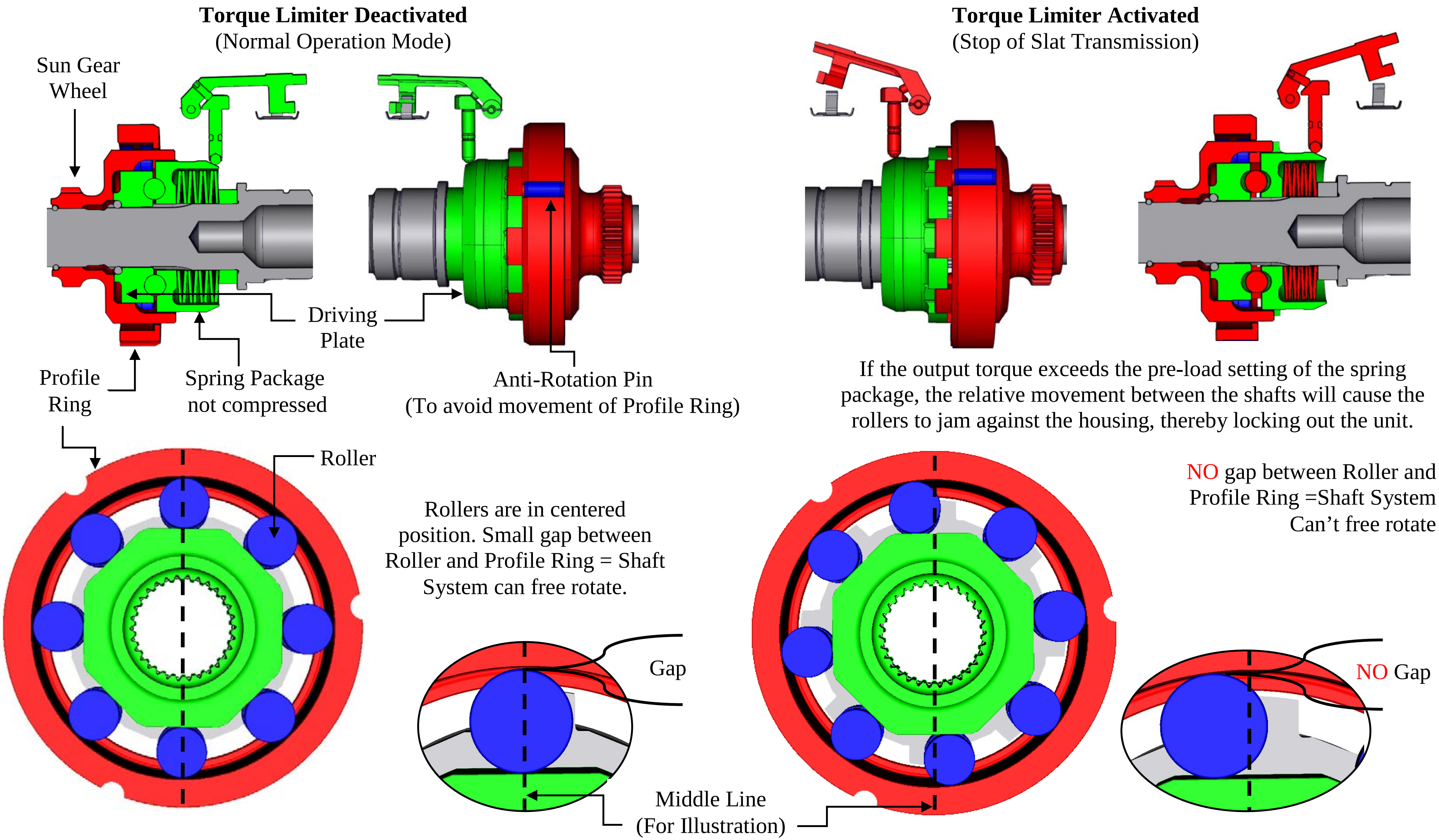
In case of a Jam, the lockout indicator will extend out and provide a visible feedback to the maintenance personal to carry out a deeper trouble shooting.

Torque Limiter Deactivated:

- Spring Package is not compressed
- Rollers don’t jam against the housing
- Lock-out Indicator retracted
- Shaft of the DNGRA can rotate freely

Torquer Limiter Activated:

- Spring Package is compressed
- Rollers jam against the housing
- Lock-out Indicator extended
- Shaft of the DNGRA is stopped (complete Slat system is fixed)


Torque Limiter Deactivated
(Normal Operation Mode)
Torque Limiter Activated
(Stop of Slat Transmission)
Sun Gear Wheel
Driving Plate
Profile Ring
Spring Package not compressed
Anti-Rotation Pin
(To avoid movement of Profile Ring)
If the output torque exceeds the pre-load setting of the spring package, the relative movement between the shafts will cause the rollers to jam against the housing, thereby locking out the unit.
Profile Ring
Roller
Rollers are in centered position. Small gap between Roller and Profile Ring = Shaft System can free rotate.
Gap
NO gap between Roller and Profile Ring =Shaft System Can't free rotate
NO Gap
Middle Line
(For Illustration)

Bevel Gearbox

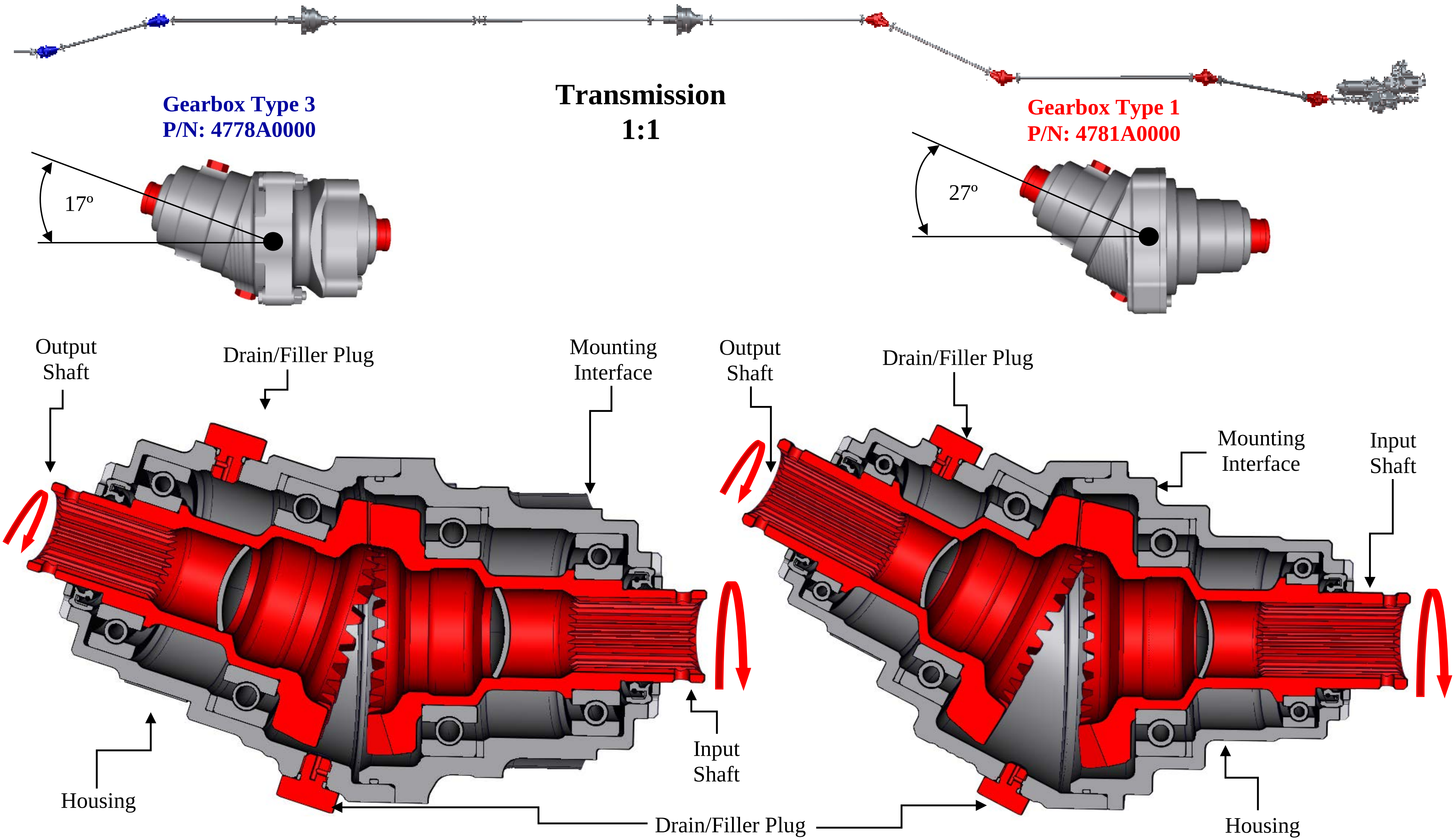
The transmission gearbox is used in the slat actuation system to accommodate a change of direction in the transmission system.

Each gearbox consists of an input gear and output gear to transfer the torque and rotation in the transmission system.

Each gear is supported by two bearings for good operation under radial and axial forces.

The transmission is connected by internal (female) splines.

The resulting torque and forces are reacted to the wing structure.


Gearbox Type 3
P/N: 4778A0000
Transmission
1:1
Gearbox Type 1
P/N: 4781A0000
17º
27º
Output Shaft
Drain/Filler Plug
Mounting Interface
Housing
Input Shaft
Drain/Filler Plug
Output Shaft
Drain/Filler Plug
Mounting Interface
Input Shaft
Housing

WING TIP BRAKE

The Slat Wing Tip Brake (WTB) is located between the two actuators of panel 7 (GRA 13 and GRA 14). It is fitted to the wing structure of the aircraft between track 15 and 17.

The WTB are used to arrest and hold the system under various load conditions.
The WTB is designed as a power off brake such if power is removed or lost the brake is engaged.
In normal operation the WTB is free to rotate with the transmission during the whole flight.

The WTB is controlled and monitored via the SFCC.

Major components of the WTB:

- 1 Solenoid (with 2 coils)
- 1 Manual Release
- 1 Proximity Sensor
- 2 Friction Packages
- 1 Ball Ramp Trigger Mechanism

Component Description:

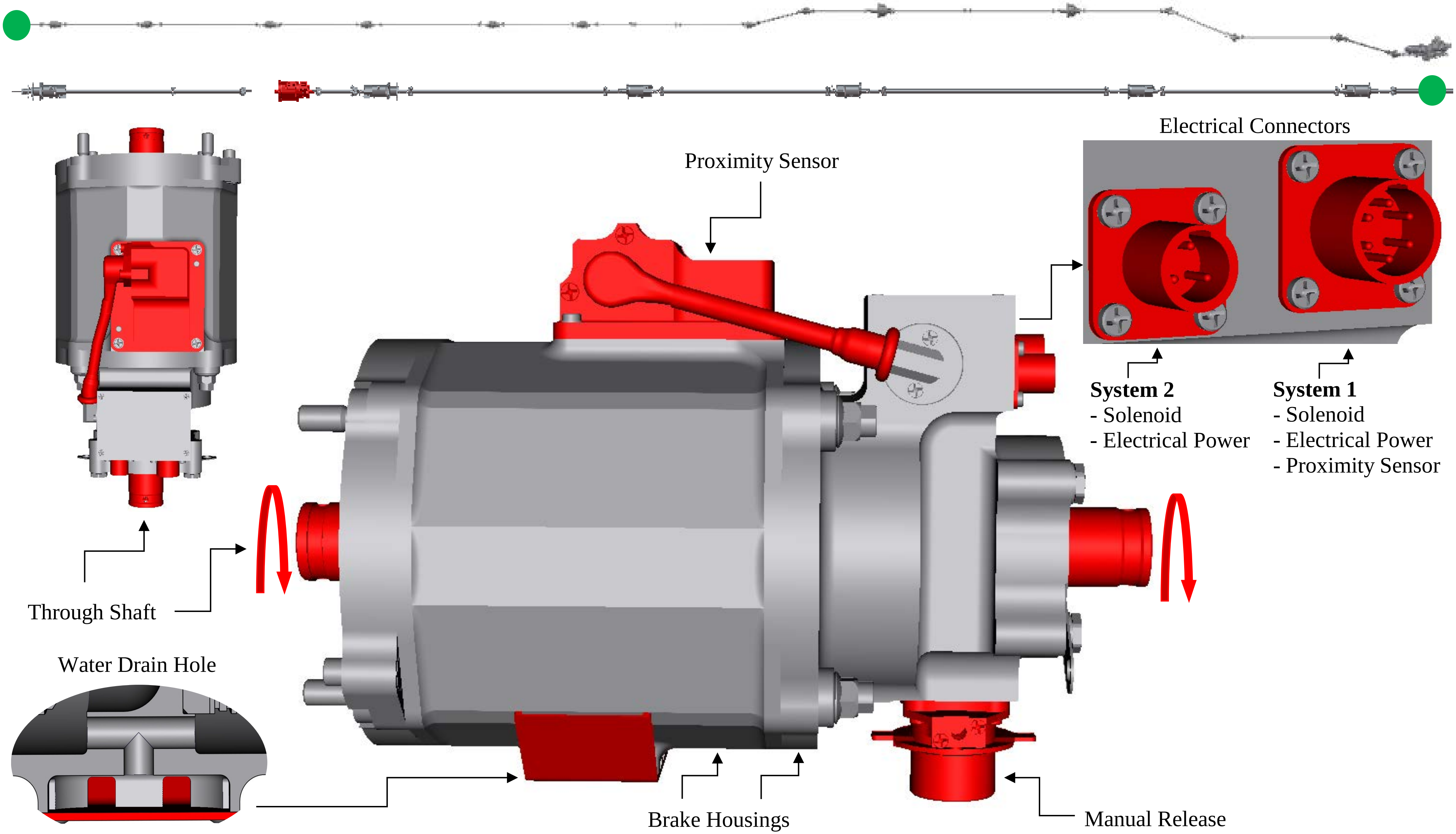
Solenoid:
The brake is released by a dual electric solenoid. Each coil of the solenoid is controlled by an independent SFCC of the high lift slat system to cater for maximum system availability.

Manual Release:
Additionally, an interface is provided to release the brake on ground for maintenance without any electrical power.

Proximity Sensor:
The WTB contains one Proximity Sensor, connected to SFCC 1 to indicate brake status: Engaged or released.

Friction Packages:
The WTB comprises two friction packages, one pre stage and one main stage.

Ball Ramp Trigger Mechanism:
The trigger friction pack activates the main friction pack via a ball ramp brake mechanism to arrest and hold the system in the specified failure cases.


Electrical Connectors
Proximity Sensor
System 2
- Solenoid
- Electrical Power
System 1
- Solenoid
- Electrical Power
- Proximity Sensor
Through Shaft
Water Drain Hole
Brake Housings
Manual Release

Wing Tip Brake Operation

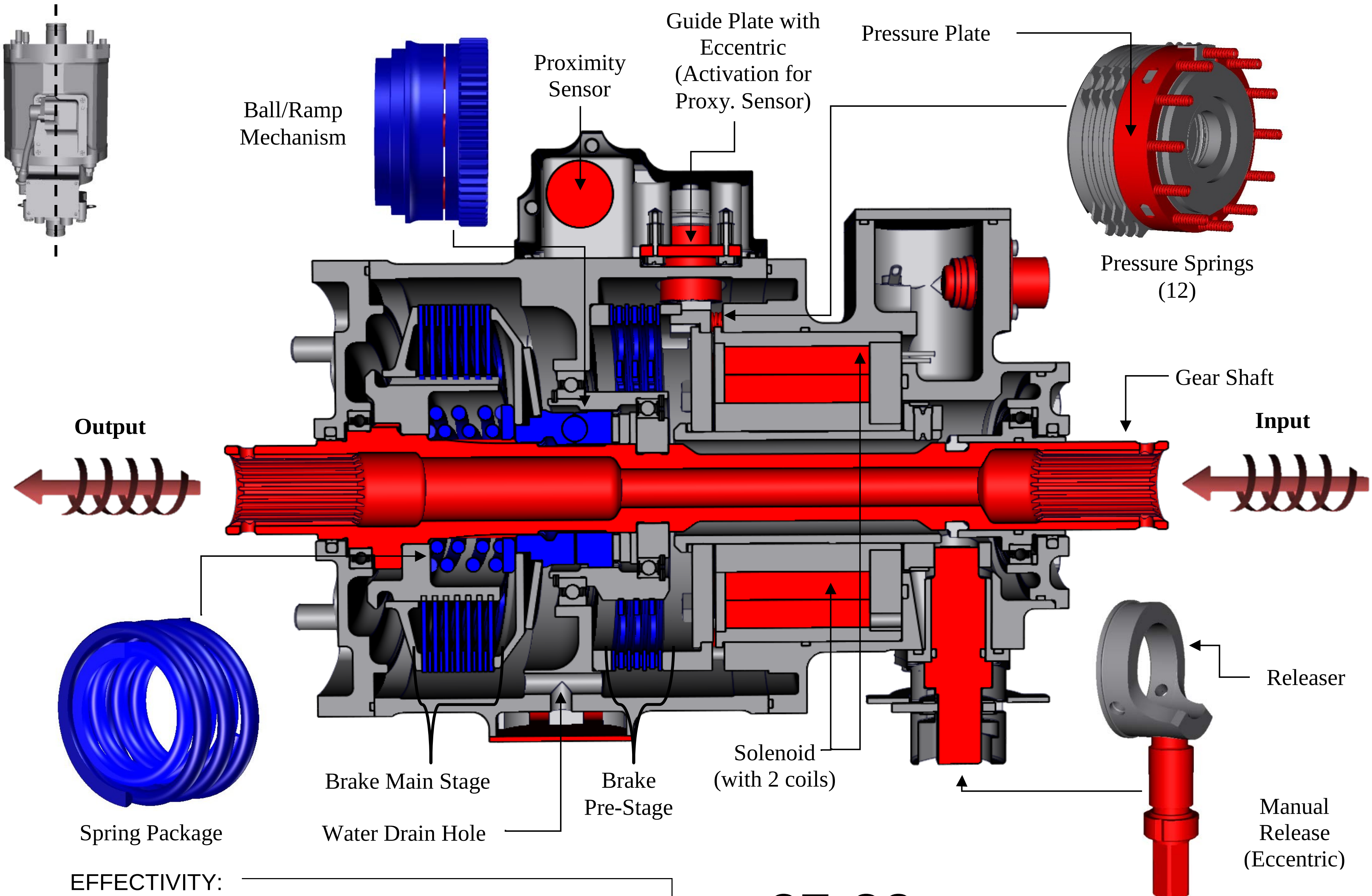
Normal Operation:

The brake is engaged when there is no power (Power-Off Brake).

Brake release:
Both electrical inputs at the brake will be applied with a voltage via the SFCC to release the brake. Electrical signals indicate the fully released brake. In this condition the brake is free to rotate.

Brake engagement:
To engage the brake the SFCC cut-off the voltage supply at both electrical control inputs. A brake torque shall be applied to the system sufficient to arrest the system.

Brake status during flight:
The brake is kept released during flight.

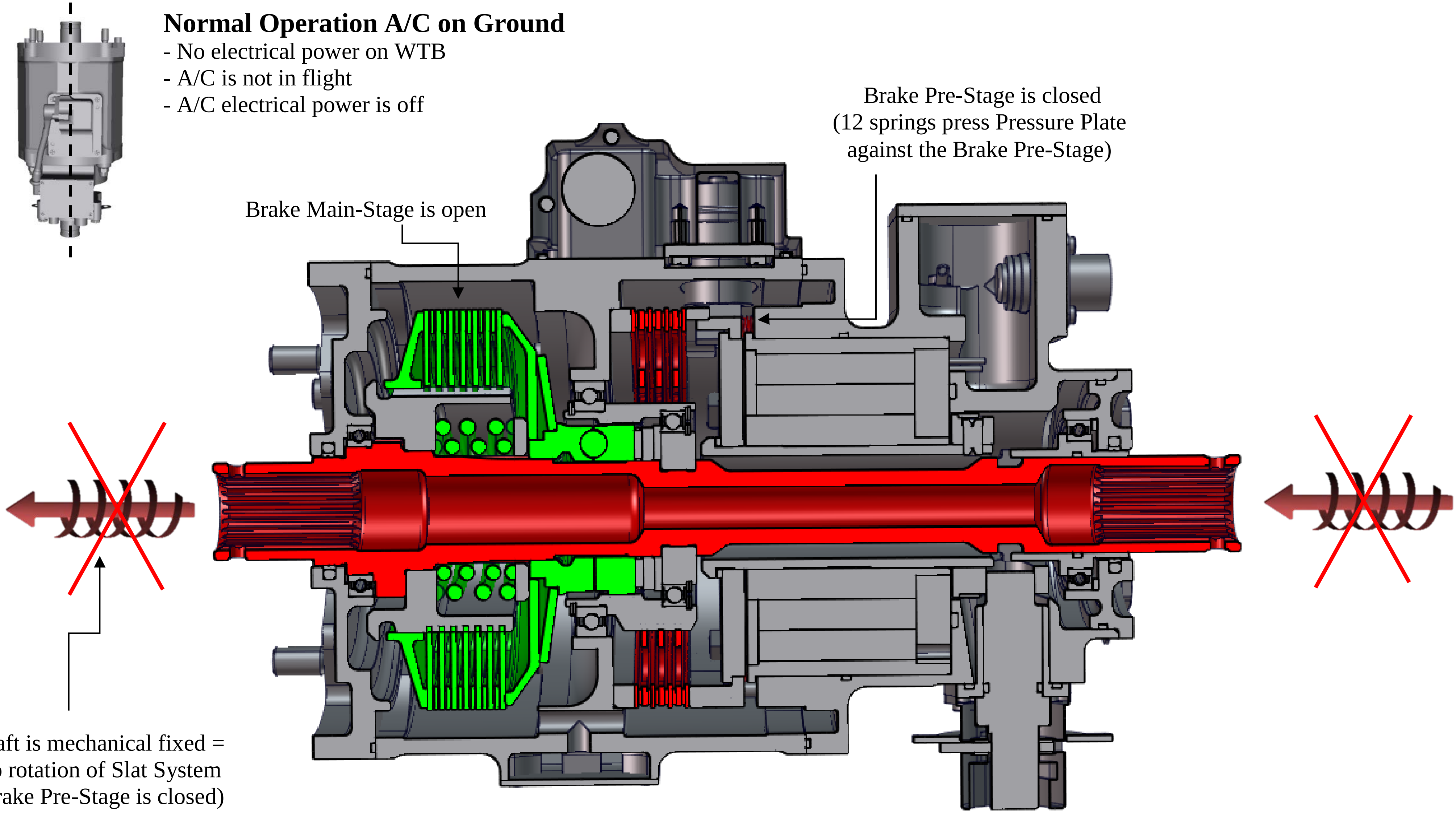

Ball/Ramp Mechanism
Proximity Sensor
Guide Plate with Eccentric (Activation for Proxy. Sensor)
Pressure Plate
Pressure Springs (12)
Gear Shaft
Output
Input
Releaser
Spring Package
Brake Main Stage
Water Drain Hole
Brake Pre-Stage
Solenoid (with 2 coils)
Manual Release (Eccentric)

Wing Tip Brake Operation

Normal Operation A/C on Ground:

The brake is engaged when there is no electrical power (Power-Off = Brake).

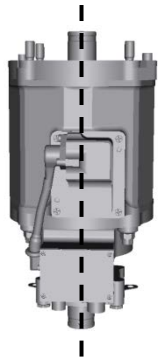
Normal Operation A/C on Ground
- No electrical power on WTB
- A/C is not in flight
- A/C electrical power is off



Wing Tip Brake Operation

Normal Operation A/C in flight operation:

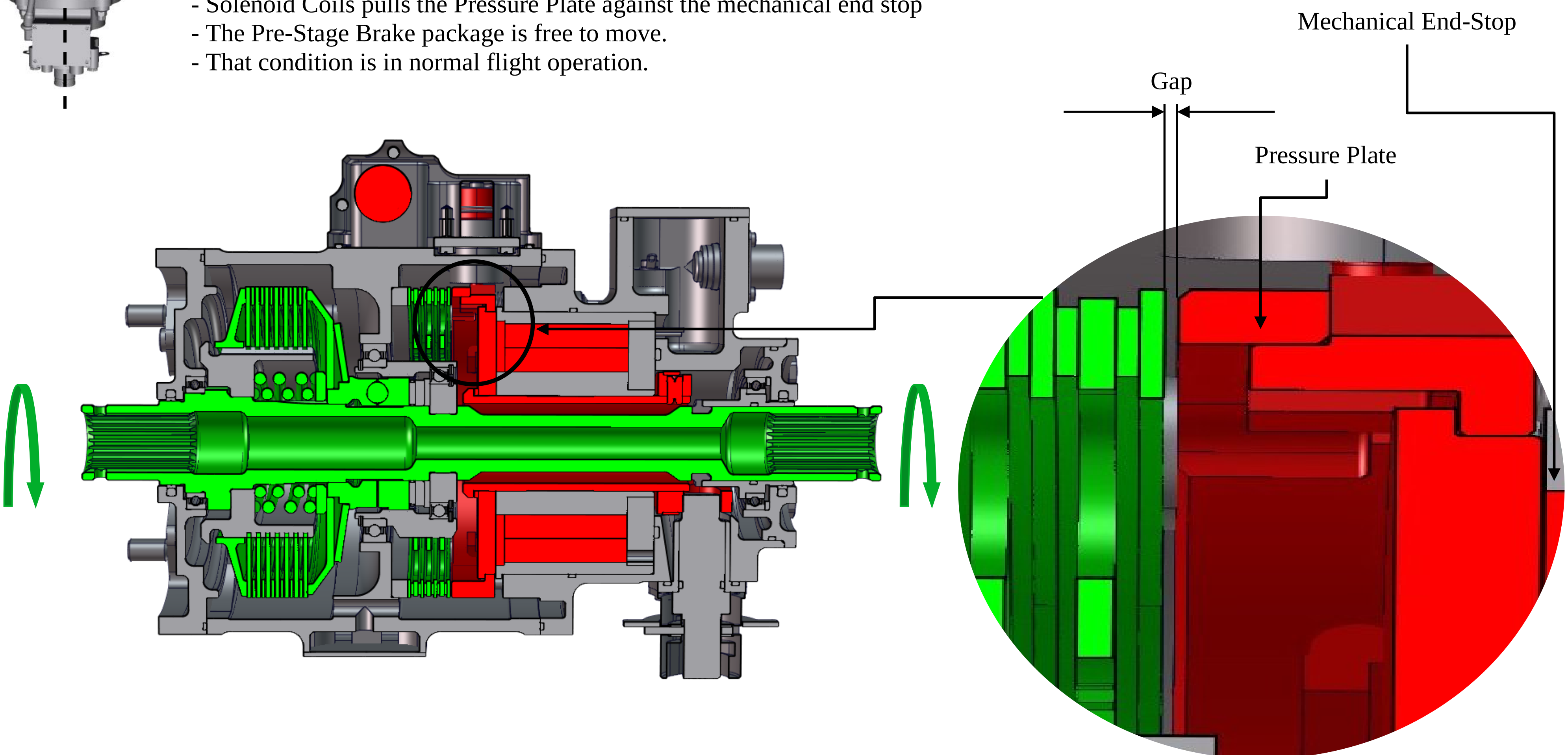
Brake release:
Both electrical inputs at the brake will be applied with a voltage via the SFCC to release the brake. Electrical signals indicate the fully released brake. In this condition the brake is free to rotate.



Normal Operation In flight Condition

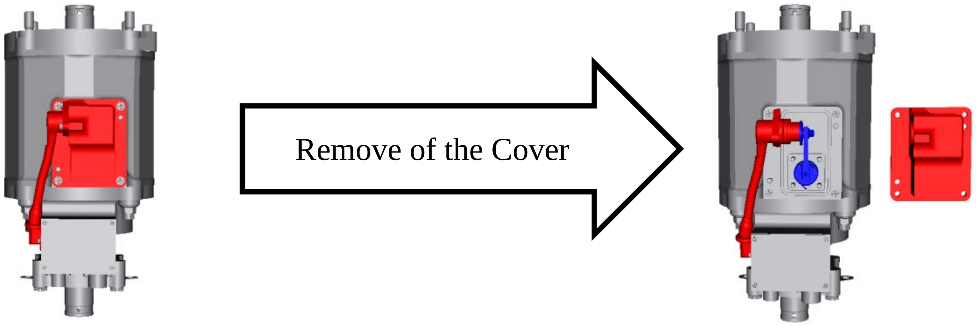
(Brake release)

- Electrical power on WTB
- Brake can free rotate
- Proxy. Signal indicates the released brake
- Solenoid Coils pulls the Pressure Plate against the mechanical end stop
- The Pre-Stage Brake package is free to move.
- That condition is in normal flight operation.



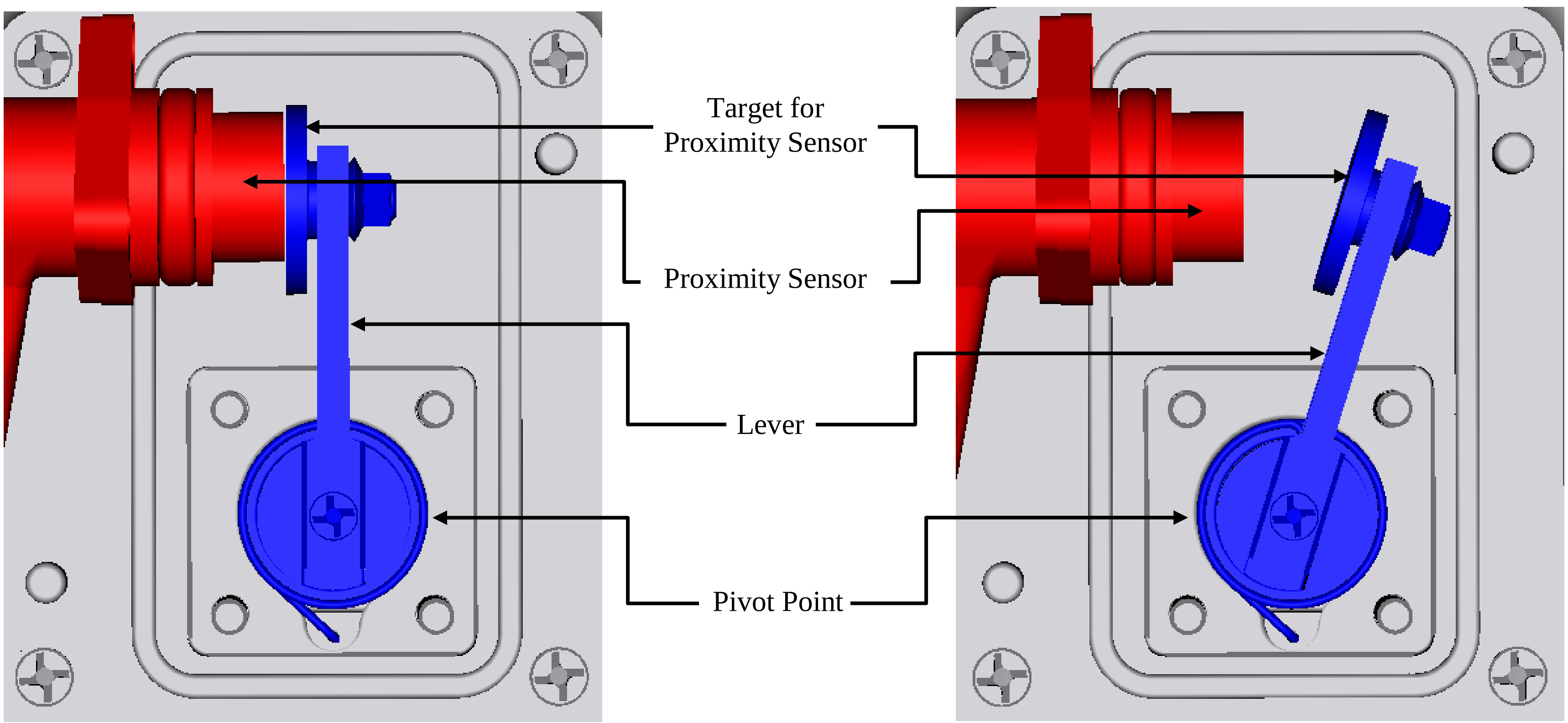
Proximity Sensor

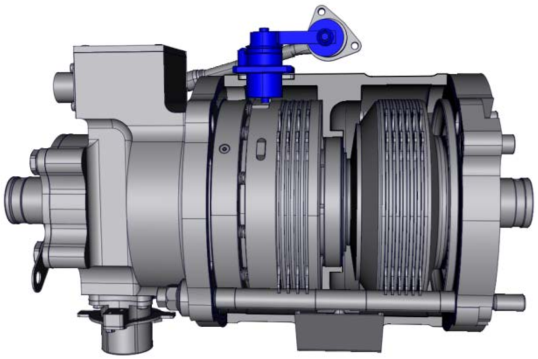
The WTB contains one Proximity Sensor, connected to SFCC 1 to indicate brake status: Engaged or released.



Brake Pre-Stage Open = Signal to SFCC

Brake Pre-Stage Closed = No Signal to SFCC

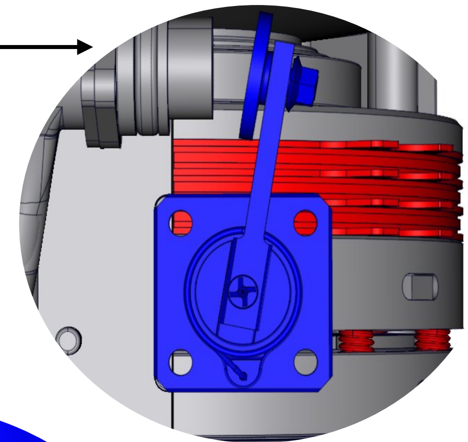




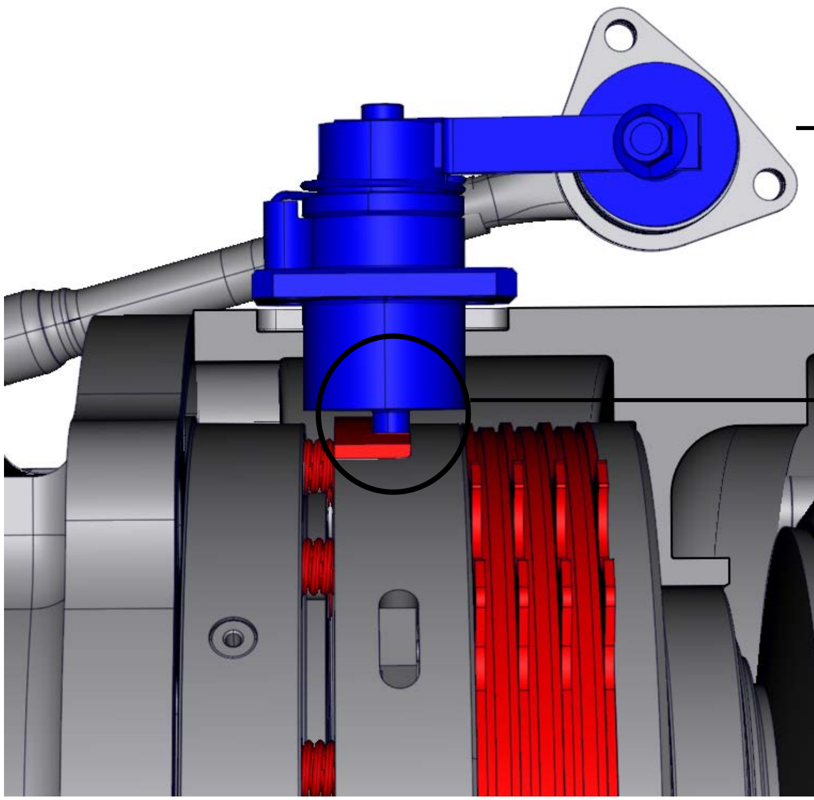
Eccentric Activation for Target Movement

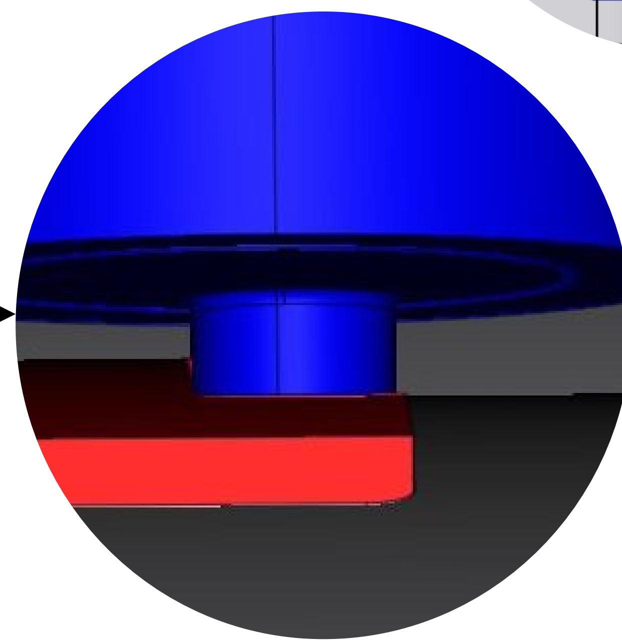
Brake Closed = No Signal to SFCC
(No electrical power on WTB)
- Pressure plate presses the Brake Pre-Stage together and holds the slat system

Target Far

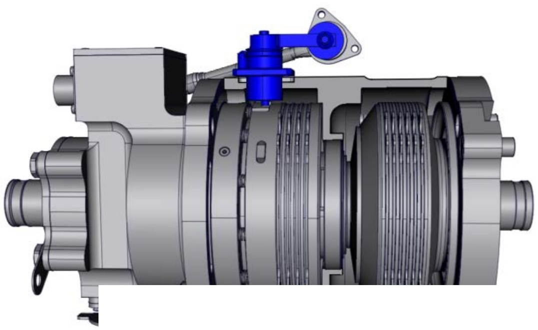


Eccentric push the target far from the proximity sensor.

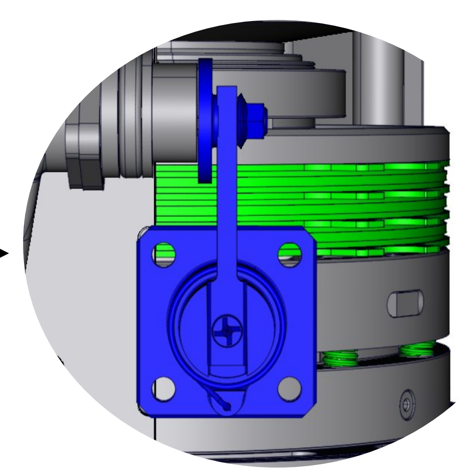


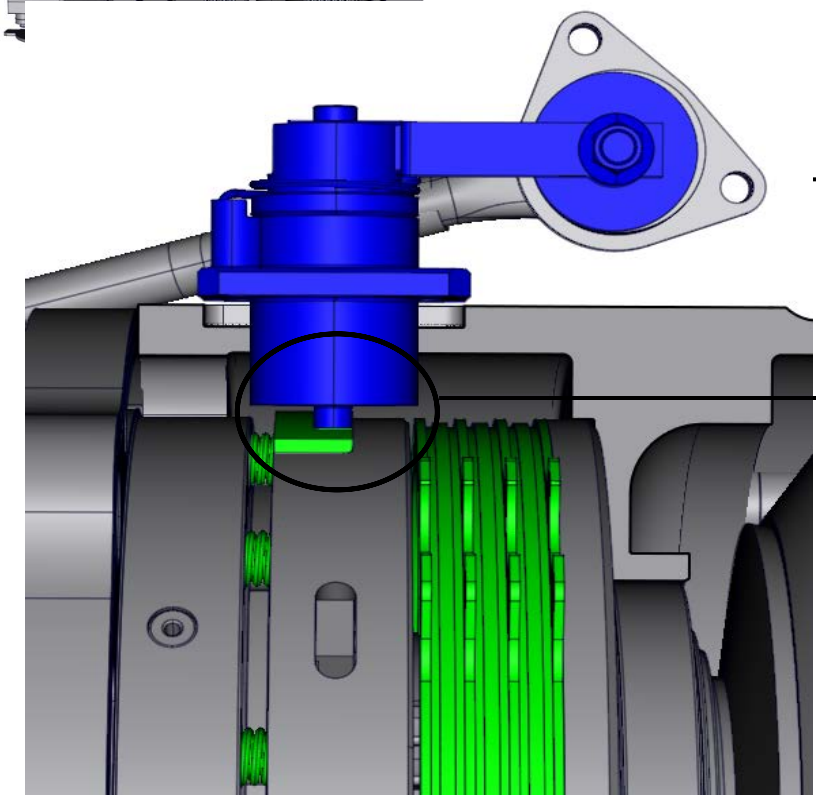


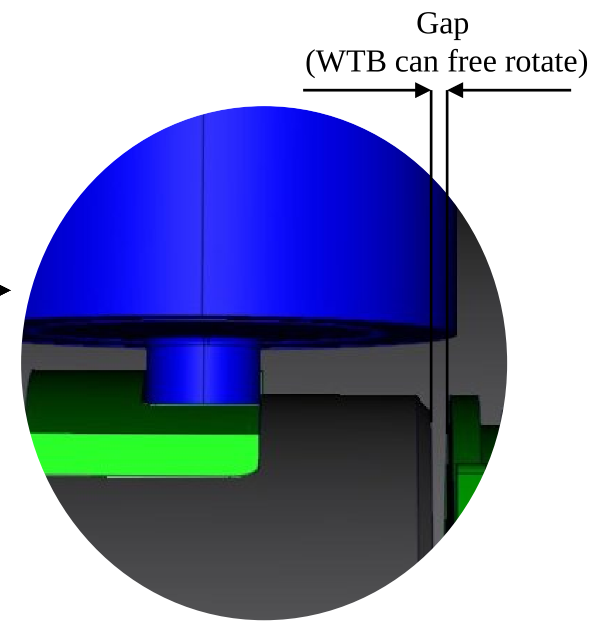
Eccentric Activation for Target Movement



Brake Open = Signal to SFCC (WTB is electrical powered)
- Electrical Solenoids attracts the pressure plate and release the brake pre-stage to operate free the slat system

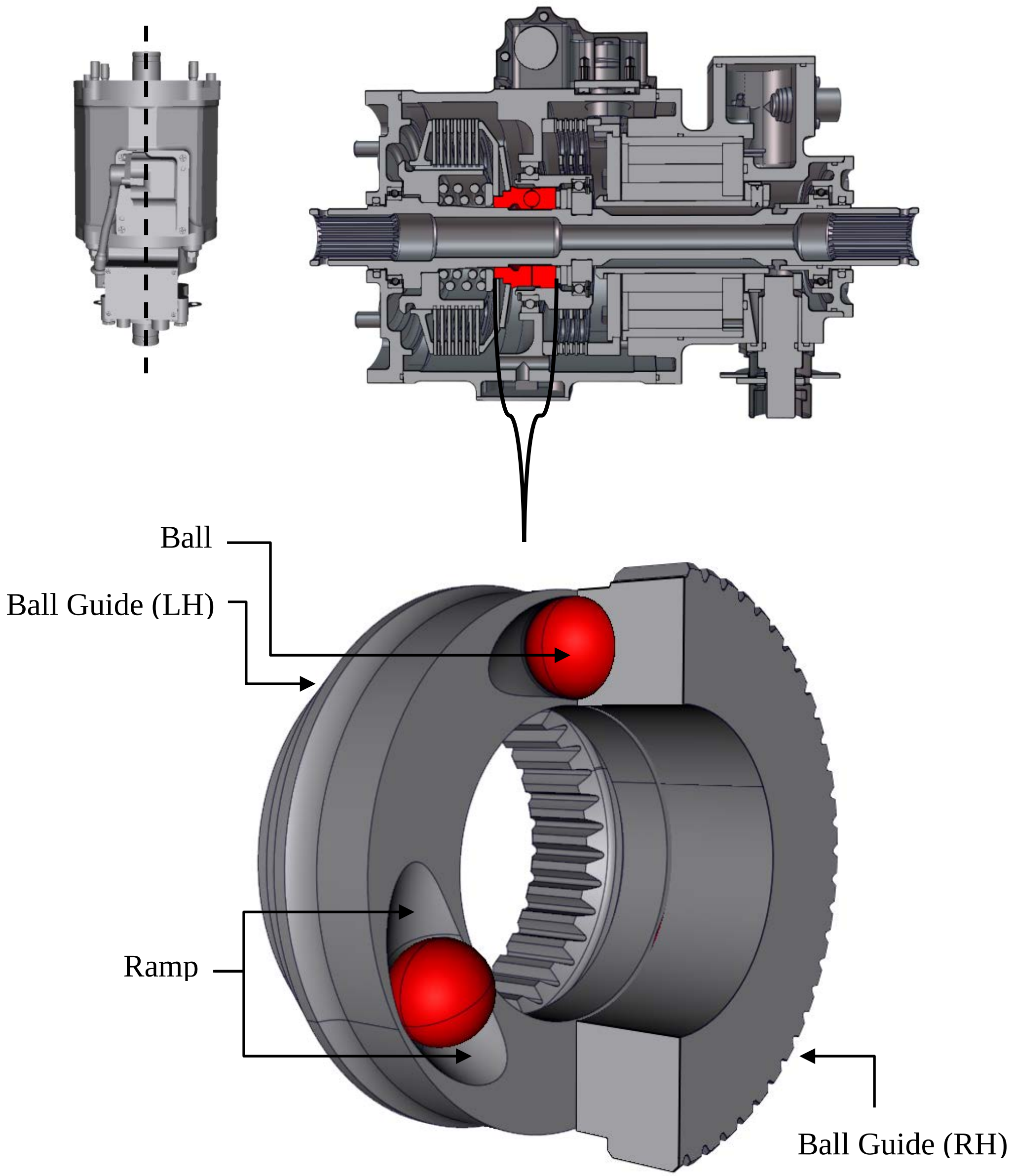






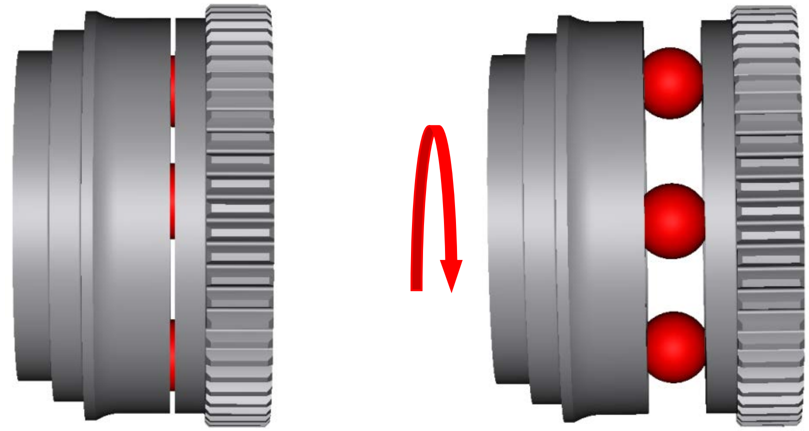
Ball Ramp Mechanism

The Ball and Ramp Mechanism activate the brake main stage to arrest and hold the system.

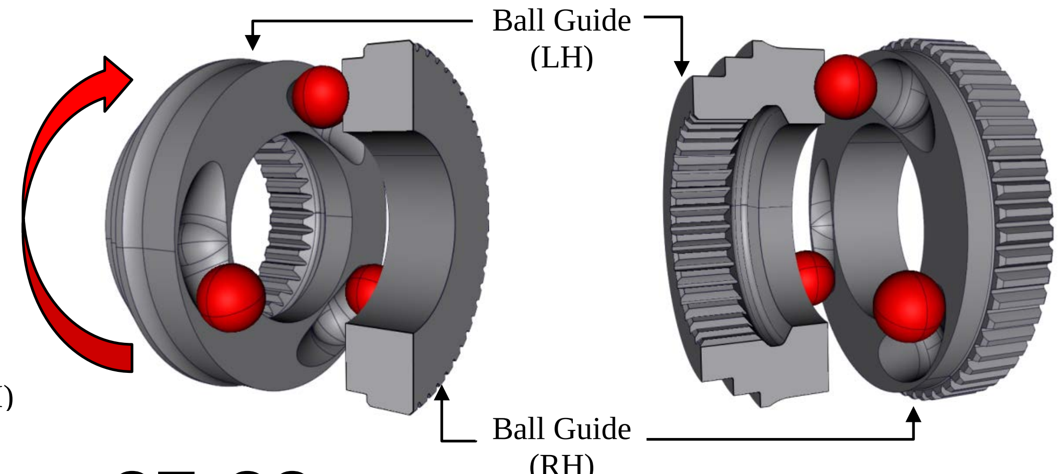


Not Active
(Ball Guides move in the same direction)

Active
(Ball Guides move in different directions)

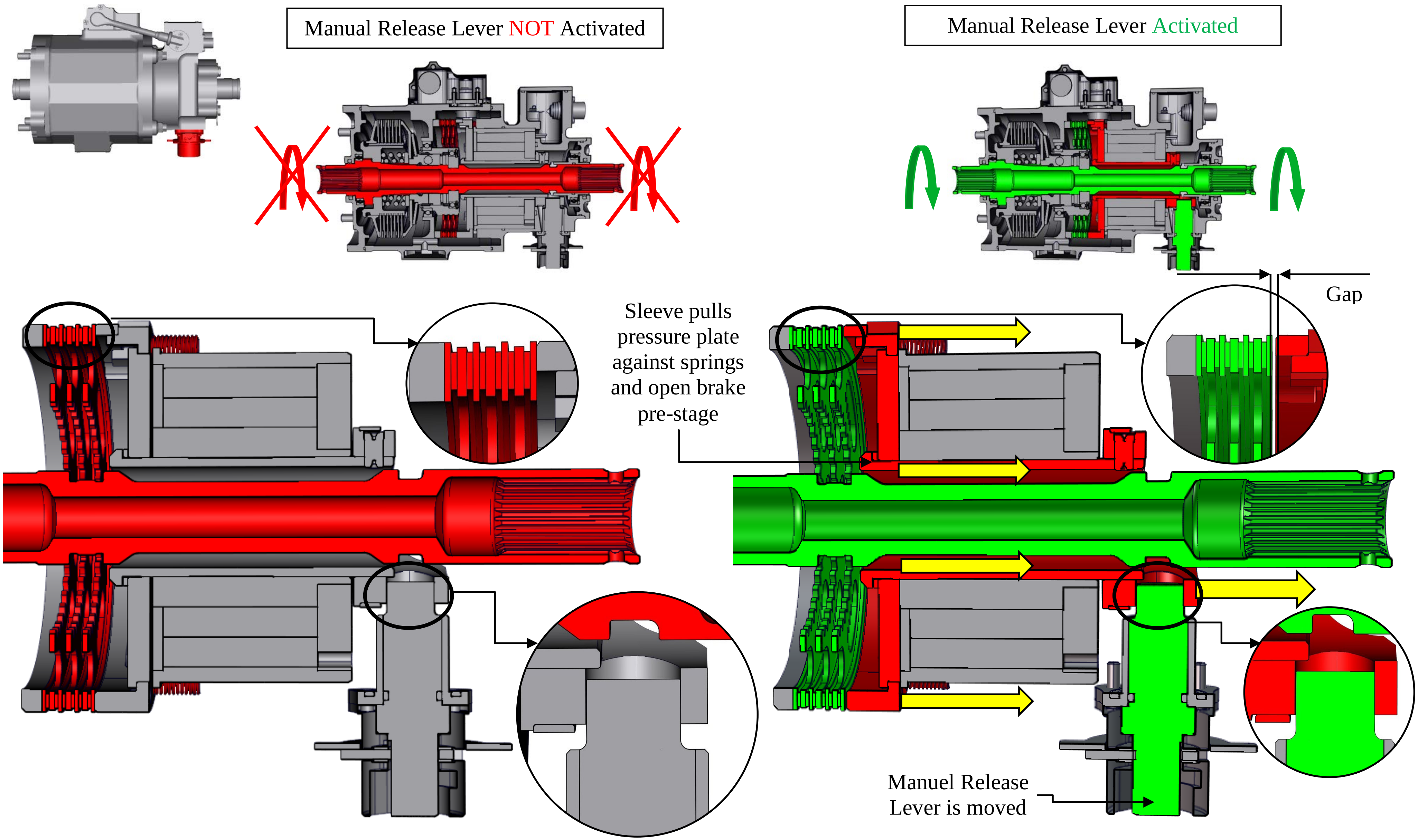


Balls are moving up the ramps and push apart the two ball guides = the brake main-stage is activated and holds the Slat System



MANUAL RELEASE

The WTB has a manual release lever to deactivate the brake on ground for maintenance without electrical power.

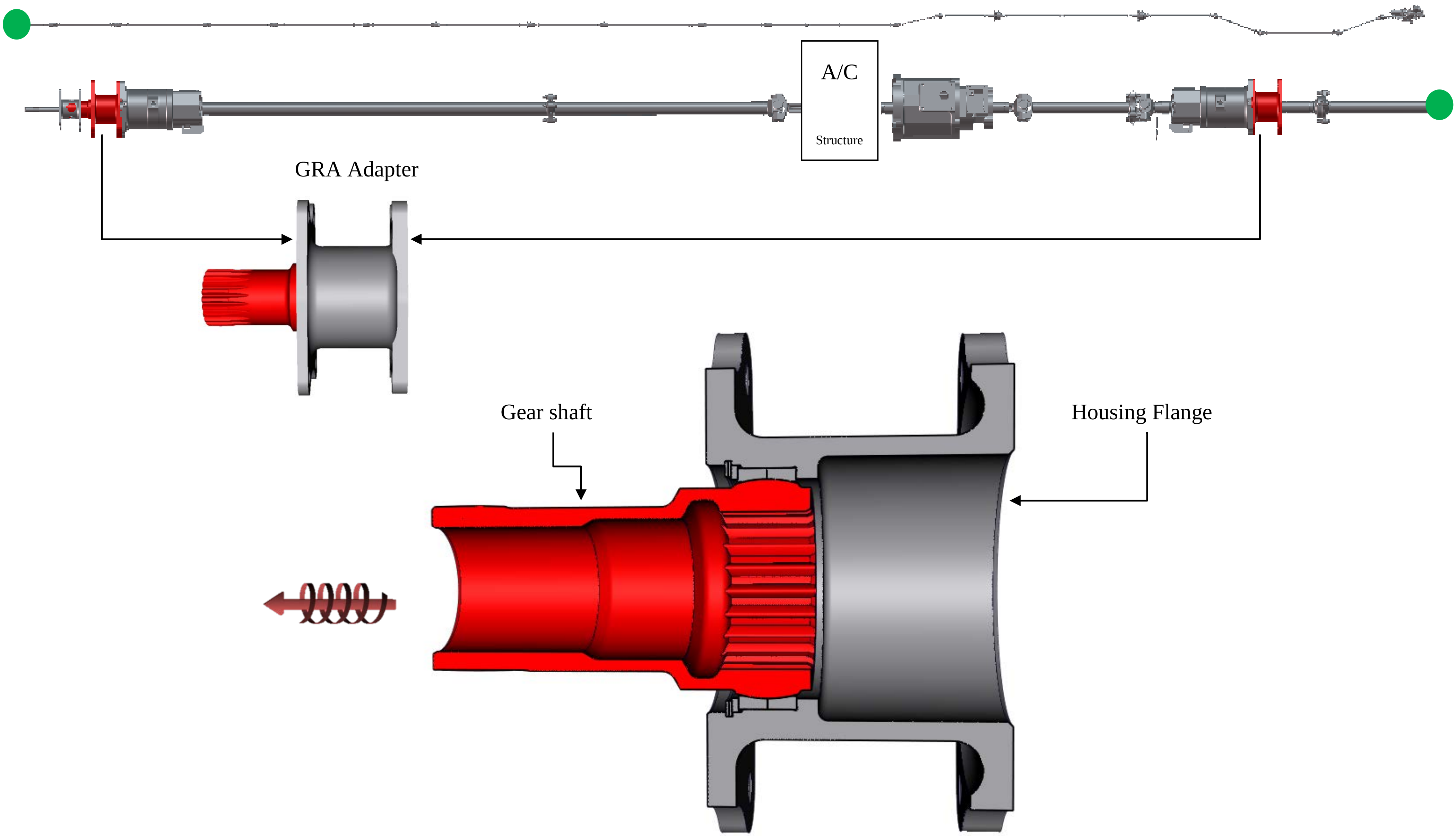

Manual Release Lever NOT Activated
Manual Release Lever Activated
Gap
Sleeve pulls pressure plate against springs and open brake pre-stage
Manuel Release Lever is moved

ADAPTER

The GRA Adapter consists of a housing flange, a gear shaft, two bearing ring races and several adjusting parts.

Attachment of each adapter to the Slat GRA and Aircraft structure is by means of four bolts and nuts per attachment. Interface to Rack and Pinion is by means of male spline.

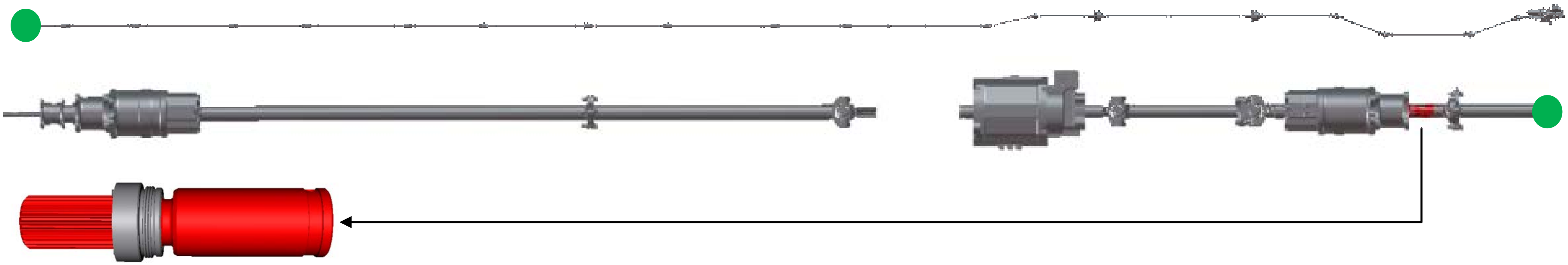
The basic function of the adapter, which is attached to GRA 2 on Track 15 LH/RH and Track 17 LH/RH, is to transfer the torque down drive to Rack and Pinion devices.

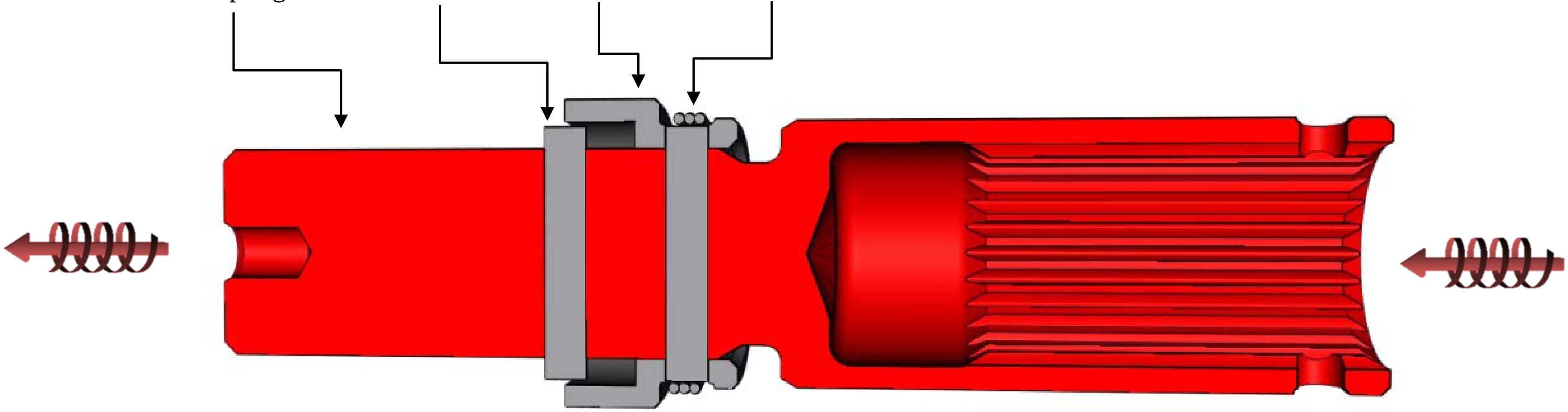

A/C
Structure
GRA Adapter
Gear shaft
Housing Flange

COUPLING

The Coupling consists of a gear shaft, a sleeve, two pins and a back-up ring.

Basic function of the Coupling is to transfer torque through transmission driveline. It is necessary to lengthen the Through Shaft of the Type II Actuator at Track 15 by a coupling to allow the assembly of the ASJ at Shaft S32. It is attached to GRA2 at Track 15 LH/RH in combination with GRA adapter.


Coupling


Coupling
Pin
Sleeve
Retainer

TRANSMISSION SET

The function of the slat transmission set is to transfer the torque delivered by the PCU to the DN GRAs and GRAs, to compensate the different extents of the A/C-structure and the slat transmission set, resulting from changes of temperature and to compensate the extent and change of angular relationship of the A/C structure resulting from wing bending, thermal expansion, structure and equipment build tolerances. The transmission shafts are made of titanium.

The transmission system transmits the PCU output power to rotary actuators. The support kinematics finally transforms to rotary actuator motion into the required surface movements. The continuous transmission shaft set, connecting all rotary actuators together and ensures a symmetrical deployment of all flap and slat surfaces.

There are 46 standard shafts per a/c and 2 compliance shafts, equipped with different joint types for slat system. A flange coupling is required if necessary for installation purposes as attachment to the following joints:
-Universal Joints (UJ)
-Articulating Spline Joints (ASJ)
-Advanced Steady Bearings (ASB)

<u>Universal Joints (UJ):</u>

Two types of universal joint are employed (flange joint and integrated joints), but their construction is identical: They differ only to suit installation requirements, pinned spline or moving spline. The function of the universal joint is to compensate deflections, manufacturing tolerances, torque shaft deviations caused through wing flexure and for component movement.

<u>Articulating Splined Joints (ASJ):</u>

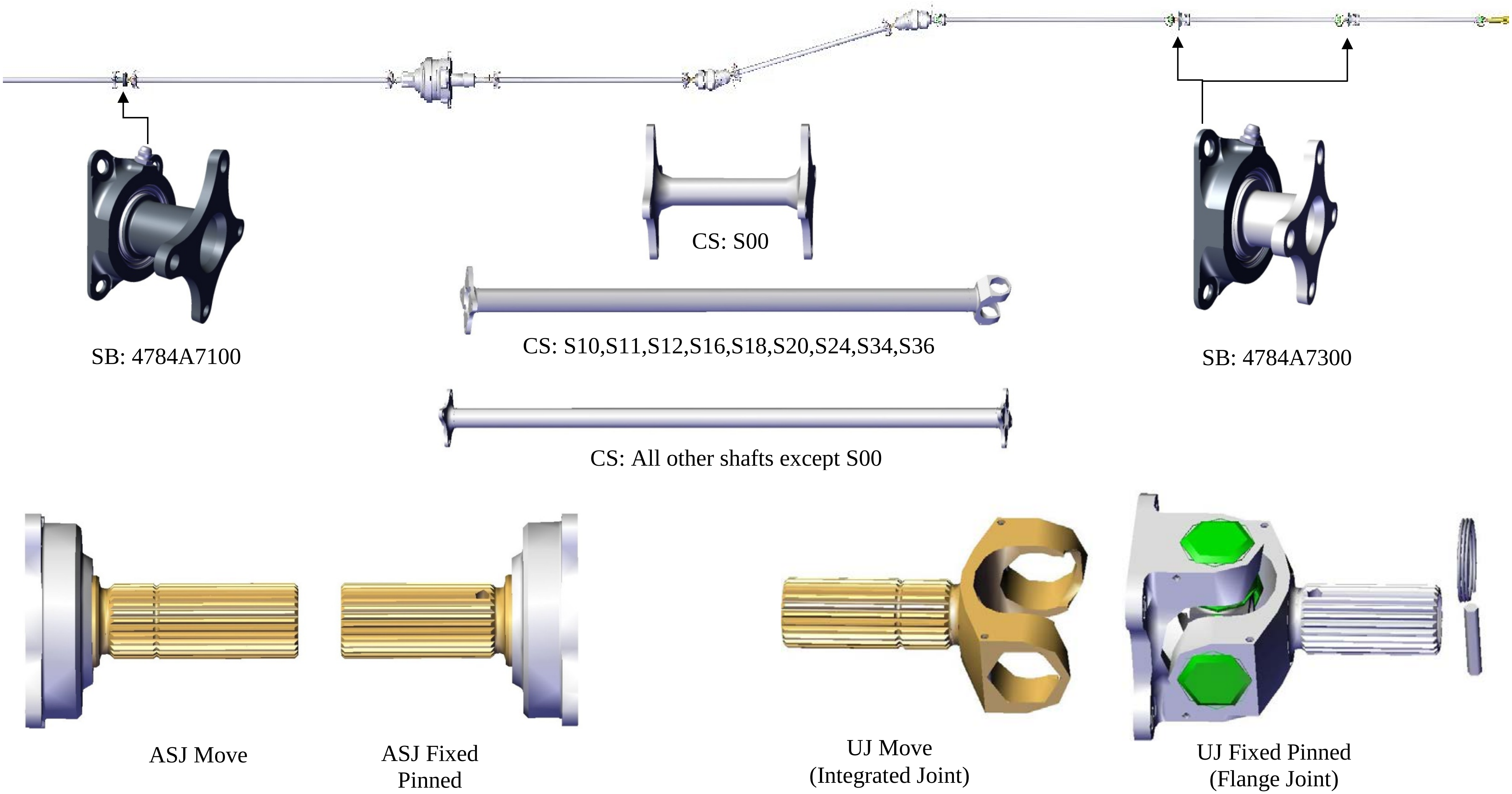
The articulated splined joint employs a crowned spline which can accommodate misalignment. The joint is grease-packed with ARMNA G4789 and sealed for life. The function of the articulating splined joint is to compensate deflections, manufacturing tolerances, torque shaft deviations caused through wing flexure and for component movement.

<u>Steady Bearings (SB):</u>

The function of the steady bearing is to support the transmission shafts, when there is a large span between adjacent units or to manage slight changes in direction.

<u>Compliant Shafts (CS):</u>

The function of the compliant shaft is to transmit system drive torque from the PCU to other transmission components and to compensate for torsional spikes during start-up.



SB: 4784A7100
CS: S00
CS: S10,S11,S12,S16,S18,S20,S24,S34,S36
SB: 4784A7300
CS: All other shafts except S00
ASJ Move
ASJ Fixed
Pinned
UJ Move
(Integrated Joint)
UJ Fixed Pinned
(Flange Joint)

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Flap System

MOVING DAMPER

The Moving Damper (MD) is a hydraulic damping device, using hydraulic fluid. The damping function is realized by two orifices in the piston. The MD is installed in the flap system in order to protect the A/C flap structure against severe damage in case of a flap-linkage disconnection. It avoids the effects from twist of the inboard-flap panel and reduces the interface load in the remaining faultless flap linkage. The moving damper is in extended position when the flaps are in extended position and vice versa.

The Moving Damper provides two operating modes:

- Normal Operation:

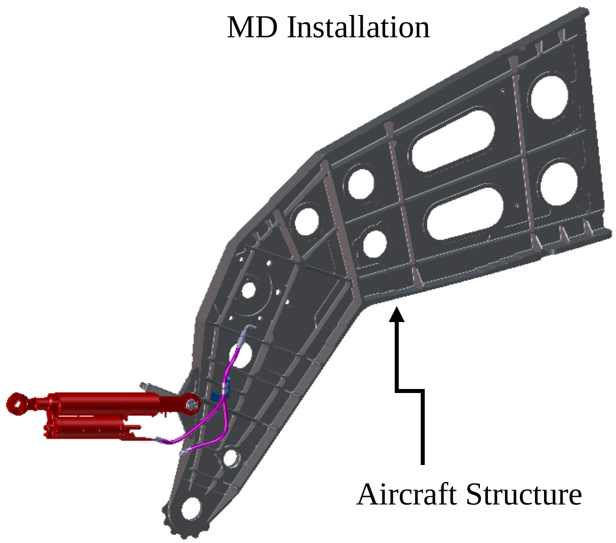
Extension and retraction driven by the inboard flap

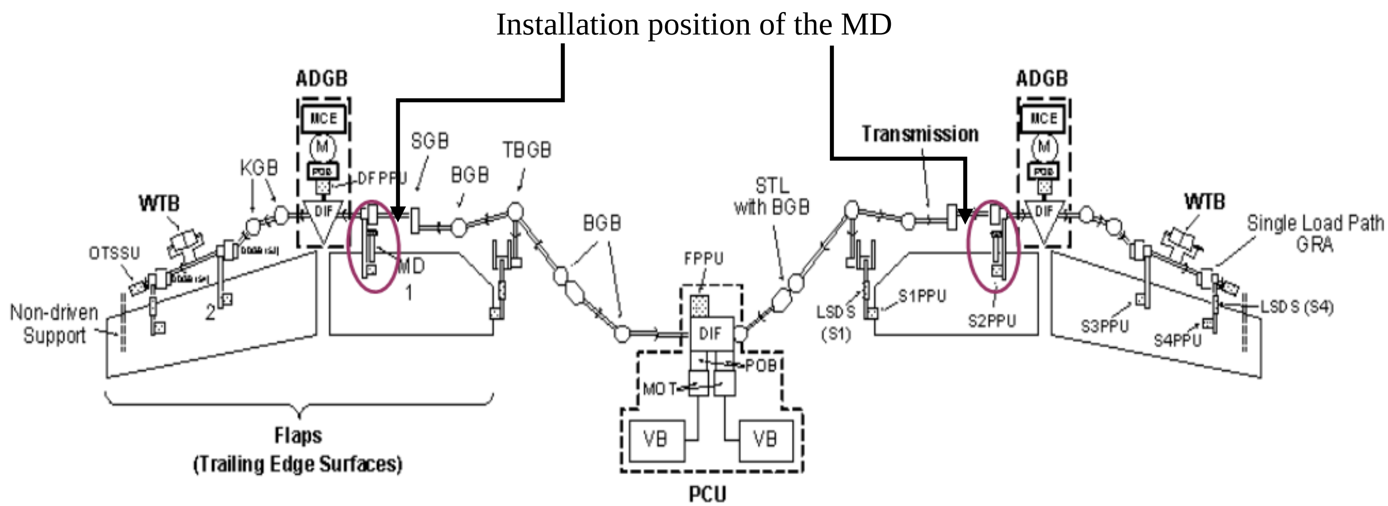
- Disconnect (Failure Mode):

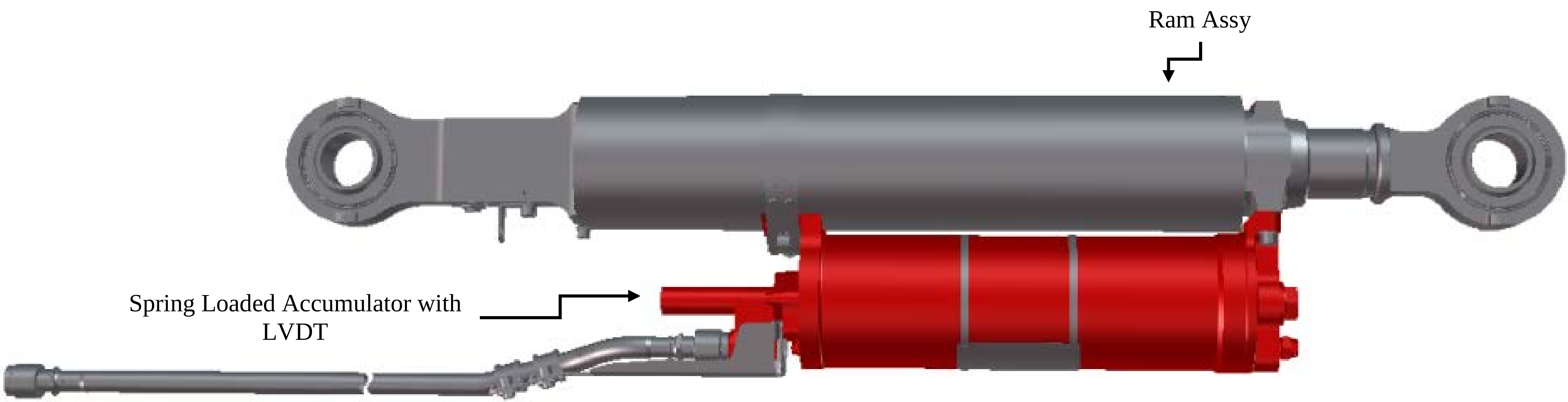
Disconnect of one drive element on Flap Station 2, damper is moved with high velocity in retraction direction

The Accumulator compensates:

- differential volume, resulting from temperature variations
- differential piston area
- external leakage


MD Installation
Aircraft Structure


Installation position of the MD
ADGB
MCE
M
POB
DIF
WTB
KGB
SGB
BGB
TBGB
OTSSU
Non-driven Support
MD
1
2
STL with BGB
FPPU
PCU
MOT
VB
VB
Transmission
S1PPU
S2PPU
S3PPU
S4PPU
LSDS (S1)
LSDS (S4)
Single Load Path GRA
Flaps
(Trailing Edge Surfaces)


Ram Assy
Spring Loaded Accumulator with LVDT

MOVING DAMPER DESIGN

The MD main part is a hydraulic cylinder with two chambers. Hydraulic fluid move from one chamber to the other via two damping orifices during extension or retraction of the cylinder. The MD is equipped with a damper fluid accumulator to compensate temperature effects and different volumes of the pressure chambers. A line Variable Displacement Transducer (LVDT, simplex) acts as an active monitoring device

The flap System Moving Damper (MD) consists of the following main parts:

- Cylinder Assembly
- Accumulator Assembly

The filling level of the accumulator can be identified electronically by a Linear Variable Differential Transformer (LVDT).

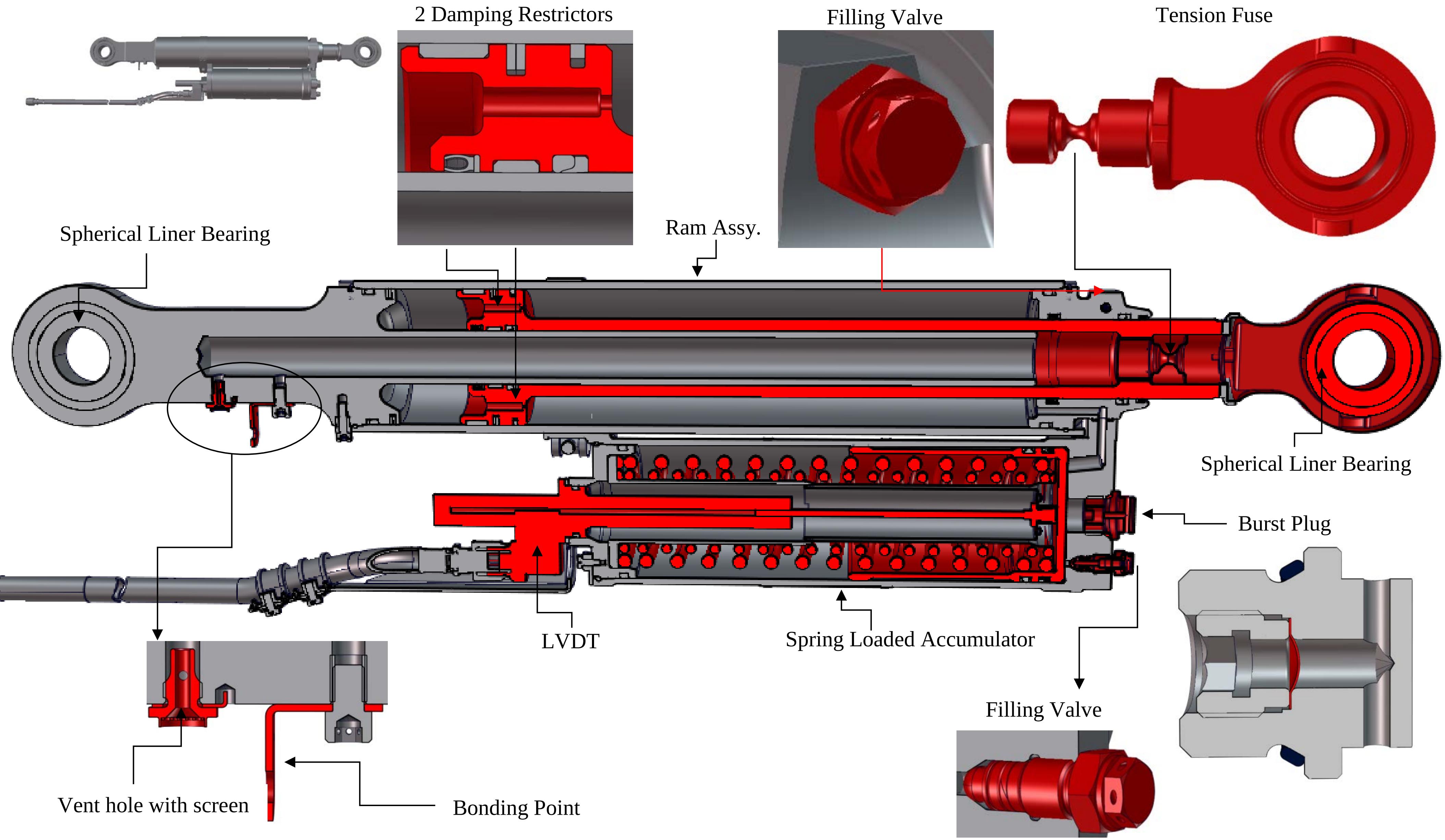
The restrictors are flushed in both directions with every movement of the actuator. The unit is filled with clean Silicone Fluid Rhodorsil 47V10 with an excellent viscosity behavior.

The Unit is a hermetically closed system and no contamination of the fluid from outside is possible.

Loss of damping is avoided by application of dual dynamic seals of piston, piston rod and end gland. Loss of damping is also avoided by application of 2 dissimilar springs within the accumulator.

The cylinder assembly is a vented design. The drain hole is protected by a safety screen in order to prevent the cylinder assembly from moisture.

The rod end (Flap side) of the MD is equipped with a perdetermined breaking point (tension fuse) to protect the A/C structure from overload caused by a sluggish or blocking actuator in extension direction.



EFFECTIVITY:

ALL

MOVING DAMPER ACCUMULATOR

The Accumulator is hermetically sealed towards atmosphere.

Two different springs provide redundancy and dissimilarity (left-winded and right-winded design, different size and wire diameter).

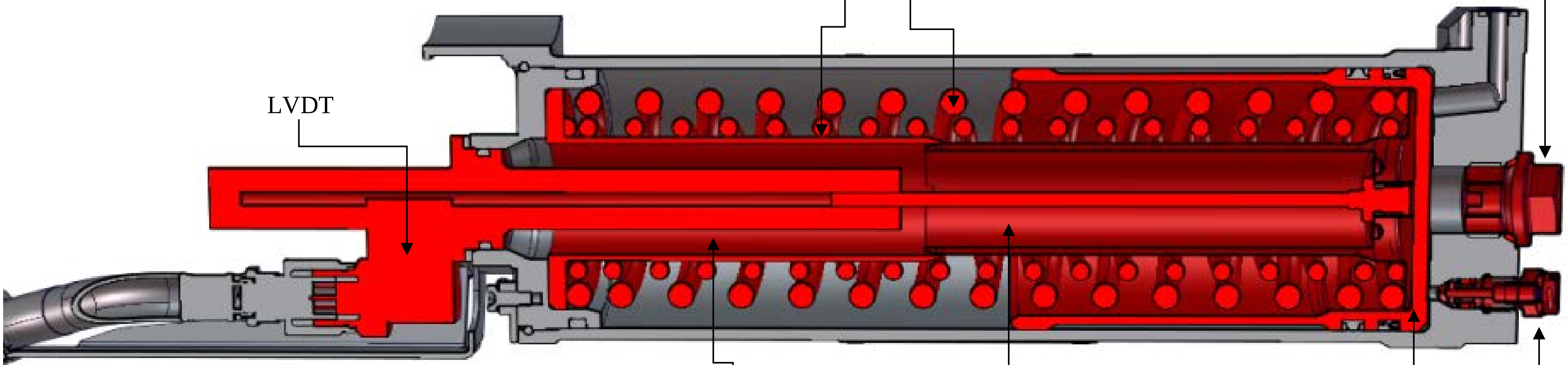
The filling level of the accumulator can be identified electronically by an Linear Variable Differential Transformer (LVDT).

The Accumulator compensates the differential volume, resulting from temperature variations, differential piston area and minor external leakage.

The accumulator is equipped with a burst item (Burst Plug) to protect the accumulator housing from overload pressure caused by an accumulator piston jam.

Burstvalue of Burst Plug to Temperature:

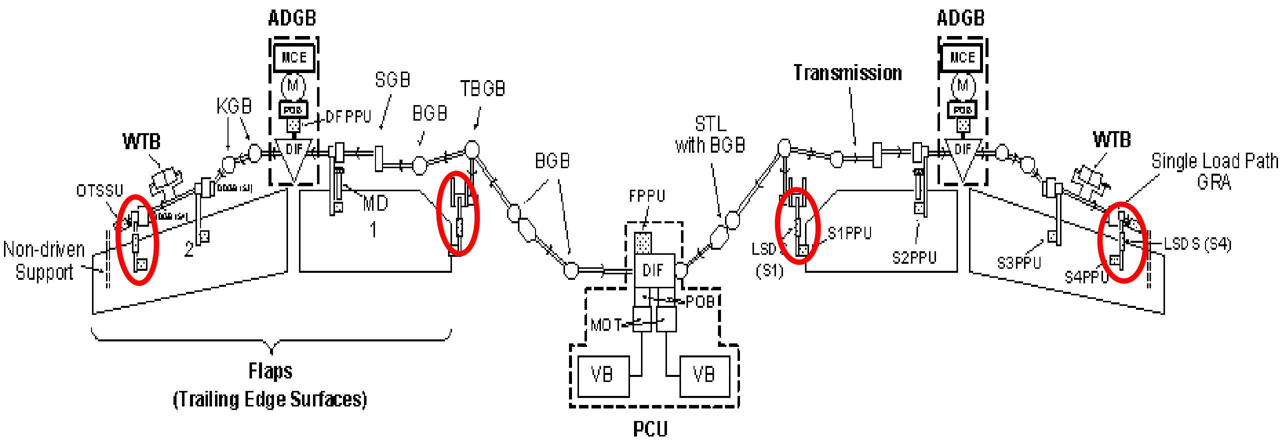
- 40 - 50 bar AT + 20°C
- 37 - 56 bar AT - 40°C to + 70°C
- 31 - 58 bar AT - 74°C to + 110°C

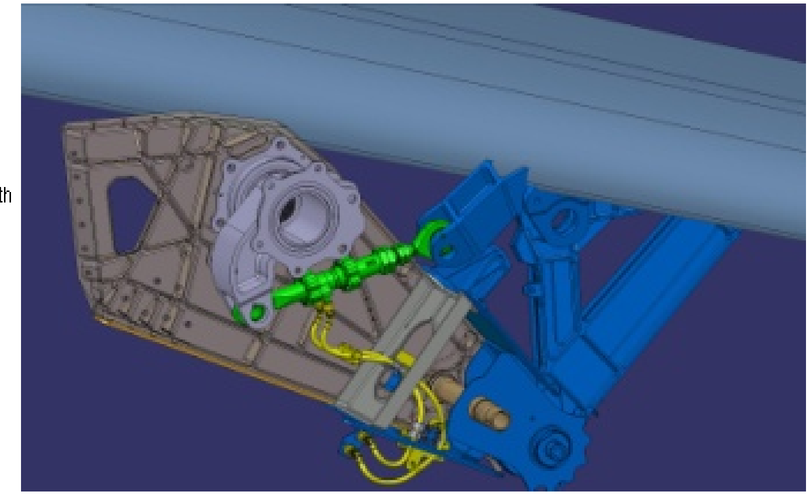

Do not open in operation,
Only for shop maintenance!
Springs
Burst Plug
LVDT
Spring Guide
Piston
Filling Valve

Load Sensing Drive Strut

The basic role of the Flap Load Sensing Drive Strut (LSDS) is to transfer the necessary loads from the rotary actuator to the flap panel to be subject to various load conditions and to arrest and hold the flap panel in any gated or intermediate position.

The LSDS will provide the SFCC with a load signal. For that the Load Cell measures the application of a force which is applied in the longitudinal axis of the sensor between areas A and B.



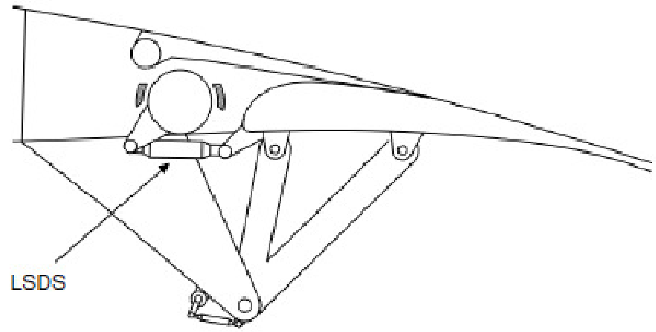


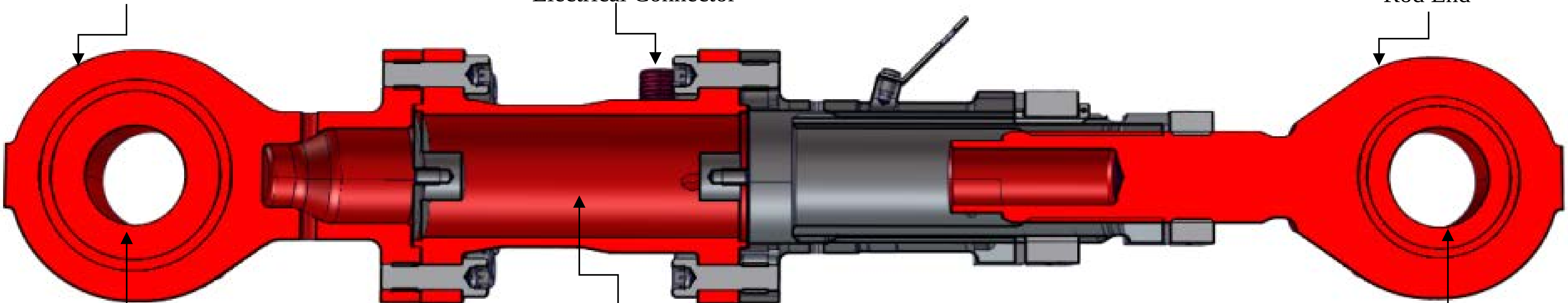
LSDS Track 1 (6341A0000)

LSDS Track 4 (6342A0000)

LOAD SENSING DRIVE STRUT

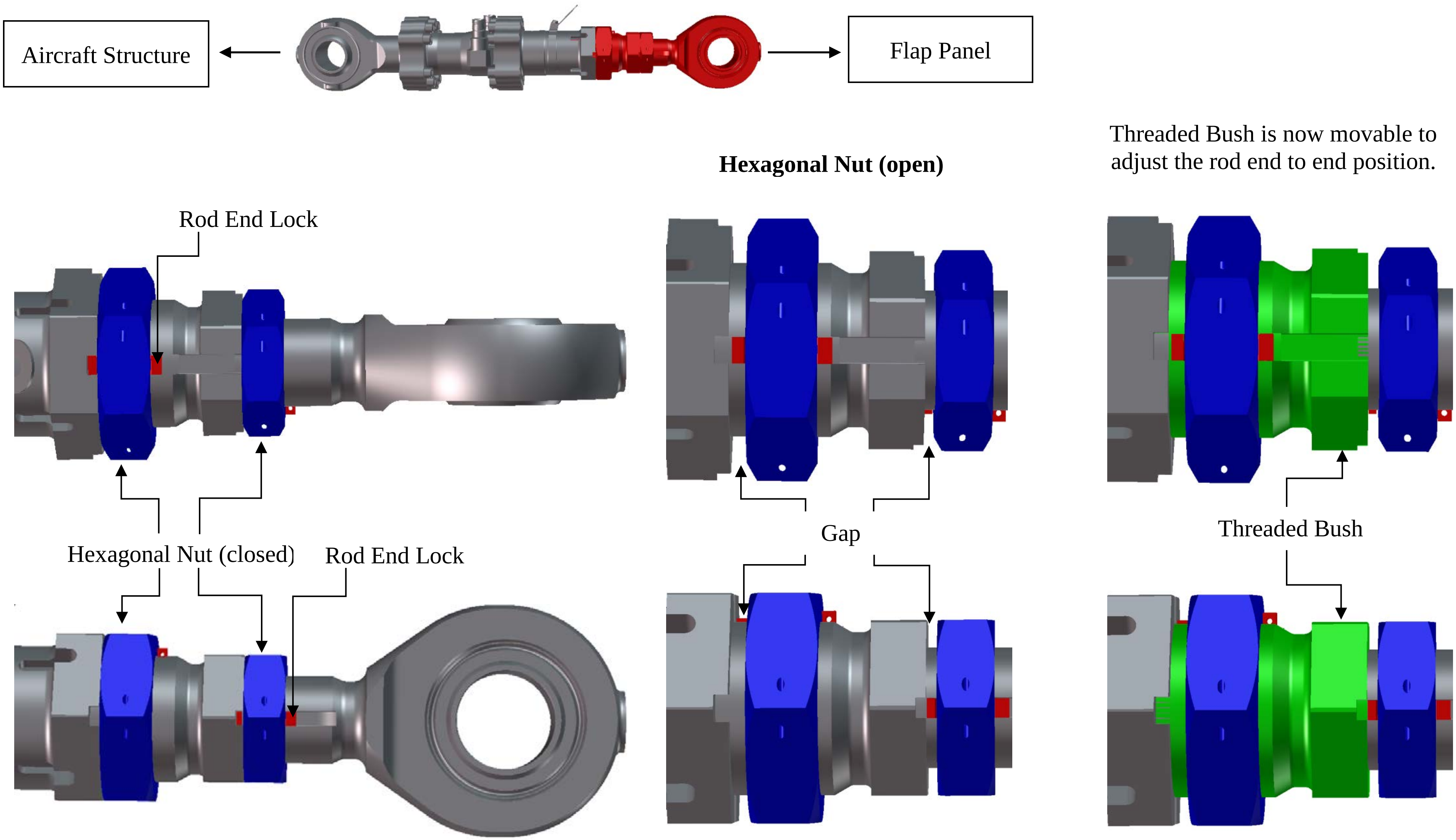
By design, the sensitive area expands or contracts at micro strain levels that are linear with the applied force. Four strain gauges are bonded on the sensitive area and expand or contract at the same strain levels as the mechanical sensitive part. The four strain gauges are incorporated into a Wheatstone bridge. By connecting the strain gauges in a Wheatstone bridge configuration and applying an excitation voltage to the bridge, the small changes in resistance of the strain gauges can be effectively summed and then read as a current output (in millivolt), the magnitude of which is also linear with the applied force.


LSDS


Rod End
Electrical Connector
Rod End
Spherical Bearing with Liner
Load Cell
Spherical Bearing with Liner

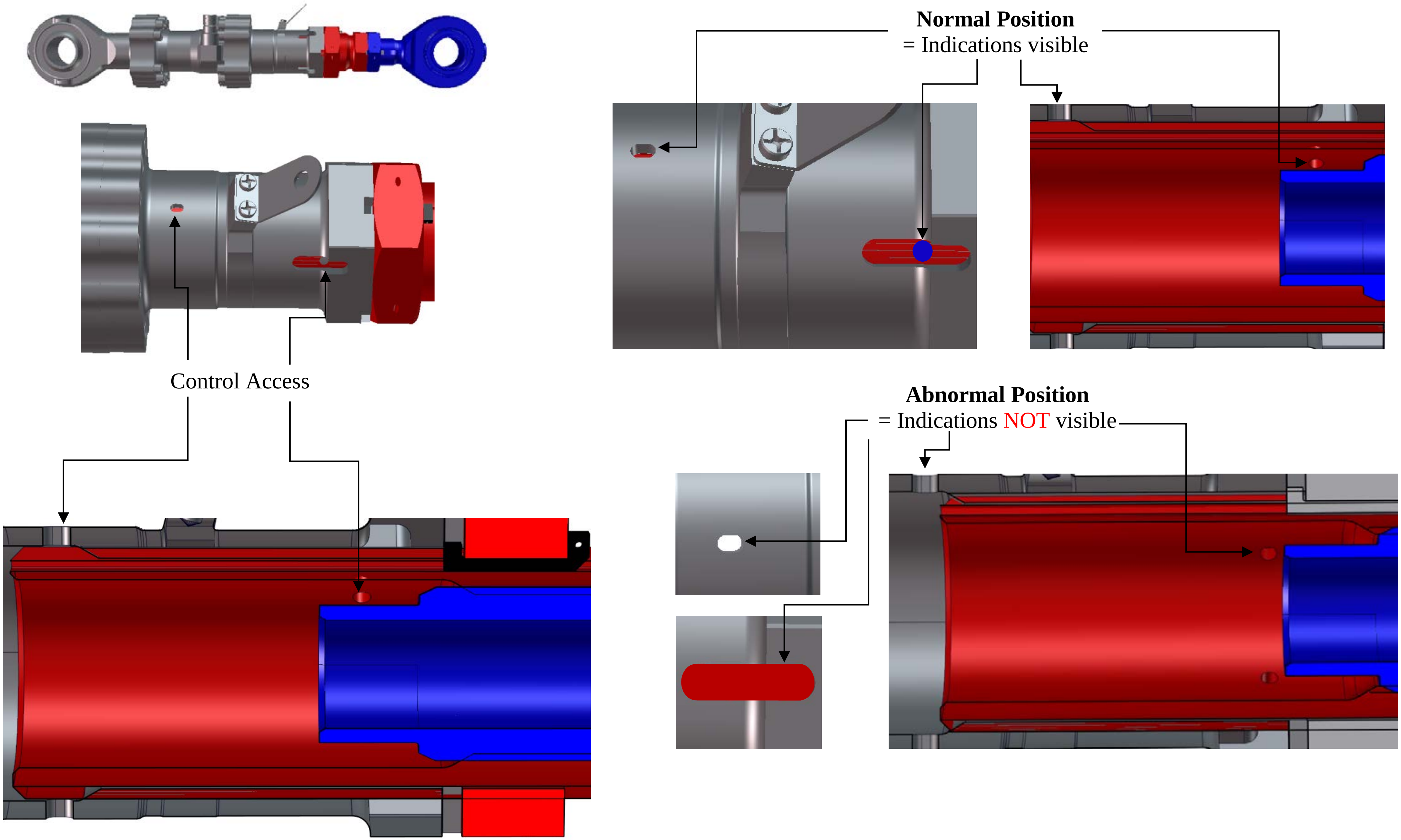
LSDS Adjustment in Aircraft

The LSDS is mechanical adjustable to flap panel side in the aircraft assembled position.


Aircraft Structure
Flap Panel
Hexagonal Nut (open)
Threaded Bush is now movable to adjust the rod end to end position.
Rod End Lock
Gap
Threaded Bush
Hexagonal Nut (closed)
Rod End Lock

LSDS MAXIMUM ALLOWABLE ADJUSTMENT

The rod end has a maximum allowable adjustment limitation to make sure, that a minimum overlapping is achieved.


Normal Position
= Indications visible
Control Access
Abnormal Position
= Indications NOT visible

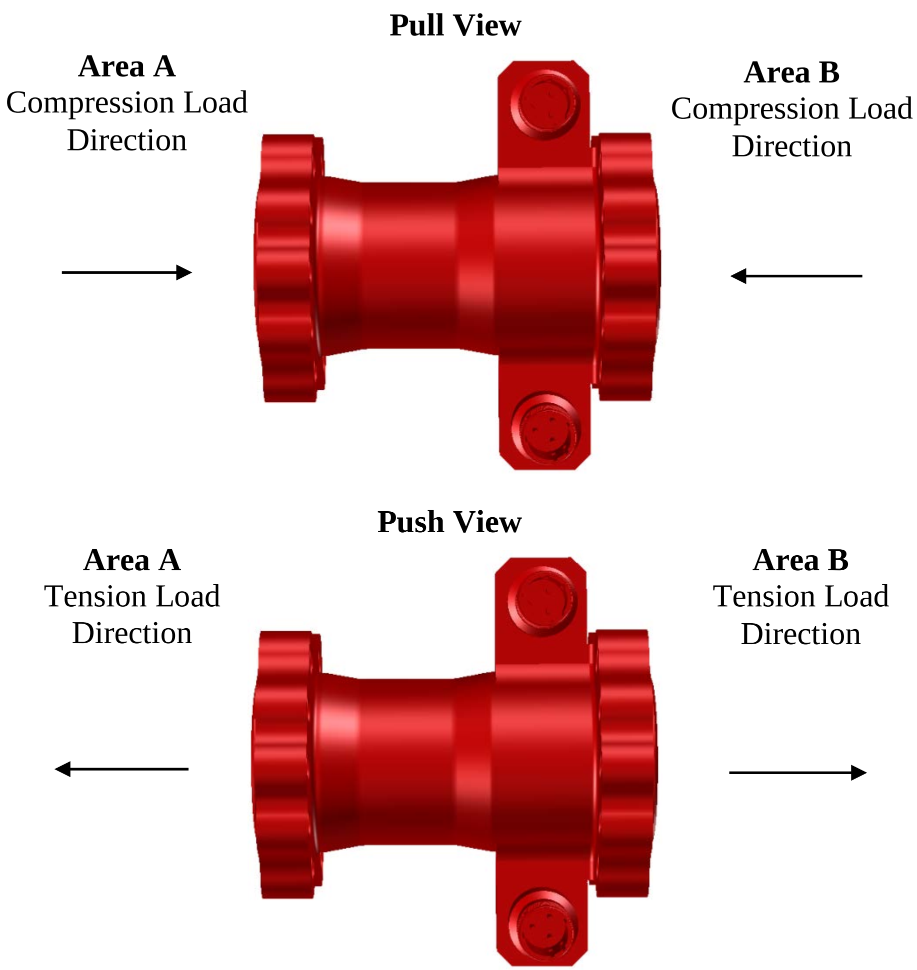
LSDS LOAD CELL

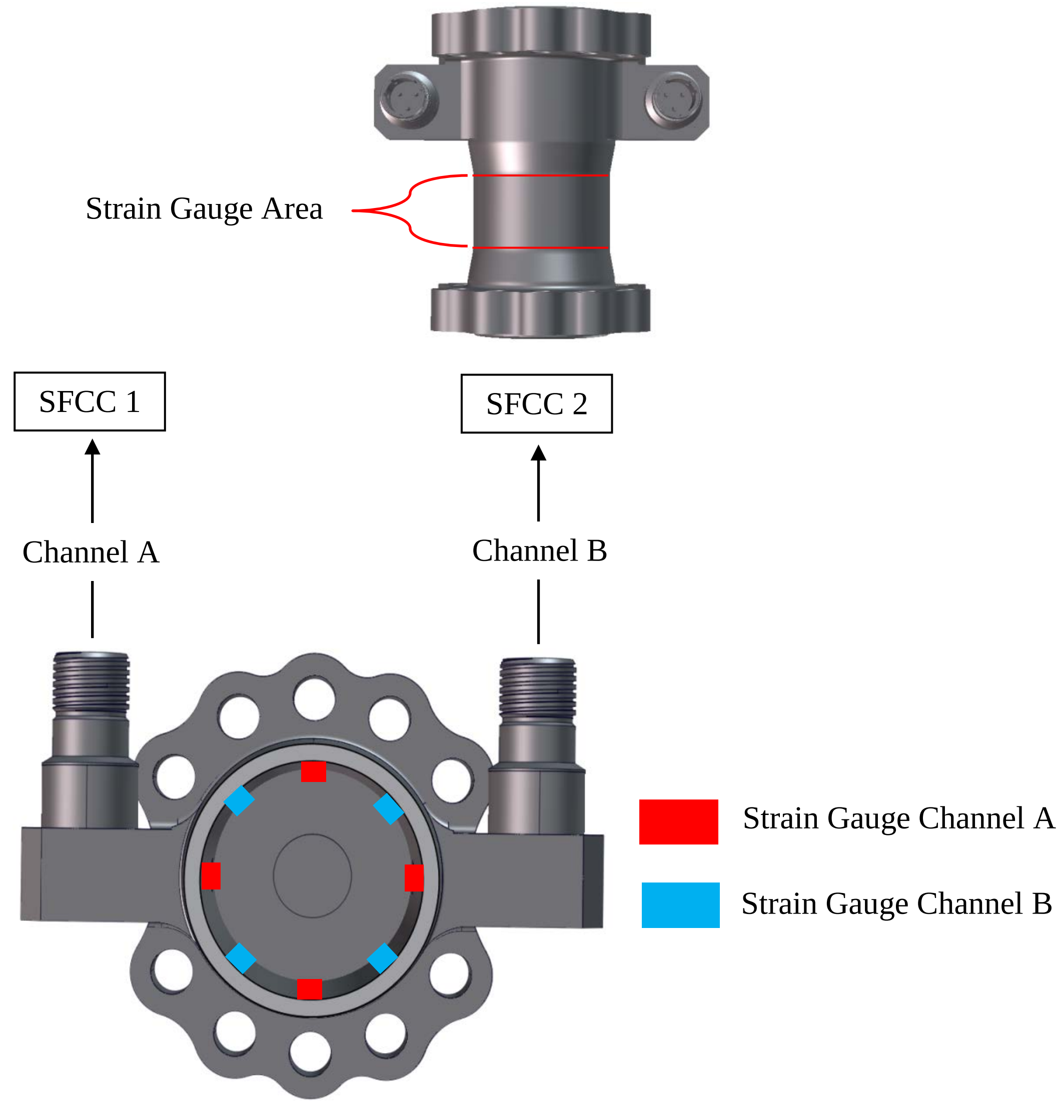
The LSDS will provide the SFCC with a load signal. For that the Load Cell measures the application of a force which is applied in the longitudinal axis of the sensor between areas A and B.

<u>Measuring Range of Load Cell:</u>

Tension Loads max. = -30kN

Compression Loads max. = +90kN


Pull View
Area A
Compression Load
Direction
Area B
Compression Load
Direction
Push View
Area A
Tension Load
Direction
Area B
Tension Load
Direction


Strain Gauge Area
SFCC 1
SFCC 2
Channel A
Channel B
Strain Gauge Channel A
Strain Gauge Channel B

ACTIVE DIFFERENTIAL GEARBOX

The Active Differential Gearbox (ADGB) is a mechanical gear system which includs one Electric Motor (EM), one Electrical Power-Off Brake (EPOB), Differential Gear (DIF), Reduction gear for DFPPU (RG), Gearbox Housing and Cover. The inboard and outboard panel can be driven synchronously or independently (Differential Flap Setting during Cruise Flight Operation). Active High-lift operation and lateral compensation.

Following modes are available on the ADGB:

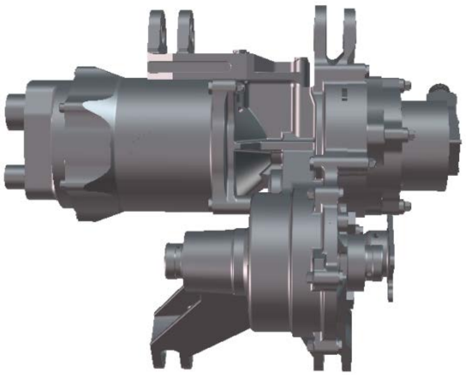
- Synchronous Flap Operation and Variable Camber
- Differntial Flap setting in Cruise Passive Flight

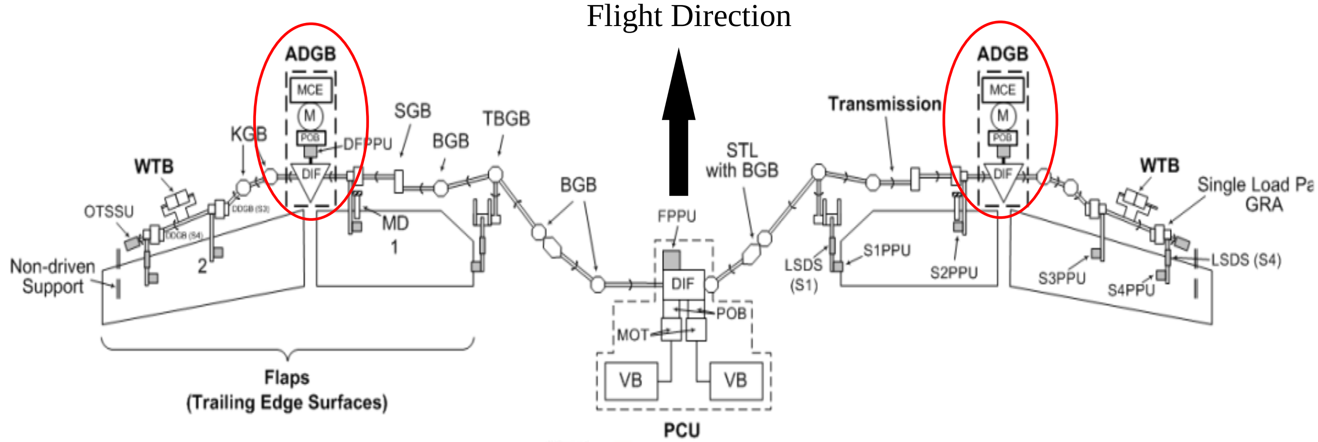
  (passive flap setting)
- Differential Flap setting in Cruise Active Flight and Lateral Trim

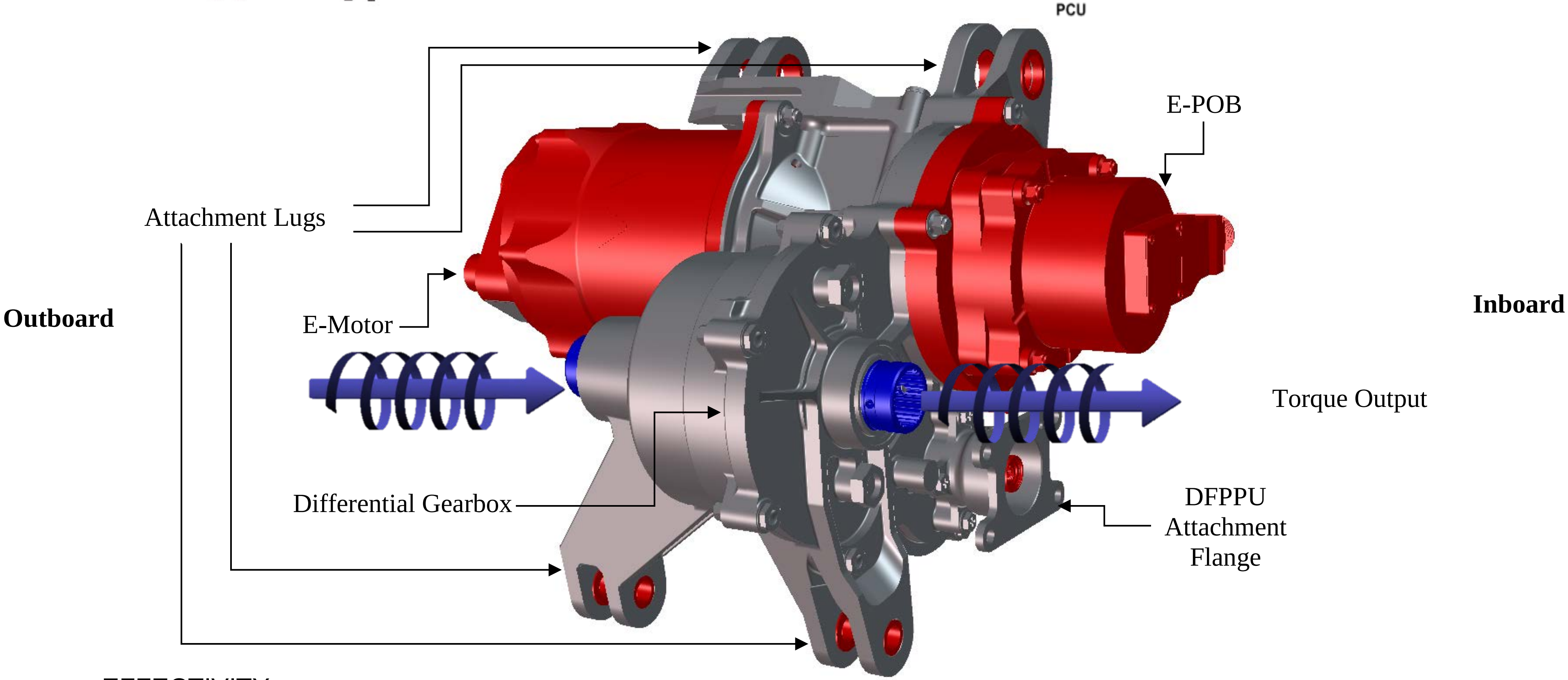
  (active flap setting)

ADGB comprises the following:

- Electric Motor (EM)
- Electrical Power-Off Brake (EPOB)
- Differential Gear (DIF)
- Reduction Gear for DFPPU (RG)
- Gearbox Housing and Cover
- Motor Control Electronic (MCE)
- Harness between MCE and ADGB

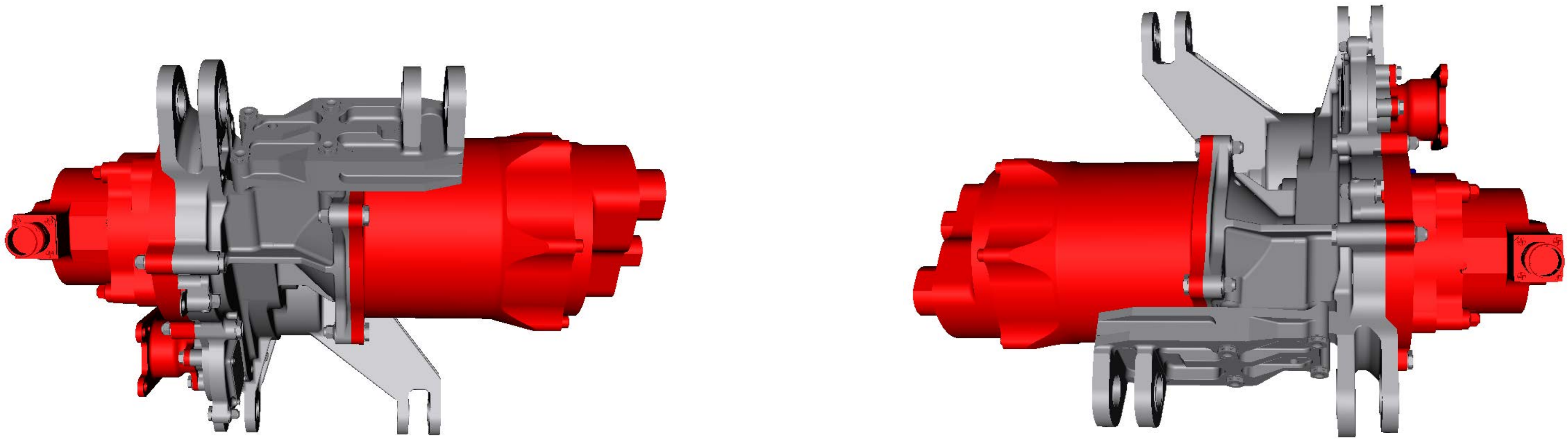



Flight Direction
ADGB
MCE
M
POB
DIF
DFPPU
KGB
SGB
TBGB
BGB
WTB
OTSSU
MD
1
2
Non-driven Support
Flaps
(Trailing Edge Surfaces)
STL
with BGB
FPPU
MOT
POB
VB
VB
PCU
Transmission
LSDS
(S1)
S1PPU
S2PPU
S3PPU
S4PPU
LSDS (S4)
GRA


Attachment Lugs
E-POB
E-Motor
Outboard
Inboard
Torque Output
Differential Gearbox
DFPPU
Attachment
Flange

INSTALLATION POSITION OF THE ADGB

The ADGB is interchangeable between LH and RH wing.



ADGB Technology

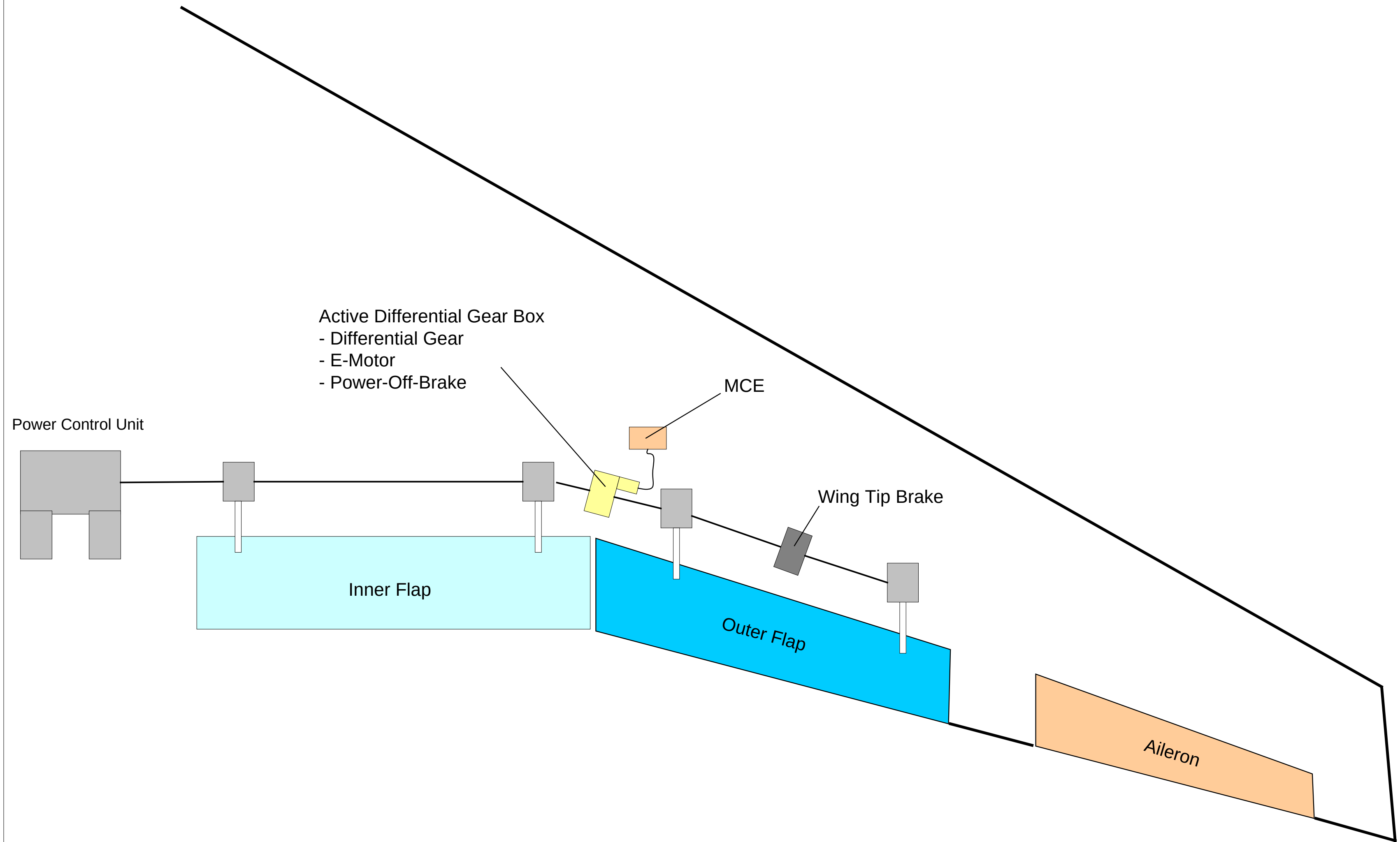
Normal High Lift operation
(Through drive mode)

Inner Flap Movement:

- ADGB POB commanded open
- E-Motor idle, not commanded
- PCU moves inner flaps +3º / -1,5º
- WTB arrests outer flaps

Outer Flap Movement:

- ADGB POB commanded open
- E-Motor commanded
- ADGB moves outer flaps +1º / -1,5º
- PCU (with POBs) arrests inner flaps


Active Differential Gear Box
- Differential Gear
- E-Motor
- Power-Off-Brake
MCE
Power Control Unit
Wing Tip Brake
Inner Flap
Outer Flap
Aileron

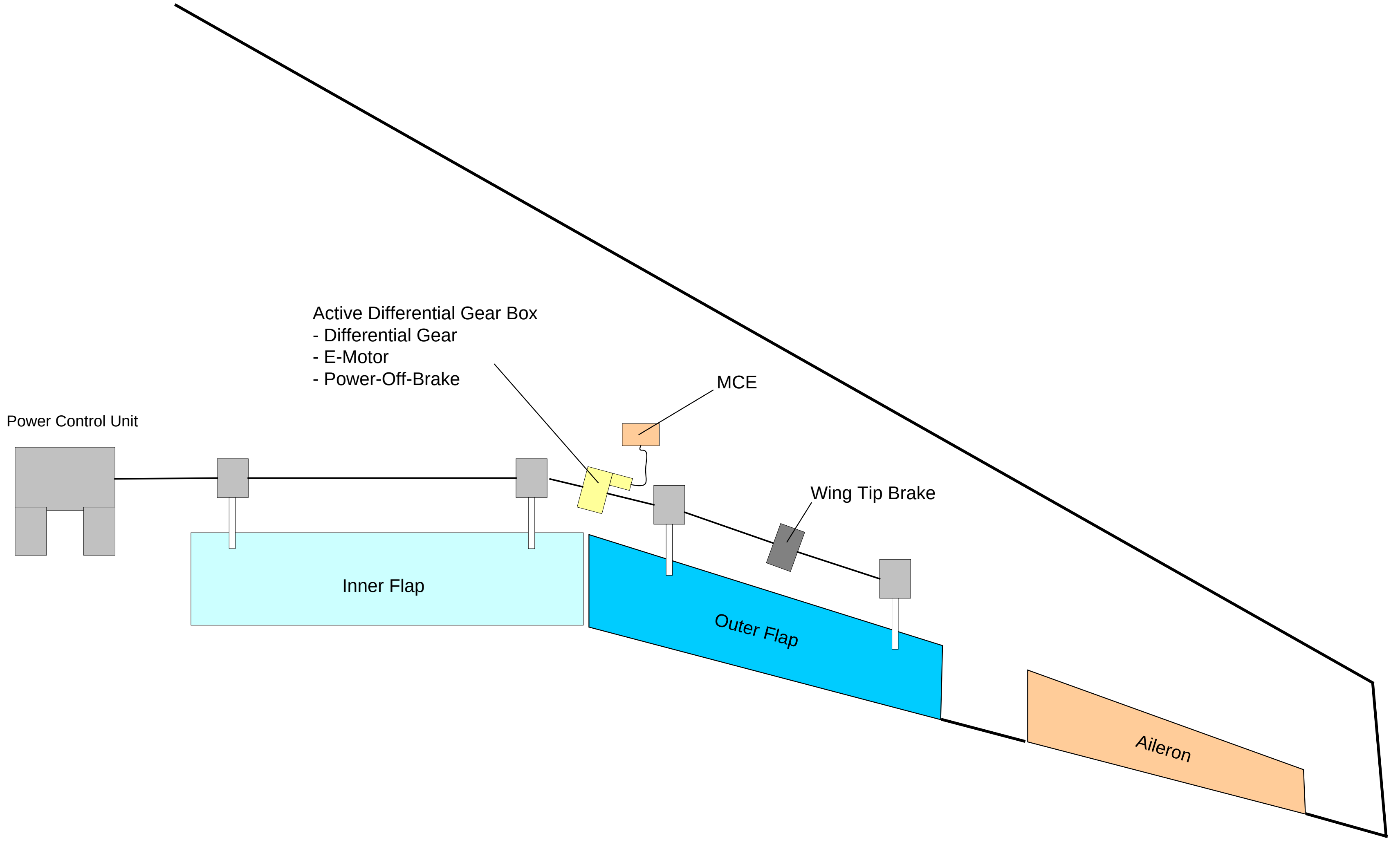
ADGB Extended Functions

Normal High Lift Operation:

- ADGB POB is arrested
- ADGB E-Motor is not commanded
- Differential gear acts as “clutch”

Emergency High Lift Operation:

- After loss of two hydraulic systems
- ADGB moves outer flaps in landing position (45º) within 100 sec
- Emergency high lift performance increased compared to other Airbus Aircrafts
- Slats (via E-Motor on PCU) and half Flaps available for emergency case


Active Differential Gear Box
- Differential Gear
- E-Motor
- Power-Off-Brake
MCE
Power Control Unit
Wing Tip Brake
Inner Flap
Outer Flap
Aileron

ADGB Electrical Power-Off Brake

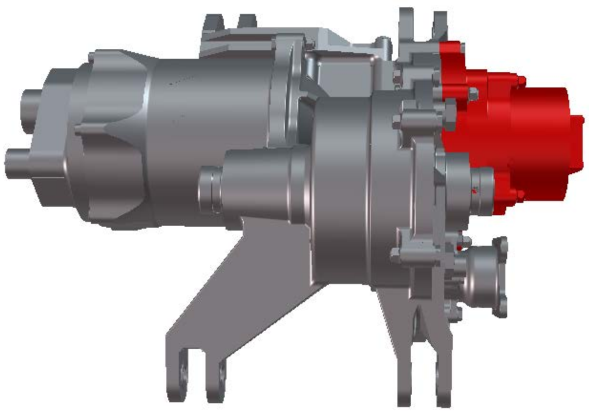
The ADGB is equipped with one Electrical Power-Off Brake (EPOB) which is capable to arrest and hold the EM during normal operation and failure cases. The EPOB consists of a duplex solenoid and spring loaded friction disks which engage automatically if the power supply fails.

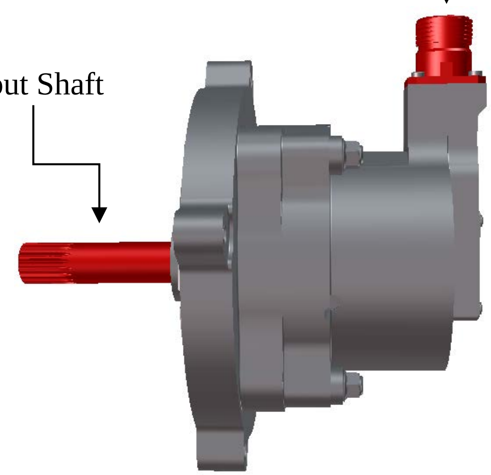
The two coils of the solenoid are independently controlled by the MCE in such way that each of the coils is capable to release the brake.

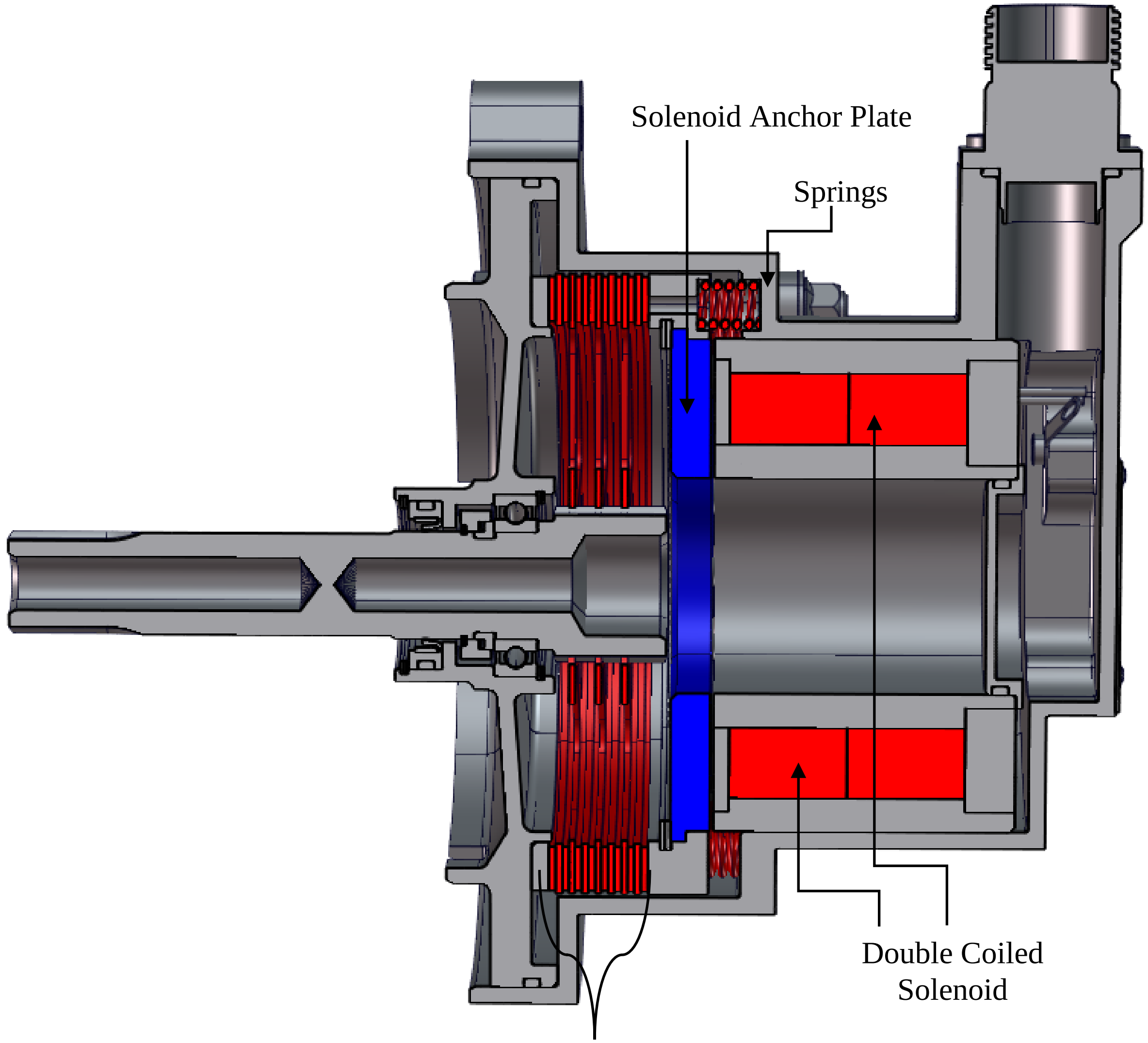
If E-motor is powered, then one coil is electrical powered.

For all passive modes, both coils are electrical powered.

The EPOB is not a safety device as is the WTB of the transmission system.

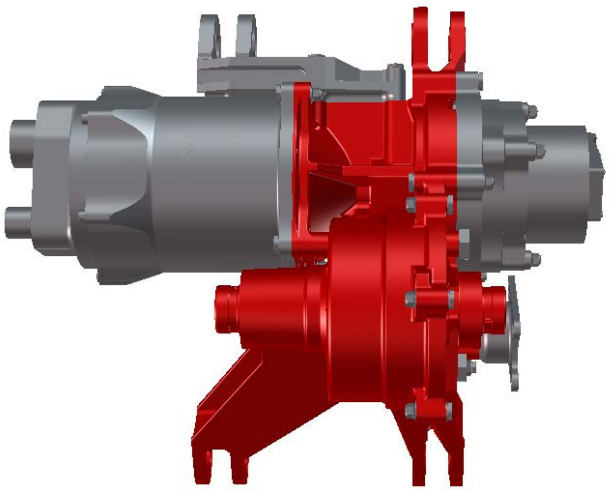



Electrical Connector
Input Shaft

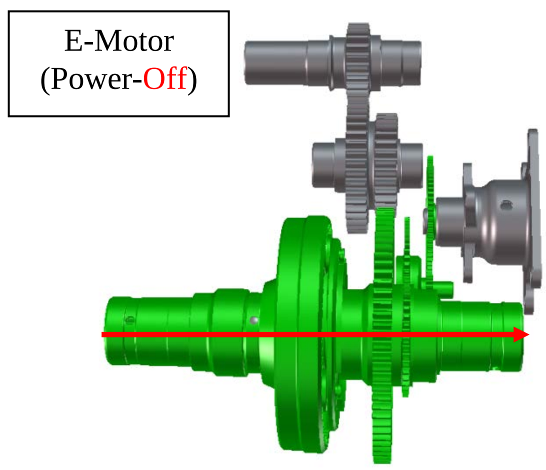

Solenoid Anchor Plate
Springs
Double Coiled Solenoid
Disc Brake Package

ADGB Differential Gear (DIF)

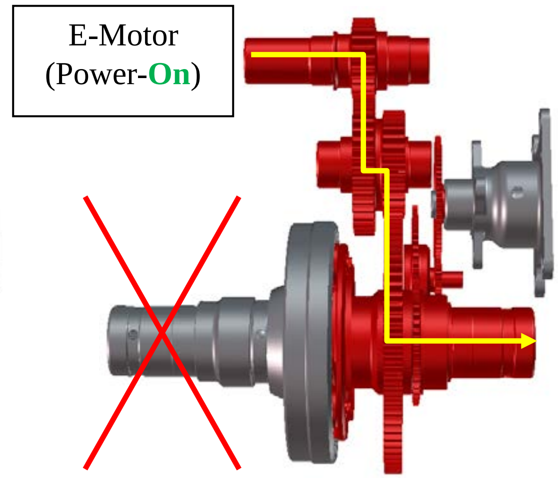
The DIF consists of a planetary gear set which enables different modes of operation. The inboard and outboard panel can be driven synchronously or independently. In the first case inboard and outboard panels are driven by the PCU whereas the ADGB provides speed transformation between ADGB input and output. In the latter case the inboard panels are arrested by the PCU EPOB and the outboard panels are driven by the ADGB. Furthermore, if the outboard panels are arrested by the WTB, it is possible to drive the inboard flaps with the PCU while the EPOB of the ADGB is released (E-motor is operated in idle).



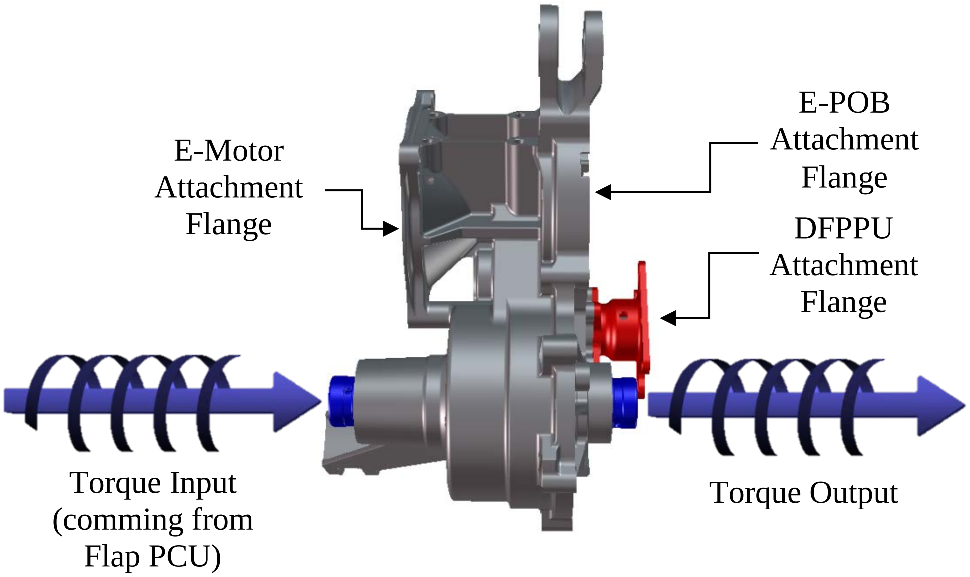
High Lift Mode

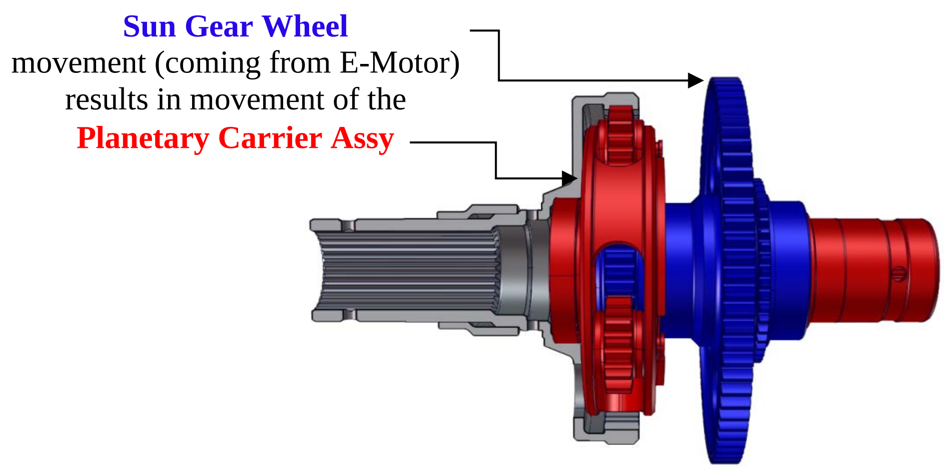


Active Mode



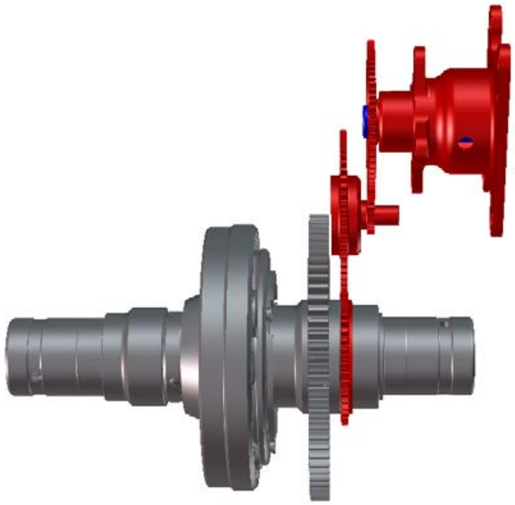
Planetary Gear is activated just in the Alternate High Lift Operation Mode

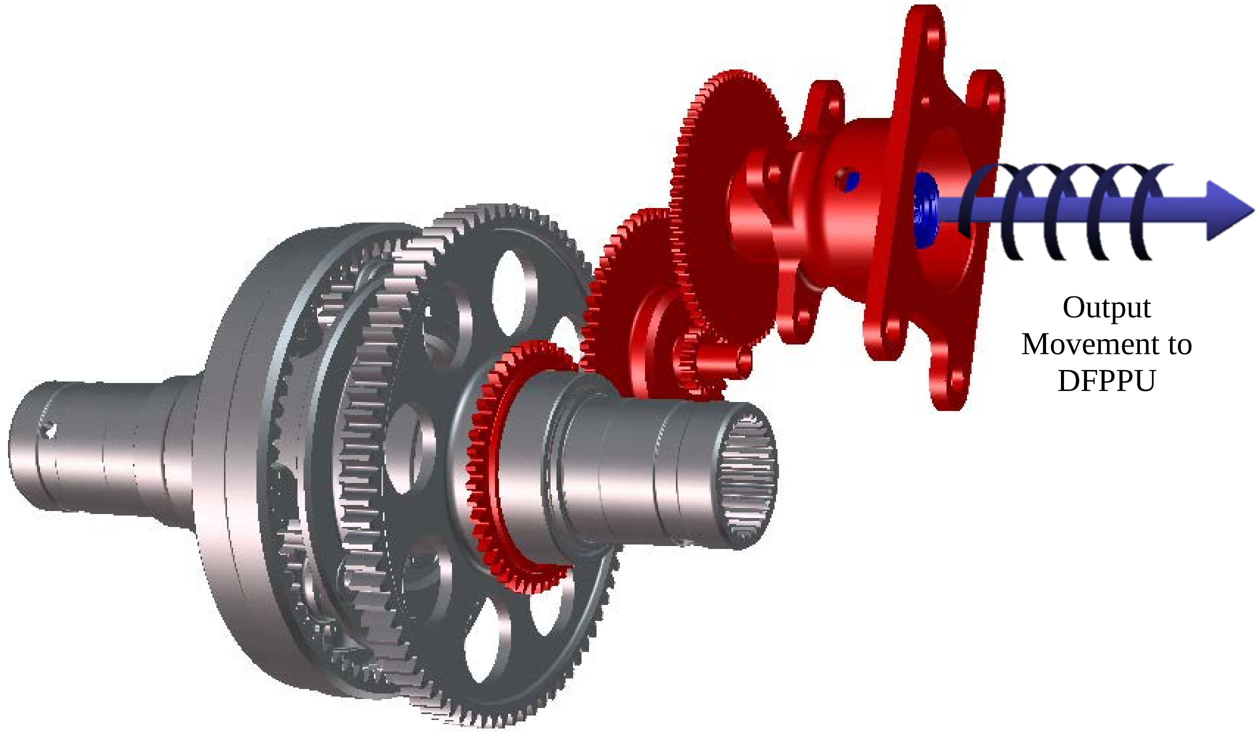


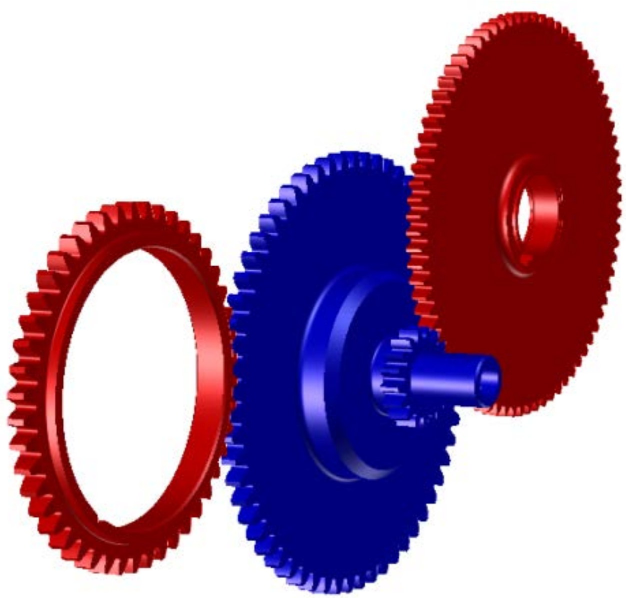


ADGB Reduction gear for DFPPU (RG)

The RG reduces the number of revolutions of the sun gearwheel of the ADGB to an appropriate value for the DFPPU (DFPPU is not a Liebherr part).





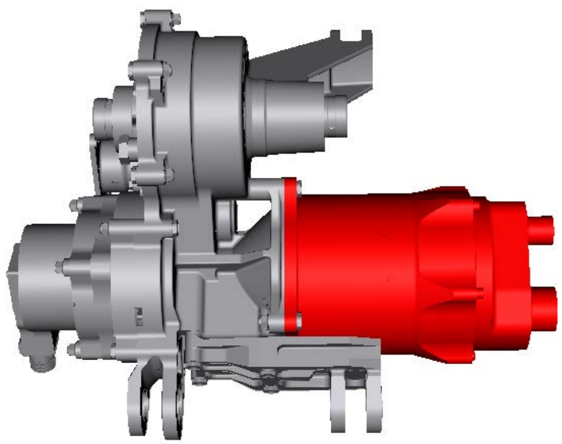


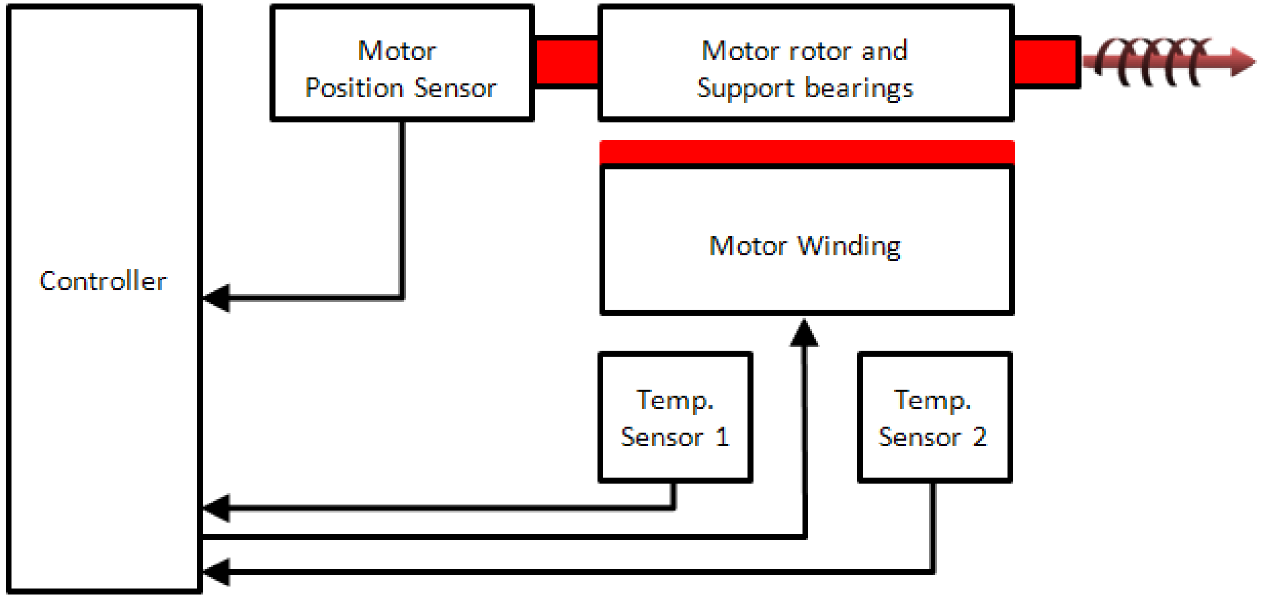
Number of teeth

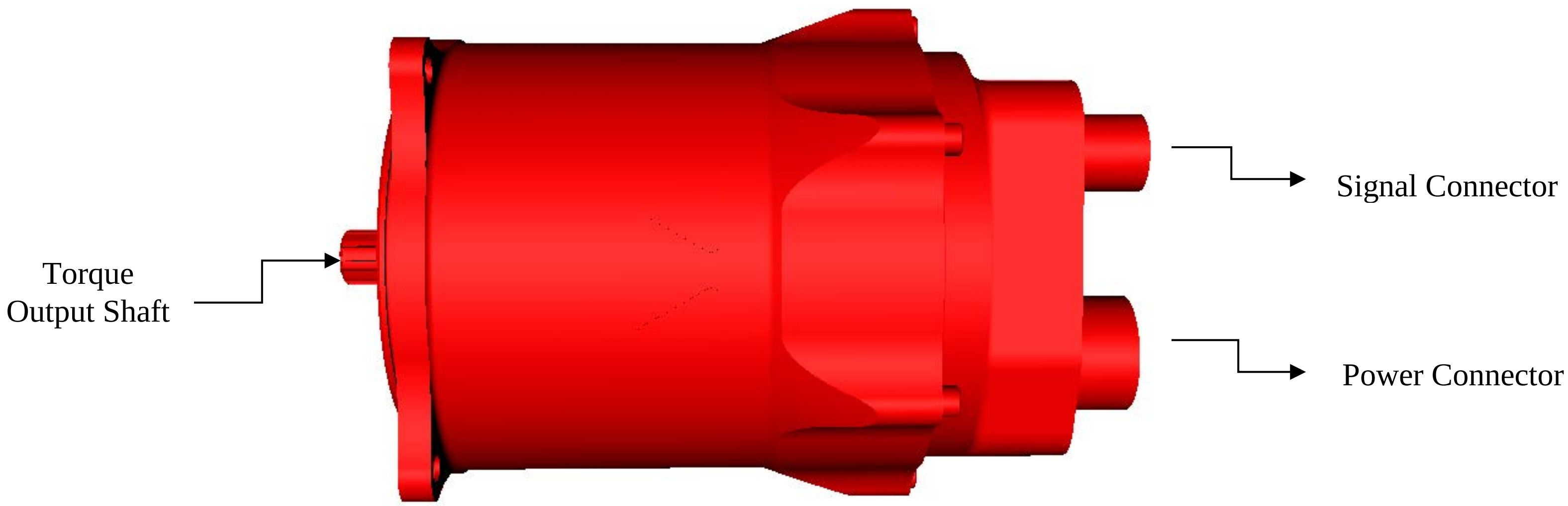
46 → 60 → 17 → 78 = **Gear Ratio**
5, 98 : 1

ADGB Electric Motor (EM)

The motor is a three phase brushless DC motor with high efficiency rare earth magnets on the rotor. The assembly of the magnets on the rotor is secured with an external ring in order to reduce the risk of jamming due to deteriorated magnets or small parts of magnet that would brake during over the time due to an undetected initial shock during assembly. A resolver, fitted on the motor shaft, provides position feedback to the communication system. The motor winding insulation is capable of withstanding up to 180°C winding temperature without deterioration. Two temperature sensors are attached to the stator windings to control motor temperature in order to avoid overheating.




Controller
Motor Position Sensor
Motor rotor and Support bearings
Motor Winding
Temp. Sensor 1
Temp. Sensor 2


Torque Output Shaft
Signal Connector
Power Connector

ADGB OPERATION

Normal Operation:

The wording “normal operation” comprises generally the following:

- Operation of the flap O/B panel by the ADGB
- Full flap deflection (ADGB High Lift Operation)
- Limited flap deflection (ADGB in Cruise Active Mode)
- DFS Take-Off Operation
- ADGB in Cruise Passive Mode

Abnormal Operation:

The wording “abnormal operation” comprises generally the type of failures which will be caught by monitoring functions performed on the SFCC or MCE.

ADGB drives Outboard panel in full extend direction

- The ADGB drives the Outboard panel in full extend direction while the EPOB of the FPCU is arrested. The inboard panel dosen’t move due to loss of power, therefore the EPOB of the FPCU is arrested.

Function after loss of the ADGB Motor Drive

In case of motor drive is not operational because of:

- Failure within the motor drive
- Loss of associated power supply

	POB of Flap PCU	ADGB EPOB	ADGB E-Motor	WTB
Synchronous Flap Operation, Variable Camber (PCU drives I/B and O/B panel, ref. 4.2.1.1)	open	closed	terminals open	open
ADGB in Cruise Passive Flight (PCU drives I/B panel Trim – nom. speed, idle speed, ref. 4.2.1.2)	open	open	terminals open	closed
ADGB in Cruise Active Flight, Lateral Trim (ADGB drives O/B panel Trim / Full Flap Deflection, ref. 4.2.1.3)	closed	open	terminals closed	open

MOTOR CONTROL ELECTRONIC (ADGB)

The main tasks of the ADGB Motor Control Electronic (MCE) are the following:

- To control the e-motor of the ADGB actuation system
- To control the electrical power off brake (EPOB)
- To control the standby EPOB (SEPOB) independently from the EPOB

The MCE consists of 6 functional modules:

1.) Power Supply Unit (PSU)

- The PSU module generates the internal voltages and supplies the other modules with power.

2.) Power Control Electronic (PCE)

- The PCE controls the e-motor depending on the input of Control Unit (CU) and the external command of SFCC II. Furthermoe it responds the internal status respectively internal signals.

3.) Control Unit (CU)

- The CU is the control center of the MCE. It provides the control laws and the monitoring function of the MCE. It also performs the communication with the SFCC and external devices through serial data links.

4.) Electrical Power-Off Brake (EPOB)

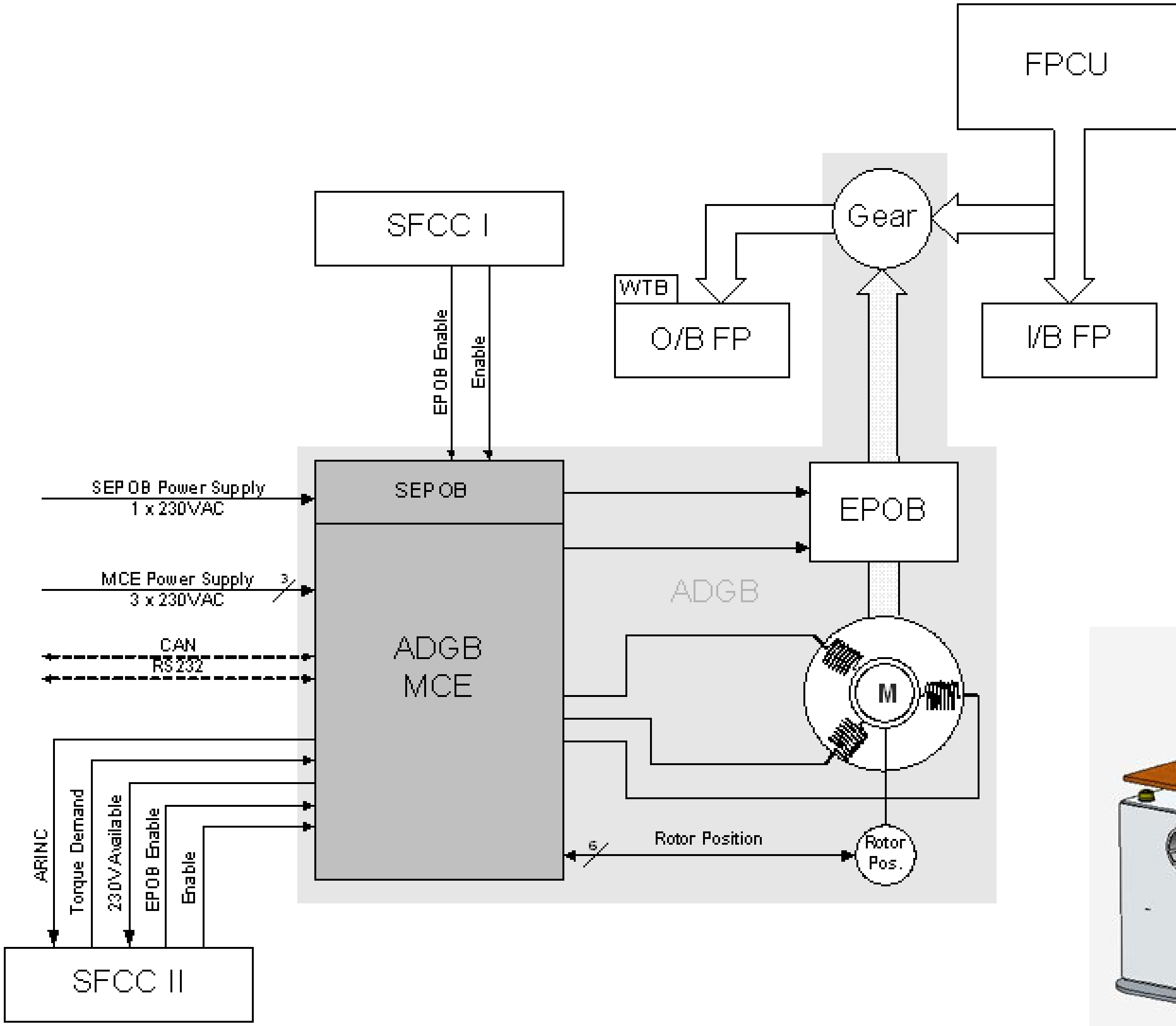
- laws and the monitoring function of the MCE. It also performs the communication with the SFCC and external devices through serial data links.

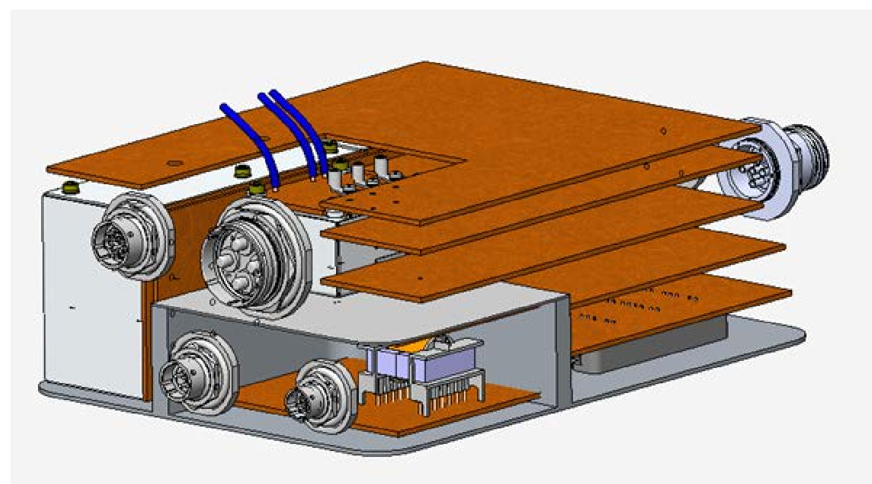
5.) Power Supply Unit for SEPOB (PSU SEPOB)

- The PSU SEPOB module generates the high voltage supply for the standby EPOB.

6.) Standby Electric Power-Off Brake (SEPOB)

- The SEPOB controls the standby power off brake depending on the input of SFCC I. Beyond it responds the internal status of the SEPOB.


FPCU
SFCC I
Gear
WTB
O/B FP
I/B FP
EPOB Enable
Enable
SEP OB Power Supply
1 x 230VAC
SEP OB
EPOB
MCE Power Supply
3 x 230VAC
3
ADGB
CAN
RS232
ADGB
MCE
M
ARINC
Torque Demand
230V Available
EPOB Enable
Enable
6
Rotor Position
Rotor
Pos.
SFCC II



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