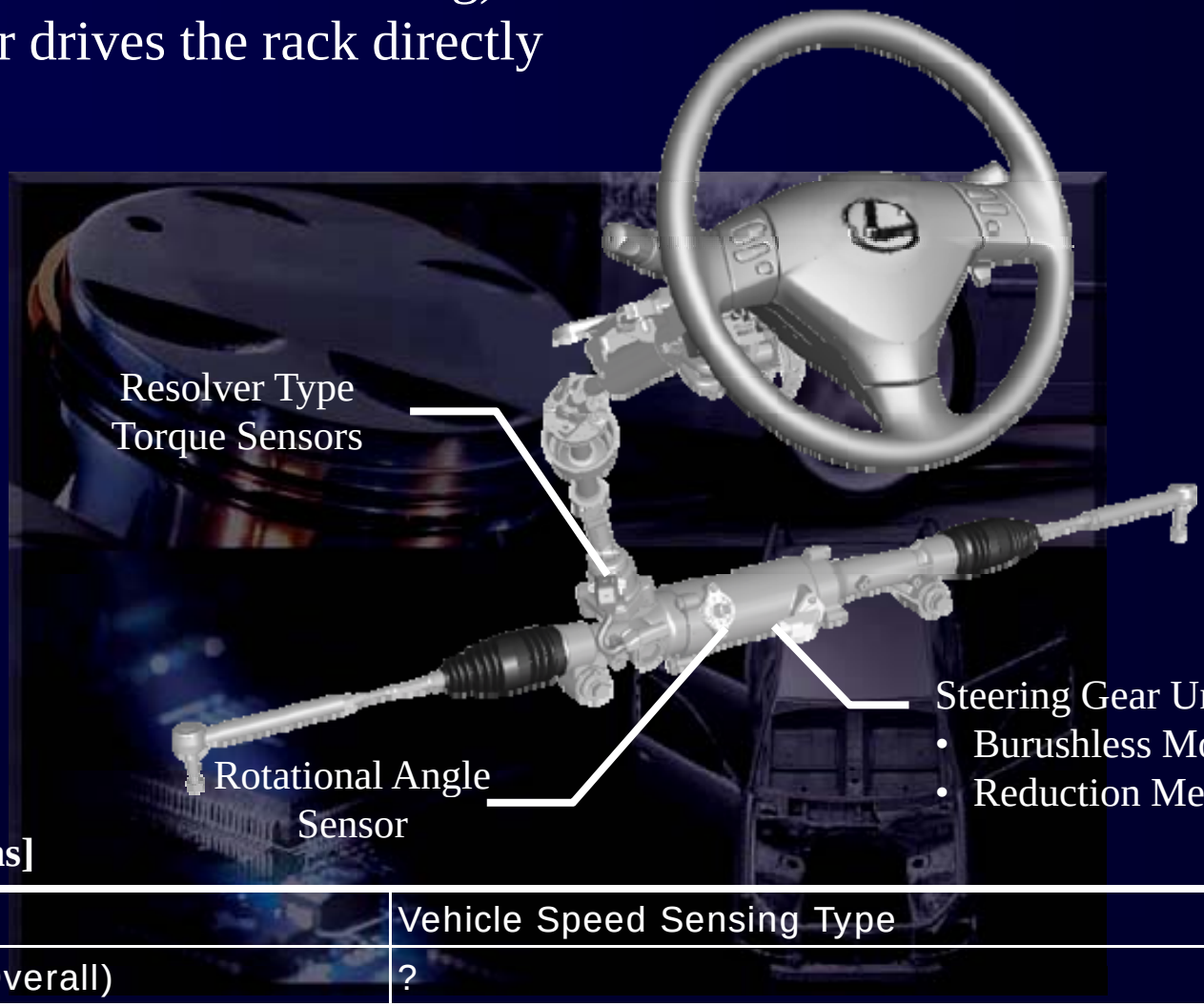
Steering

- EPS (Electric Power Steering)
  - Motor drives the rack directly

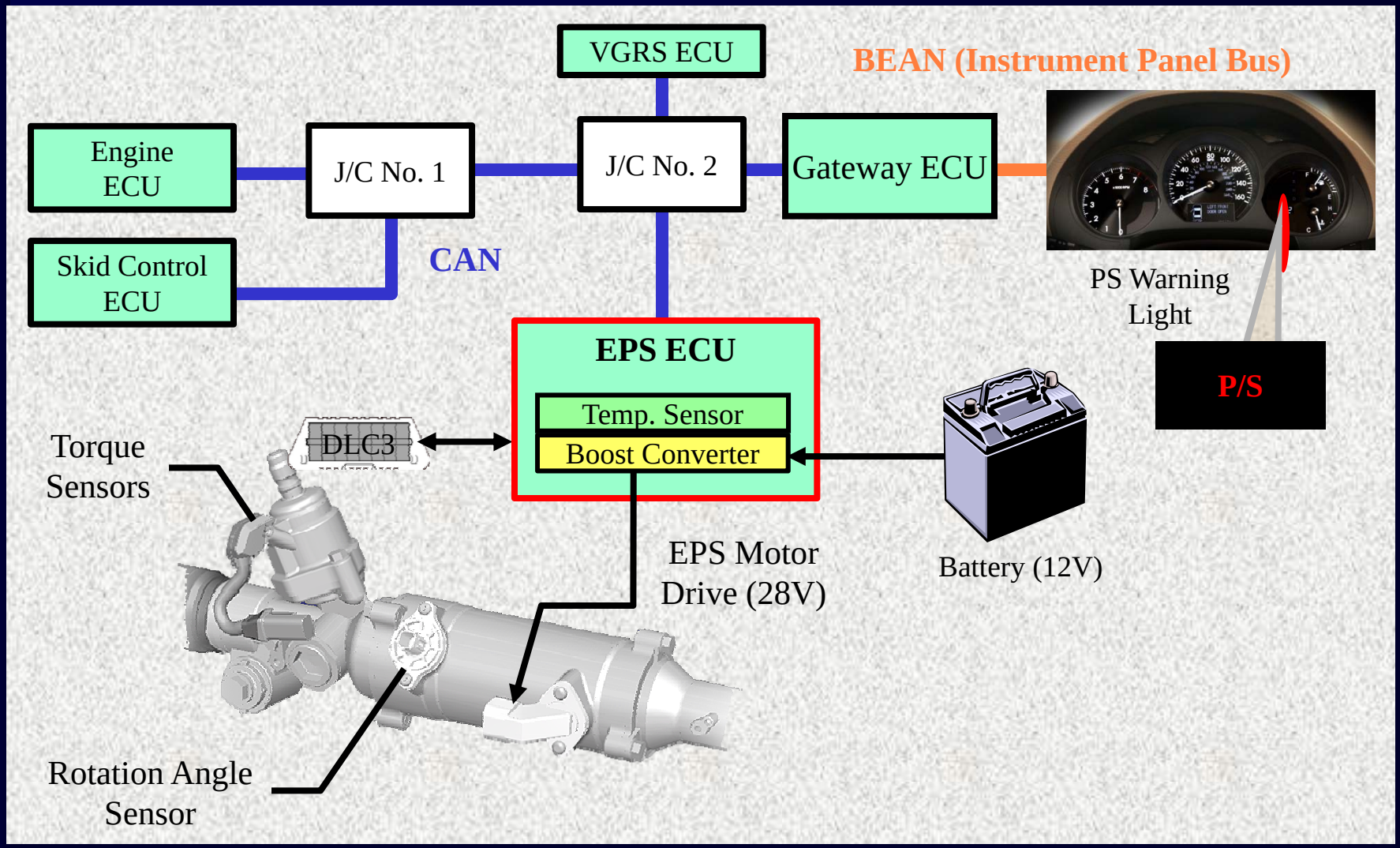


[Specifications]

Type	Vehicle Speed Sensing Type
Gear Ratio (Overall)	?
No. of Turns Lock to Lock	?
Rack Stroke [mm in.)]	?

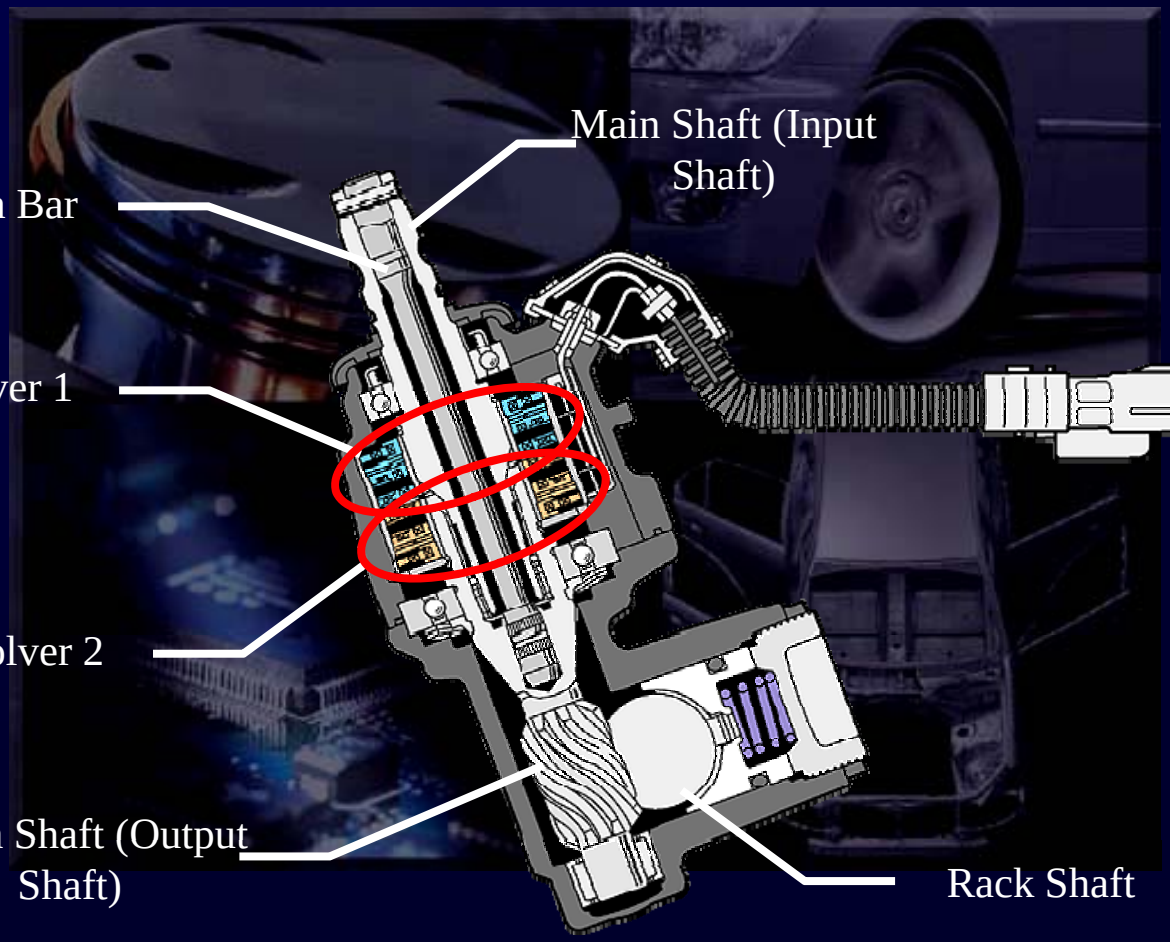
Steering

System Diagram



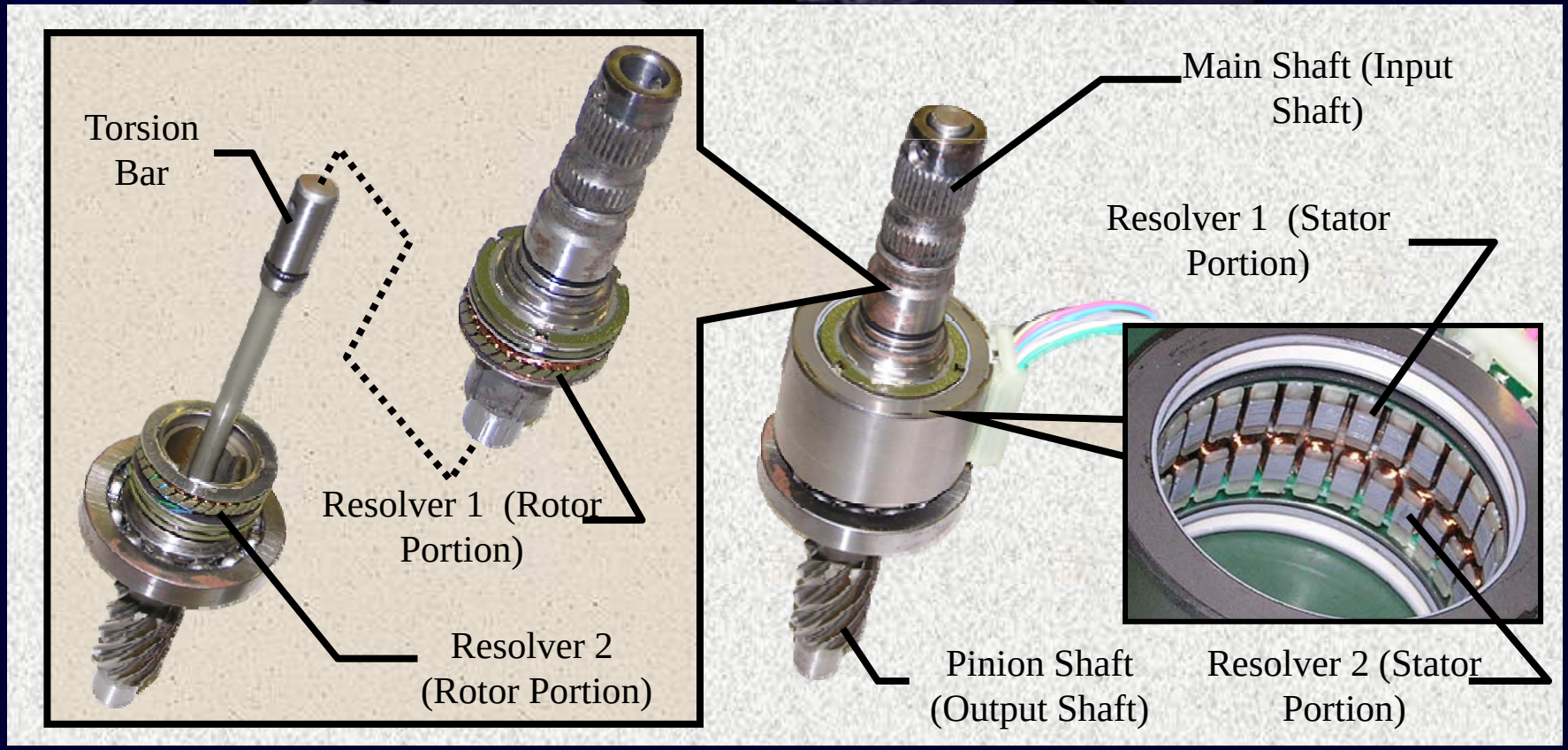
Steering

- Torque Sensor (Resolver Type)
  - Torque sensor detects the twist of torsion bar, changes it into the electric signal, and outputs it to EPS ECU



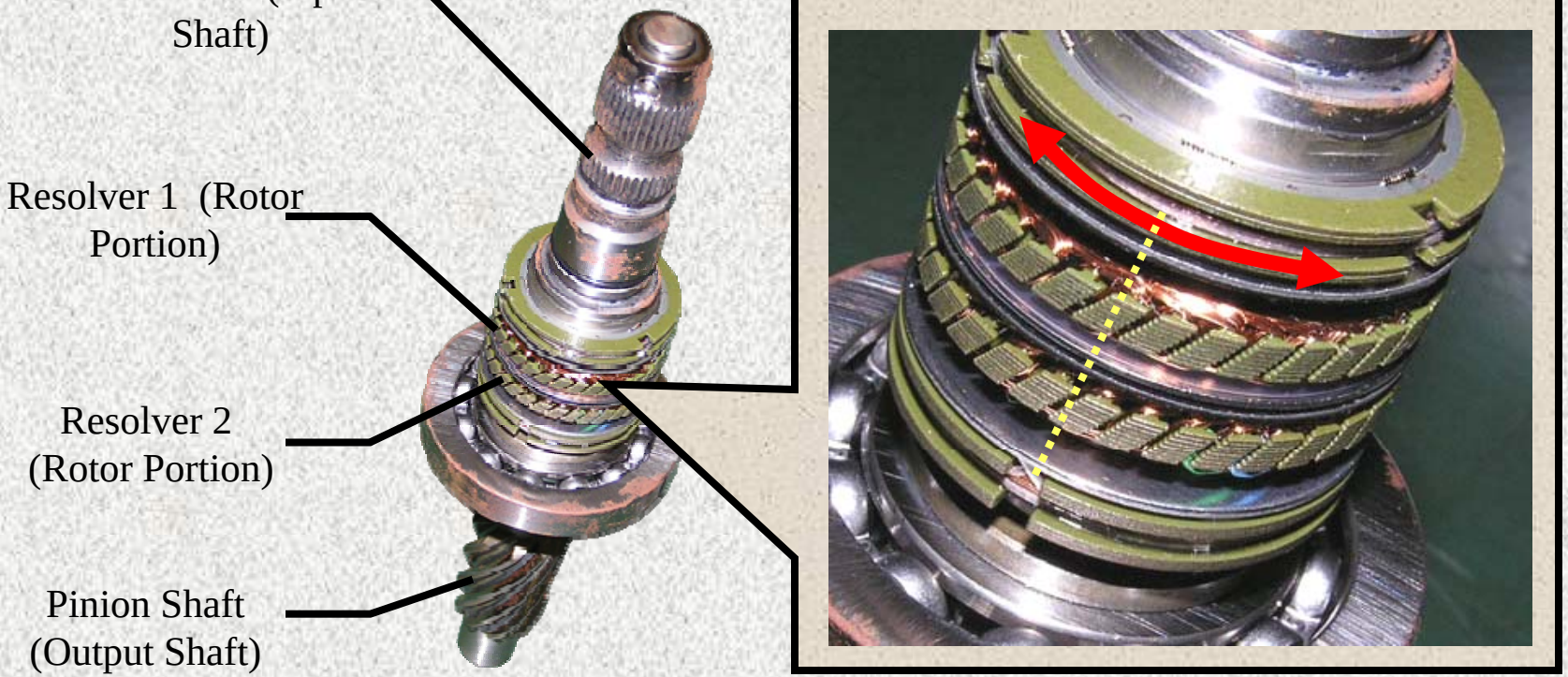
Steering

- Torque Sensor (Resolver Type)
  - Torque sensor consists of resolver 1, 2 and torsion bar
  - Resolver 1 of rotor portion is fixed to main shaft, resolver 2 of rotor portion is fixed to pinion shaft.



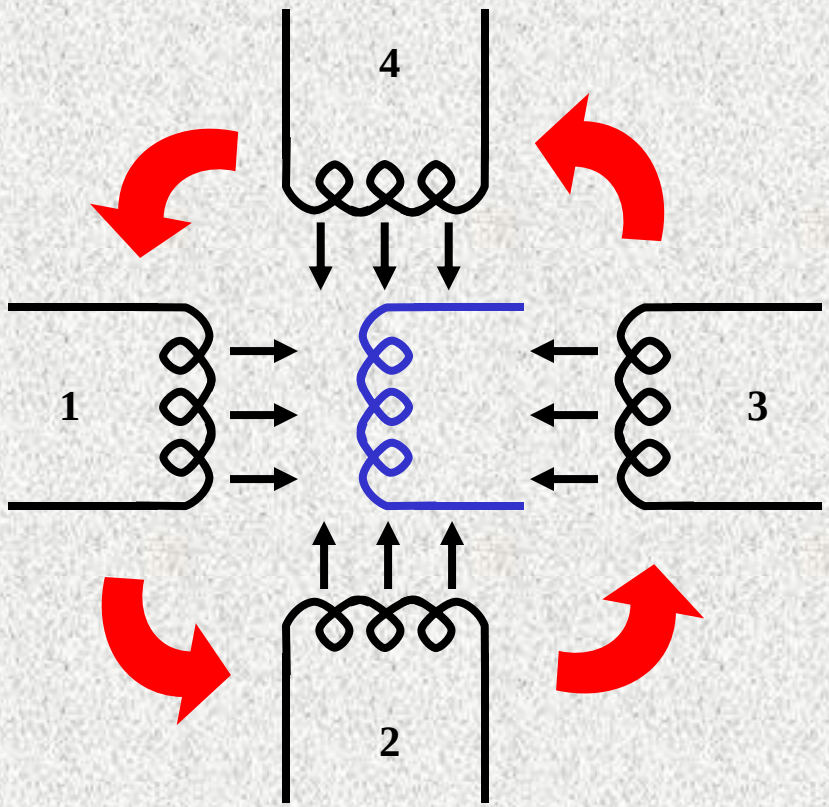
Steering

- Torque Sensor (Resolver Type)
  - Resolvers of rotor portion generate a relative angle difference of a twist of the torsion bar



Steering

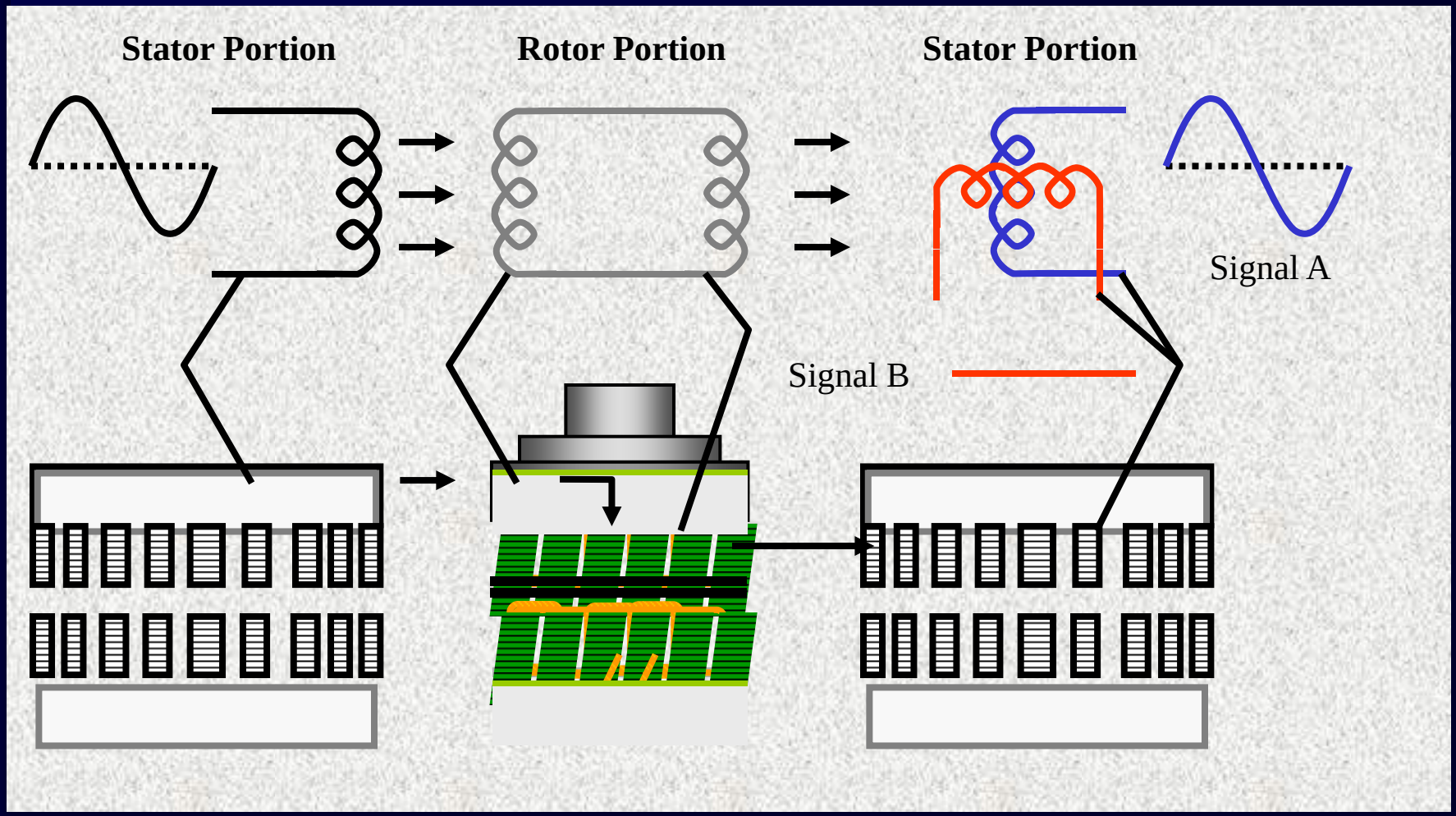
- Torque Sensor (Resolver Type)
  - Characteristic of resolver



	Exciting Coil	Detection Coil
1		
2		
3		
4		

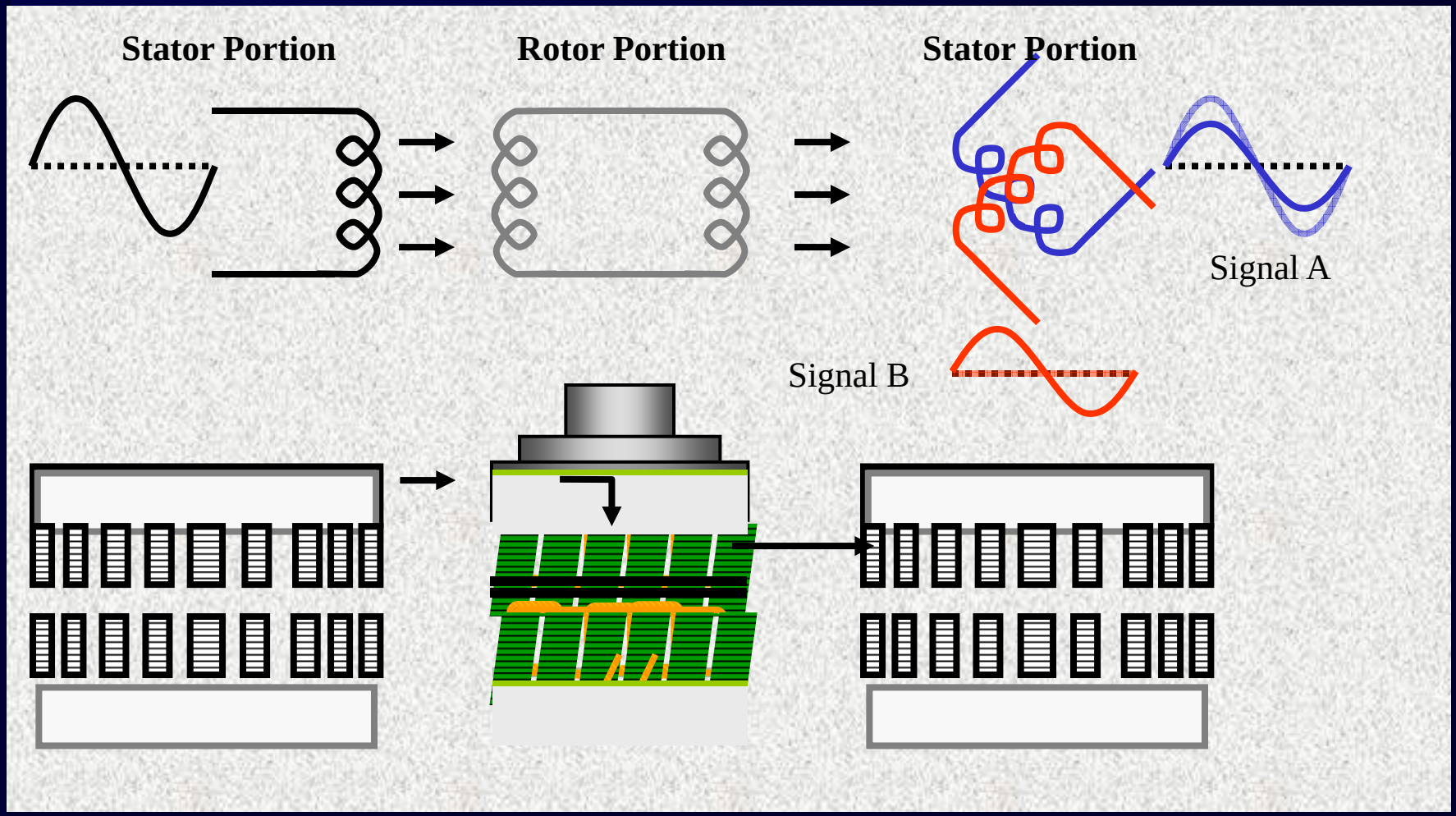
Steering

- Torque Sensor (Resolver Type)
  - Detection method of torque sensor



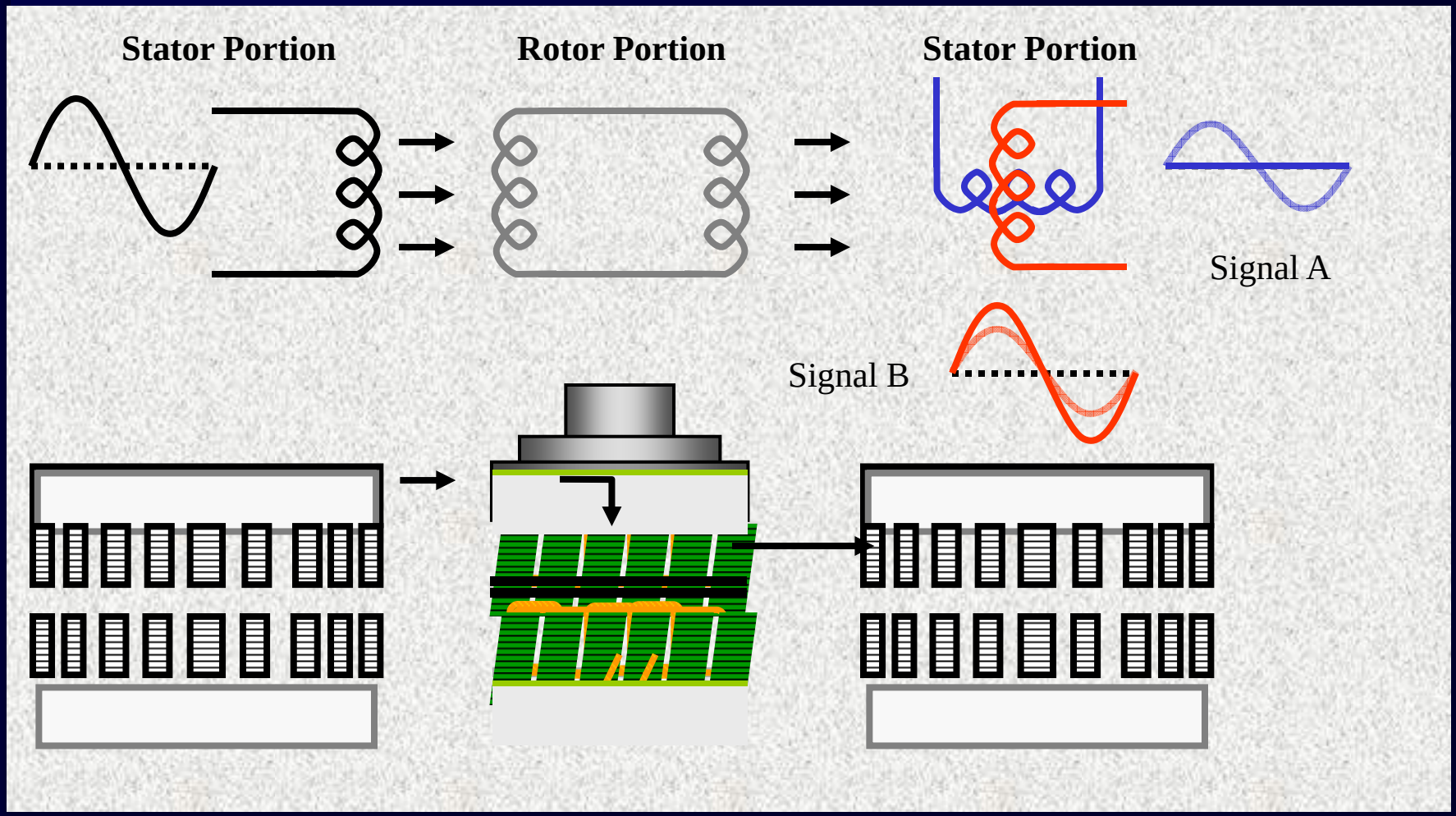
Steering

- Torque Sensor (Resolver Type)
  - Detection method of torque sensor



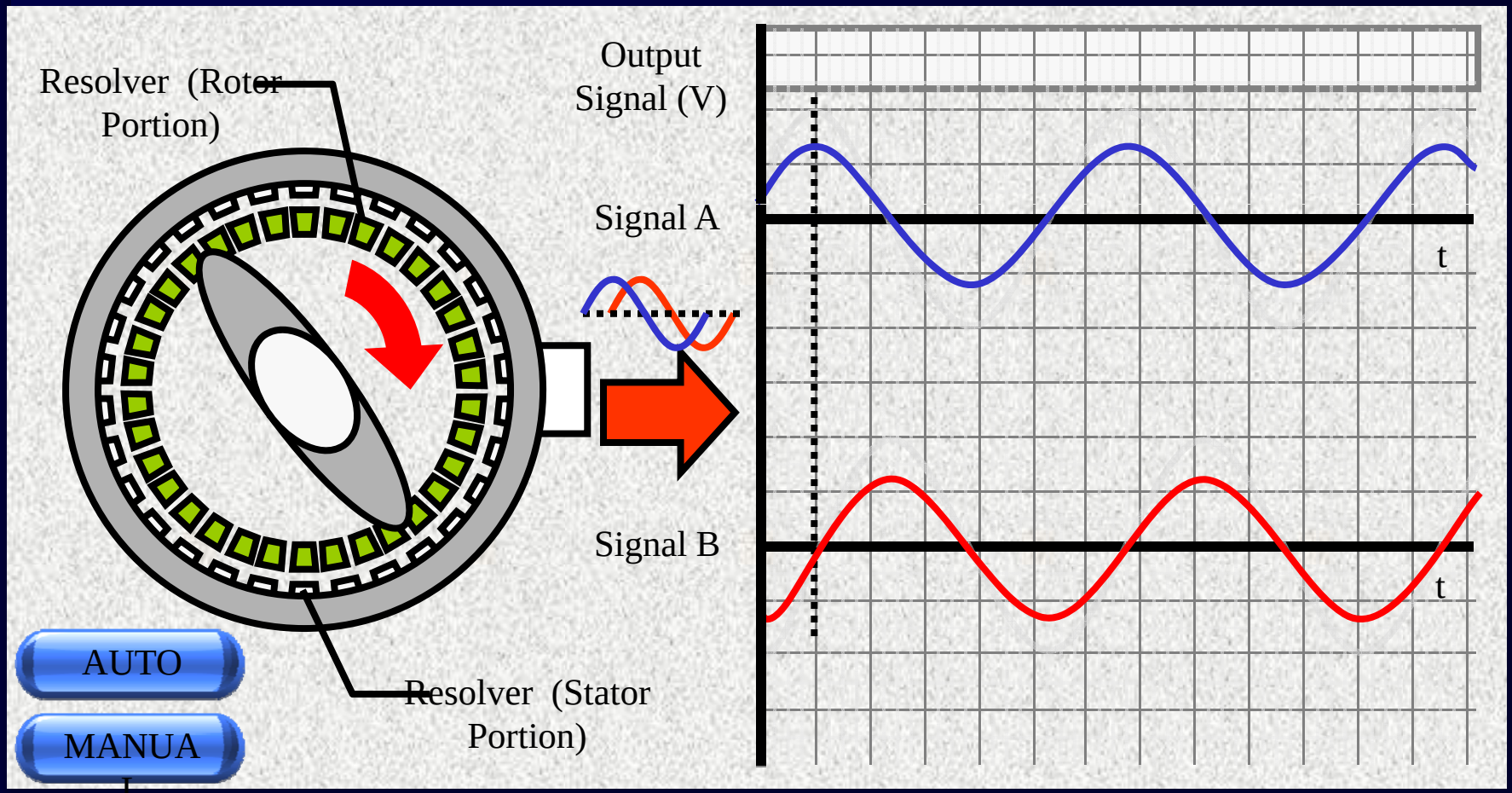
Steering

- Torque Sensor (Resolver Type)
  - Detection method of torque sensor



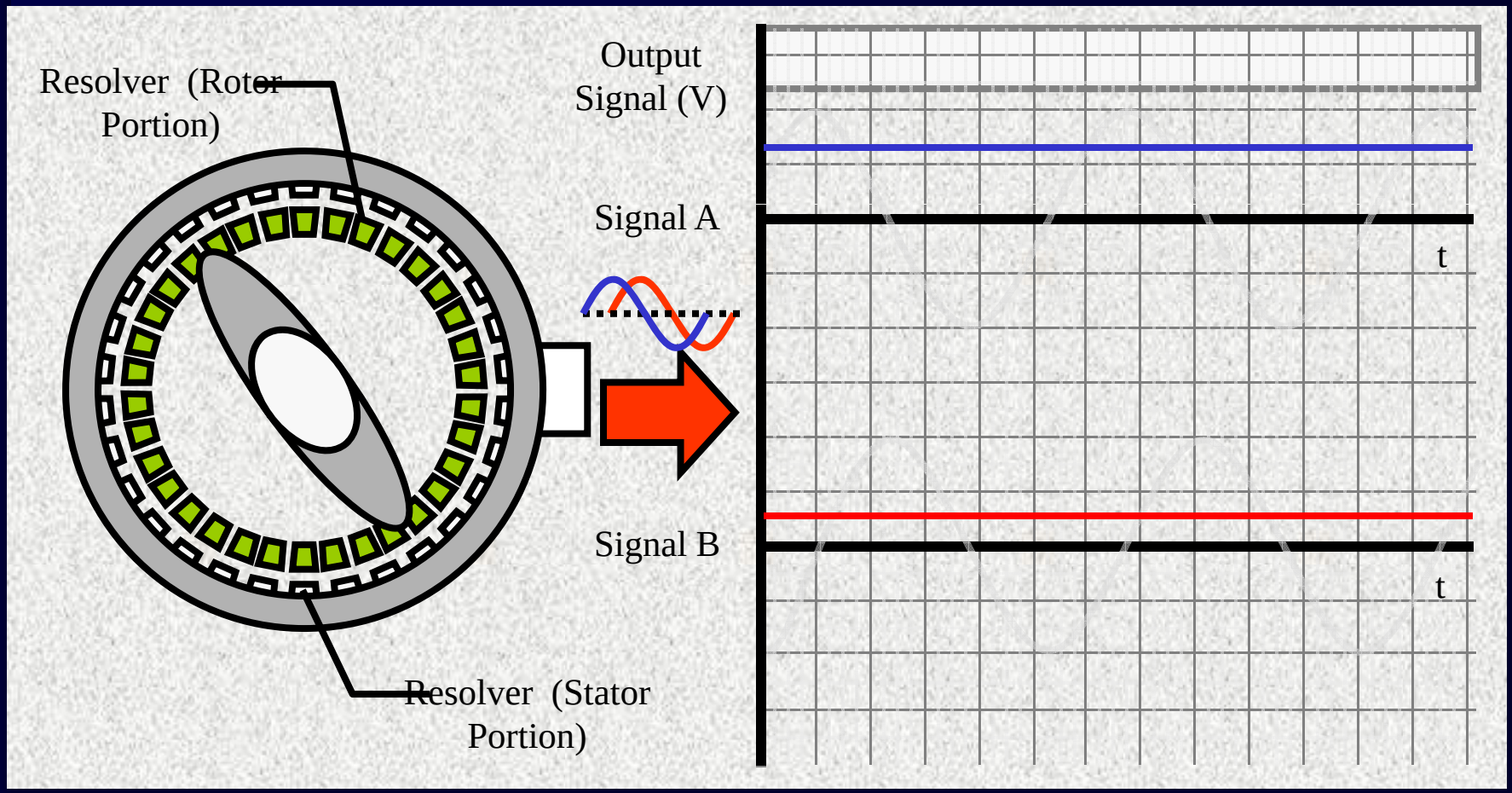
Steering

- Torque Sensor (Resolver Type)
  - One resolvor outputs two signals with which the phase lagged 90 degrees to detect a relative angle



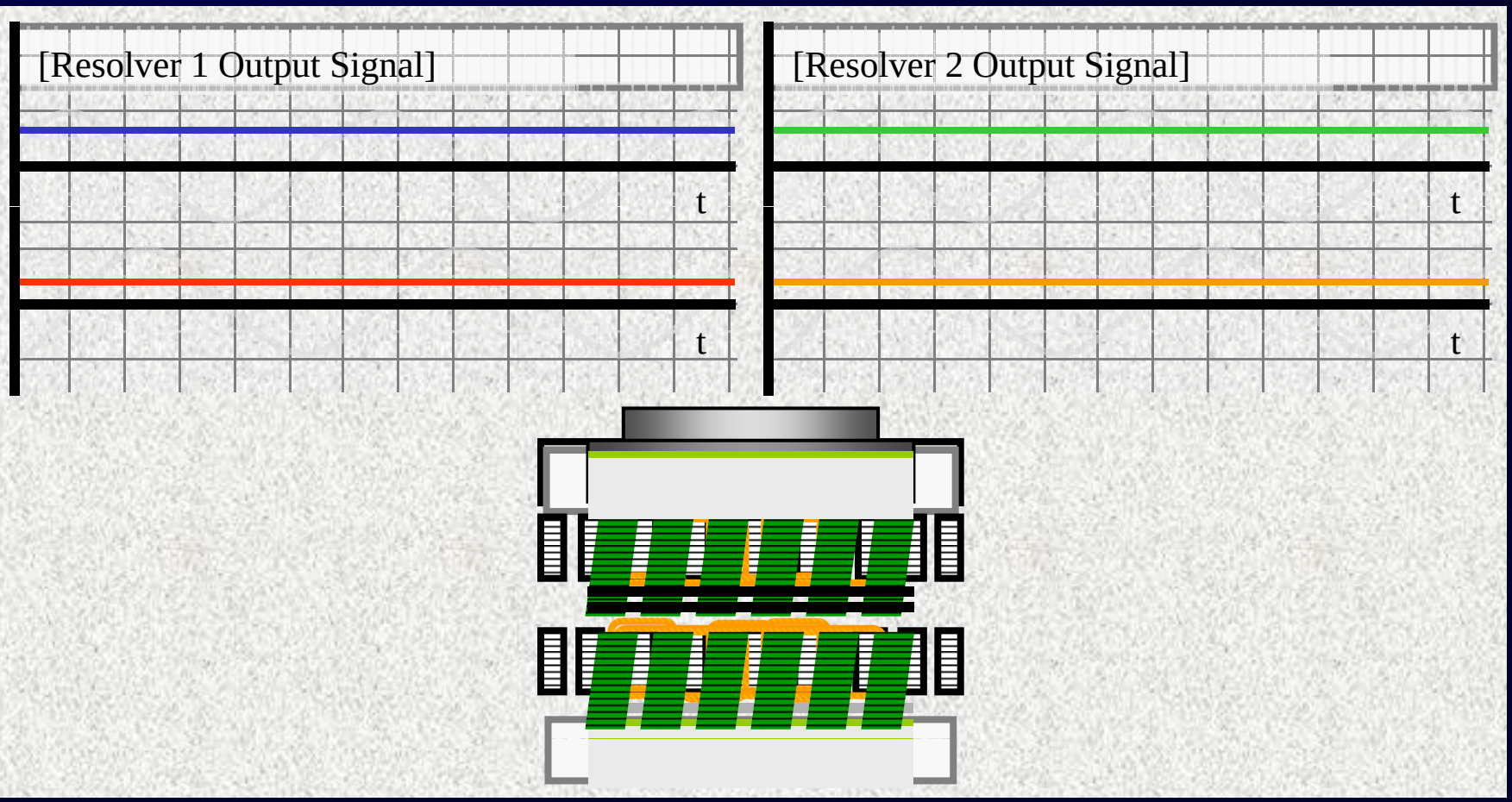
Steering

- Torque Sensor (Resolver Type)
  - Resolver of rotor portion outputs the straight signal, when resolver of stator portion stayed



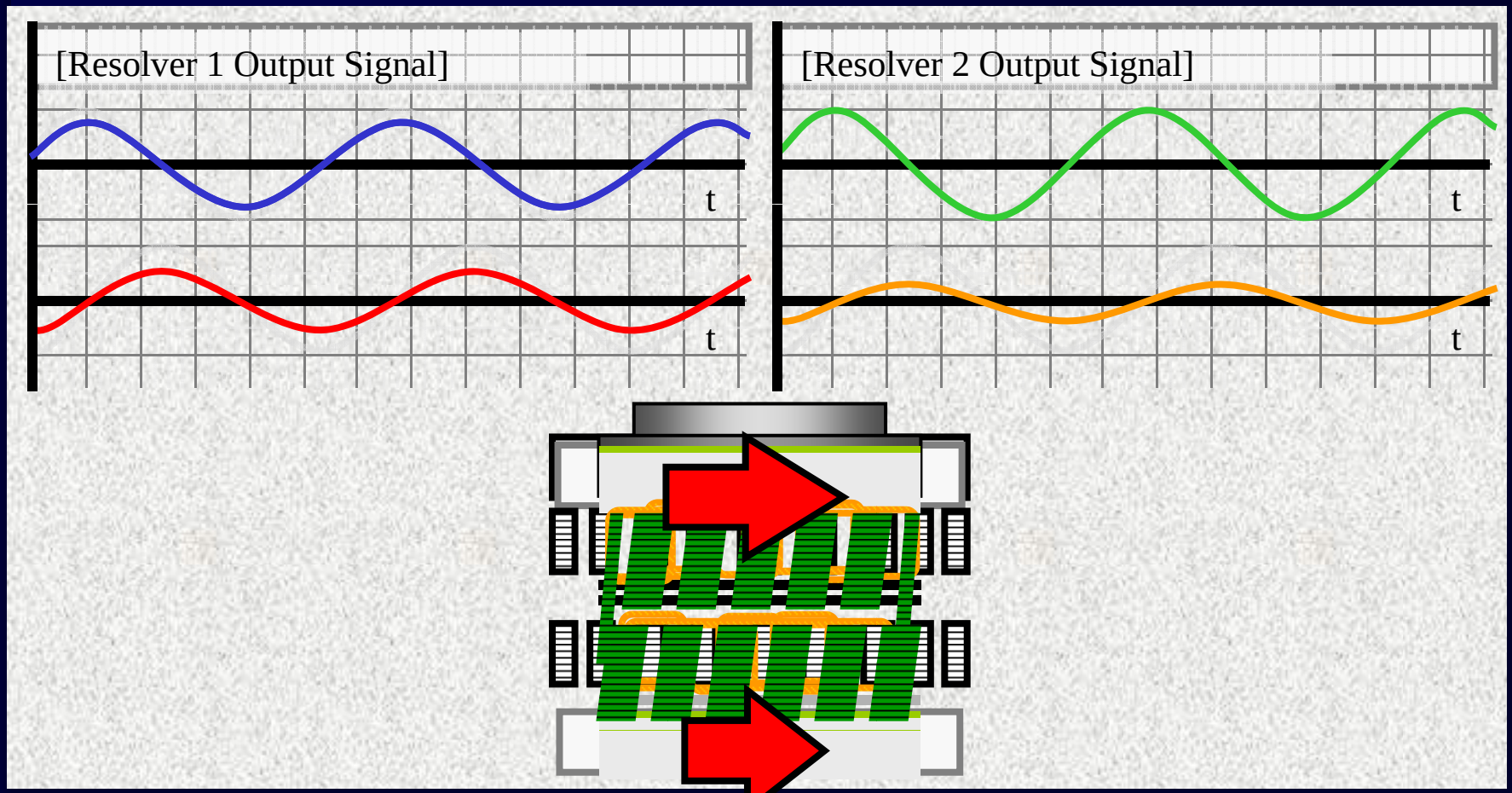
Steering

- Torque Sensor (Resolver Type)
  - When vehicle is driven straight, resolver 1 and 2 output the signals of the same signal



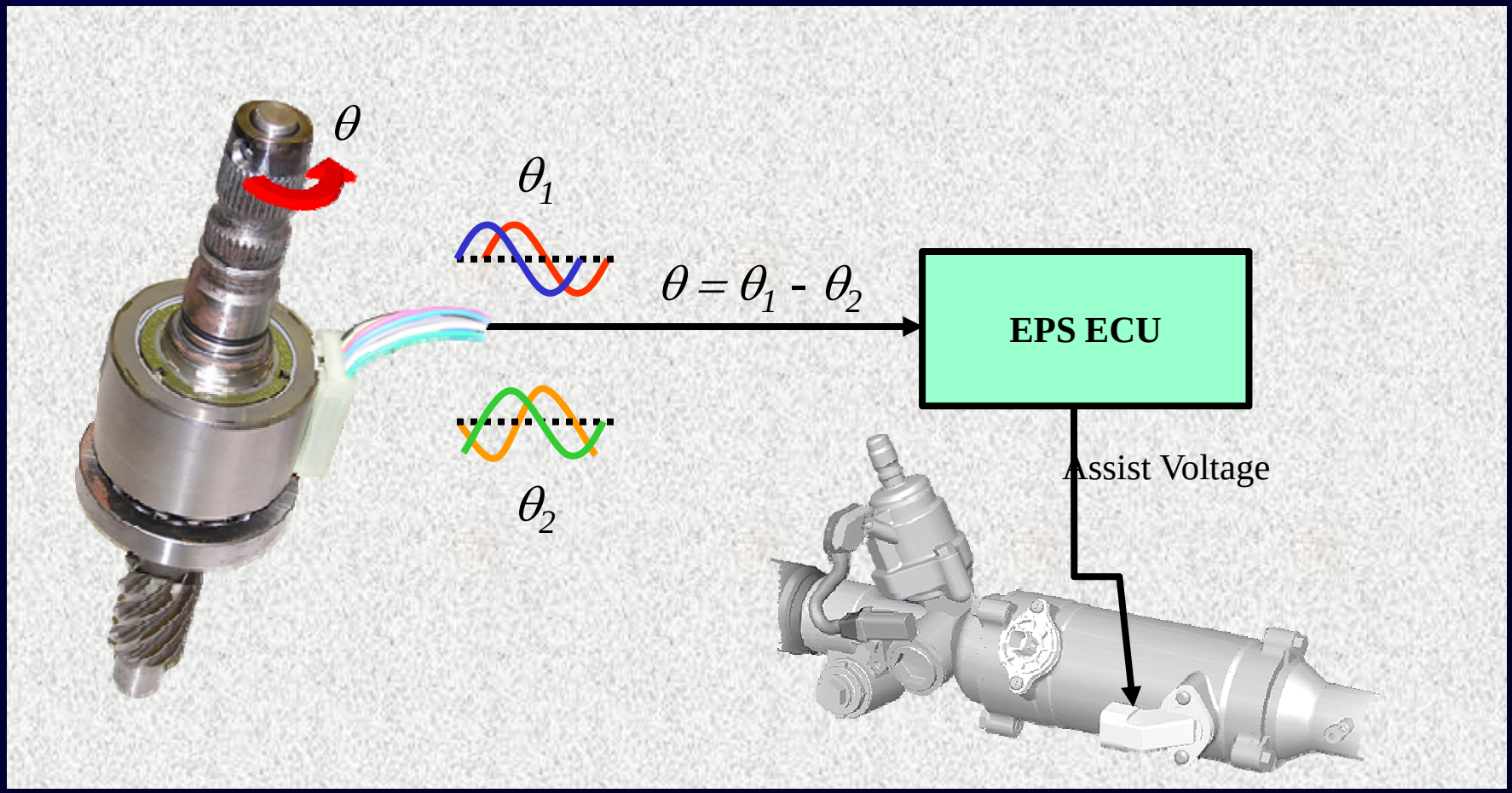
Steering

- Torque Sensor (Resolver Type)
  - When steering is turned, relative angle difference is created between the resolver 1 and 2 of rotor portion



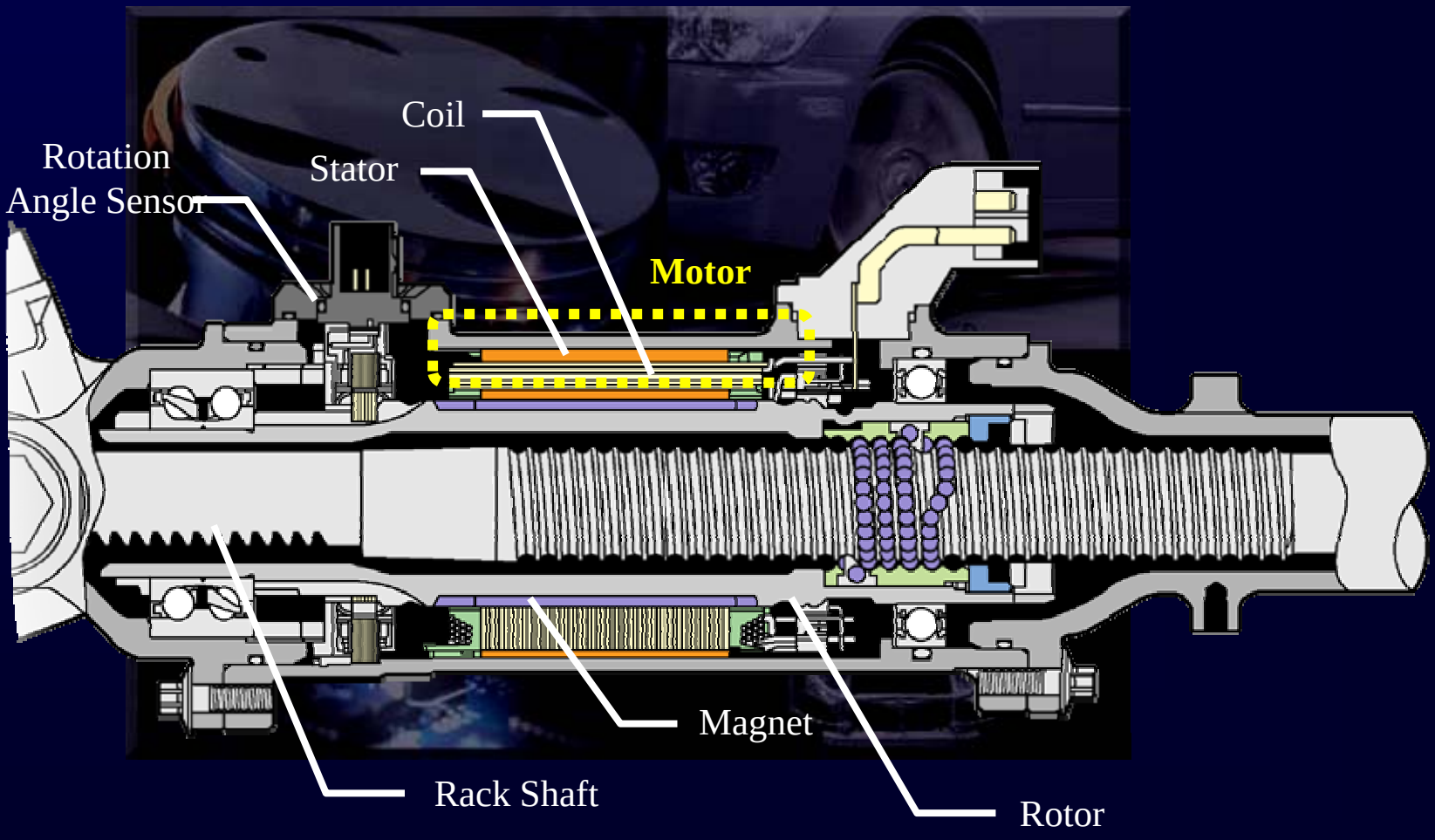
Steering

- Torque Sensor (Resolver Type)
  - EPS ECU decides assist voltage to a EPS motor from difference in relative position of resolver 1 and 2



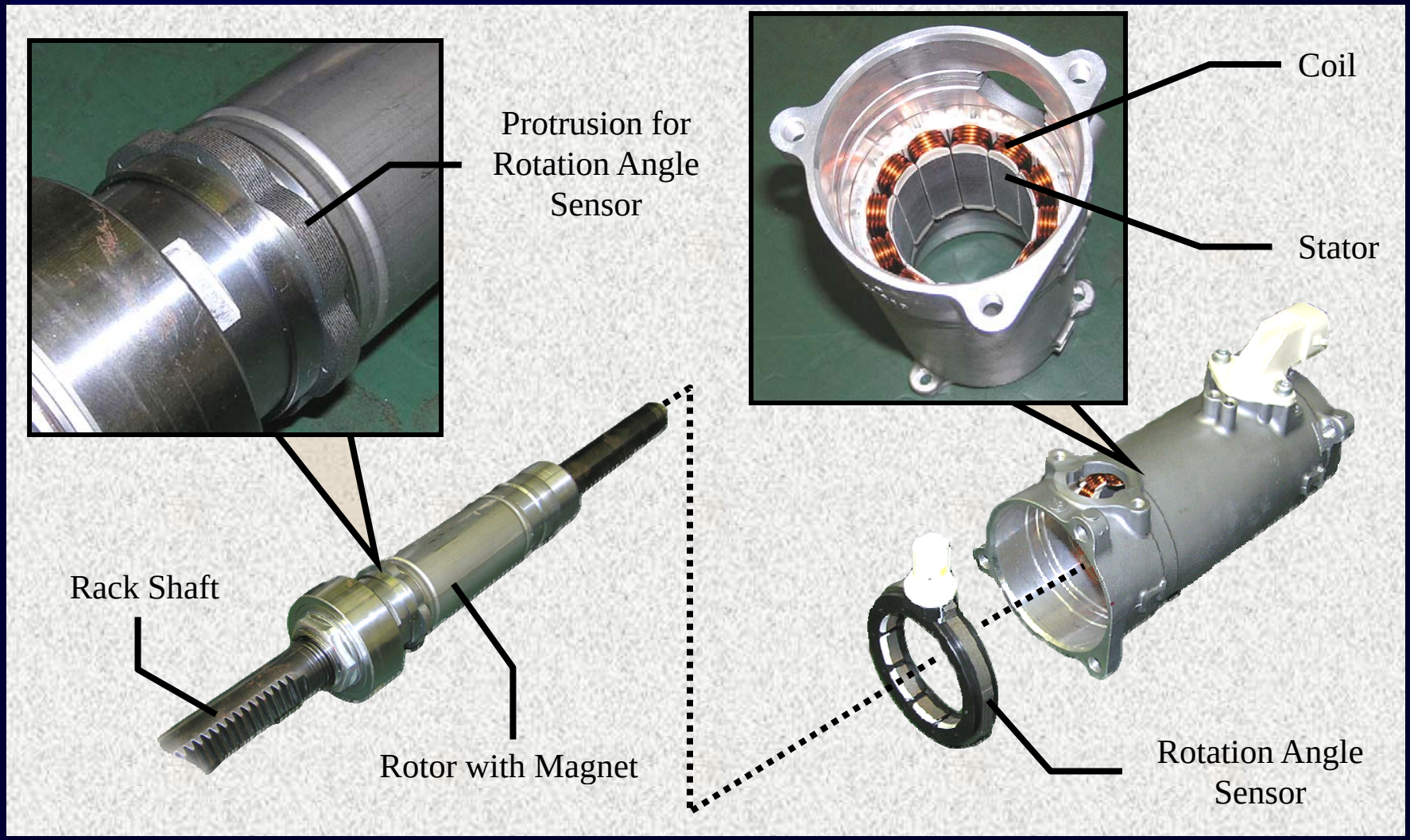
Steering

- Motor (Brushless Type)
  - Motor is concentric with rack shaft, and consists of rotation angle sensor, stator and rotor



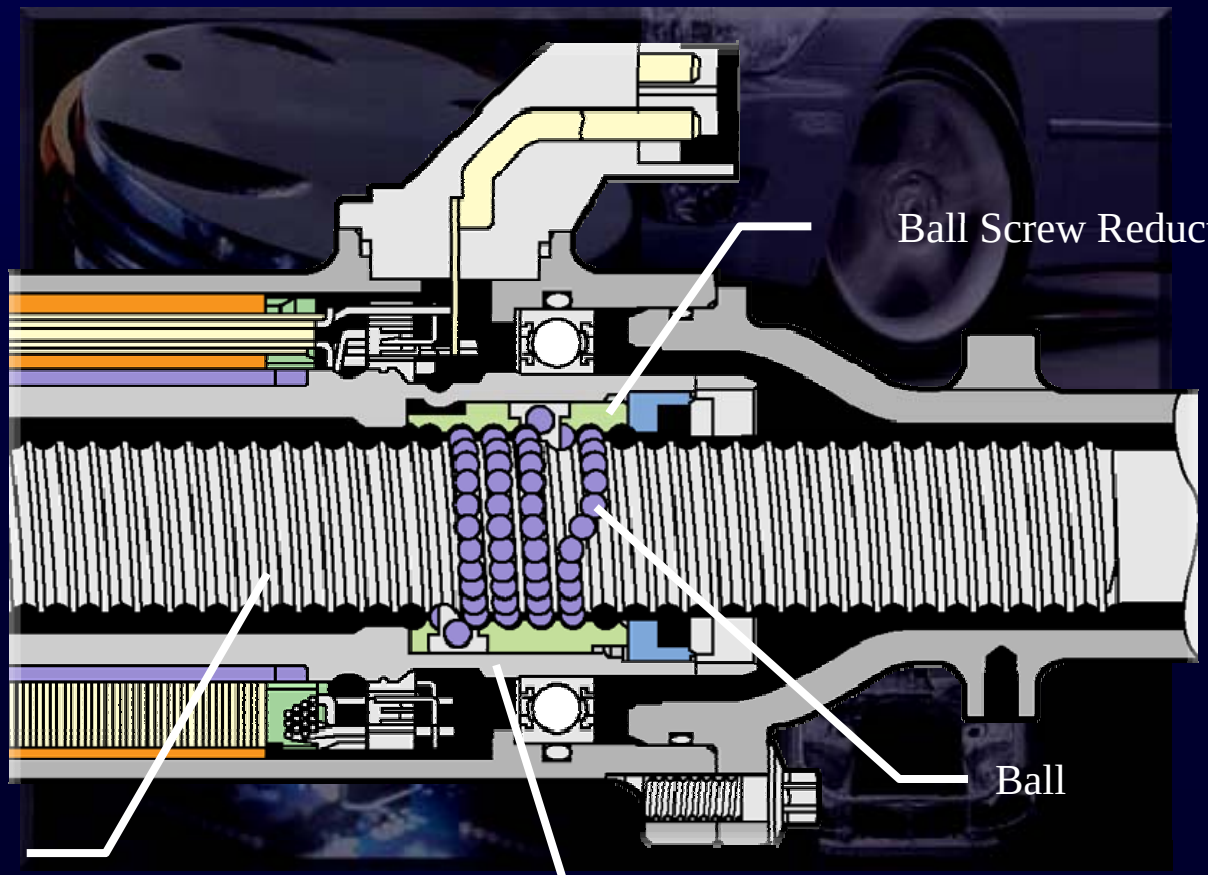
Steering

- Motor (Brushless Type)



Steering

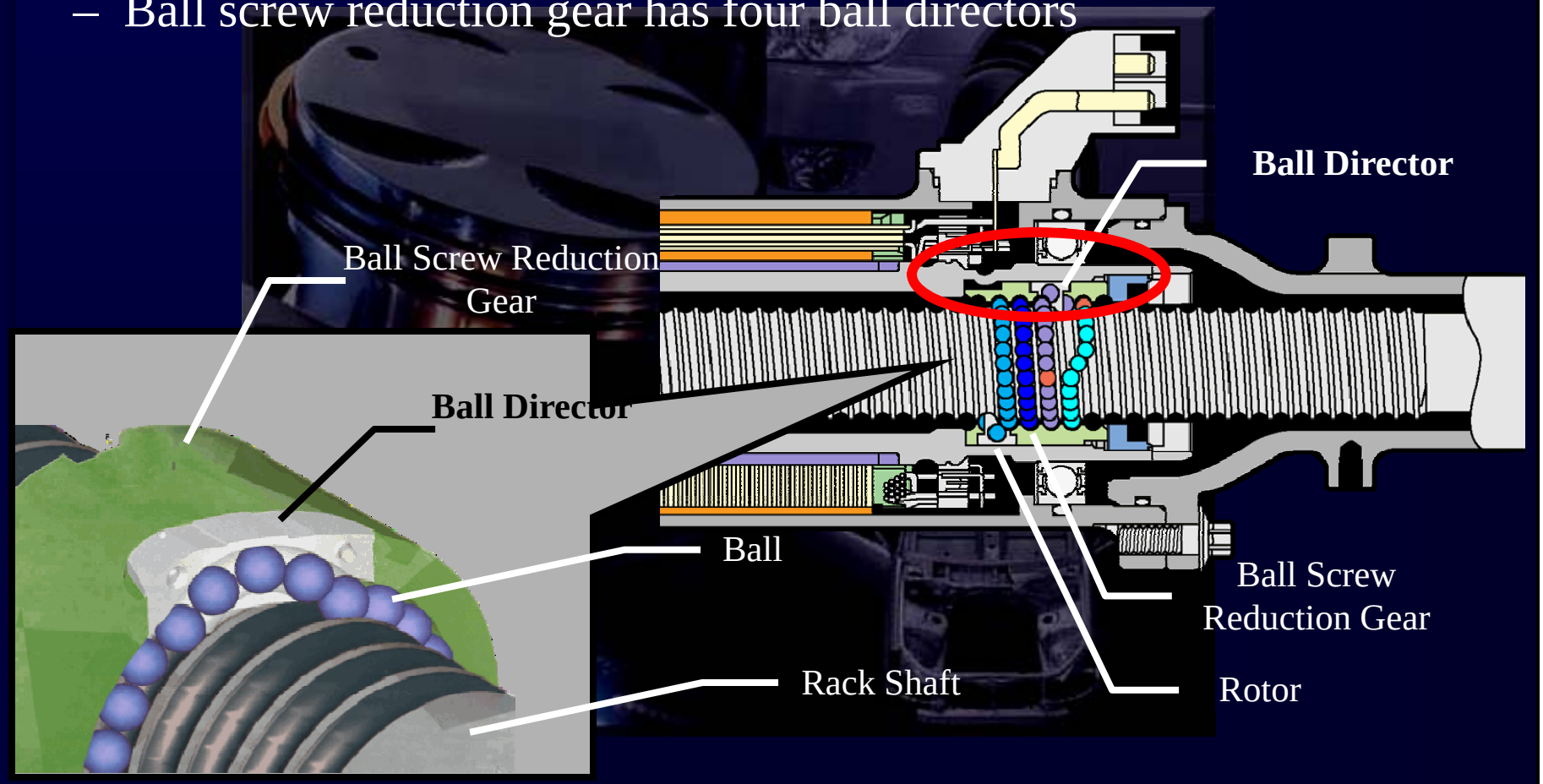
- Reduction Mechanism
  - Movement of motor travels to ball screw reduction gear, via balls, to gear that is created on rack shaft



Ball screw reduction gear is fixed to rotor

Steering

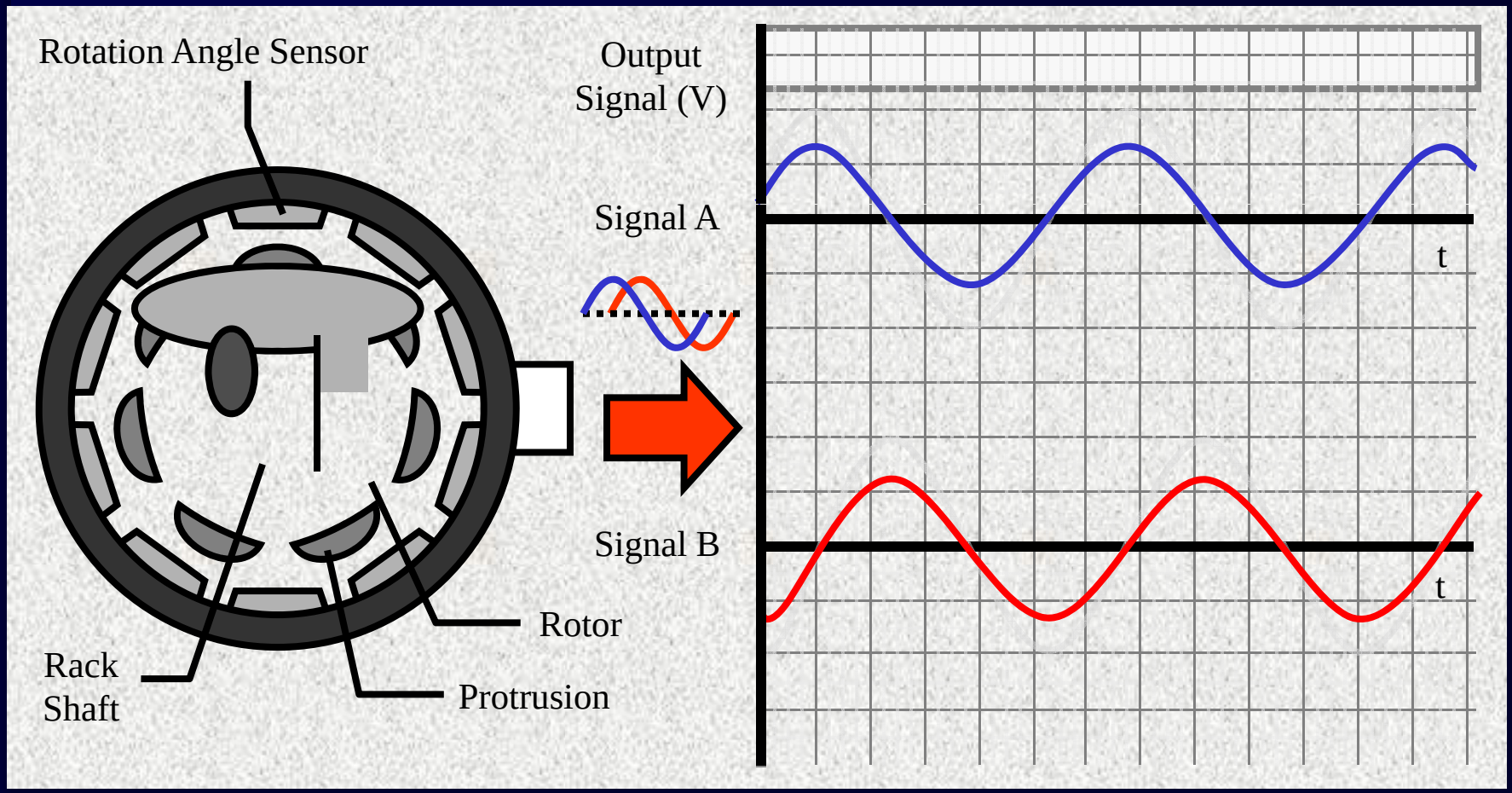
- Reduction Mechanism
  - Ball is circulating the inside of the ball screw reduction gear by the ball director
  - Ball screw reduction gear has four ball directors



Ball screw reduction gear is fixed to rotor

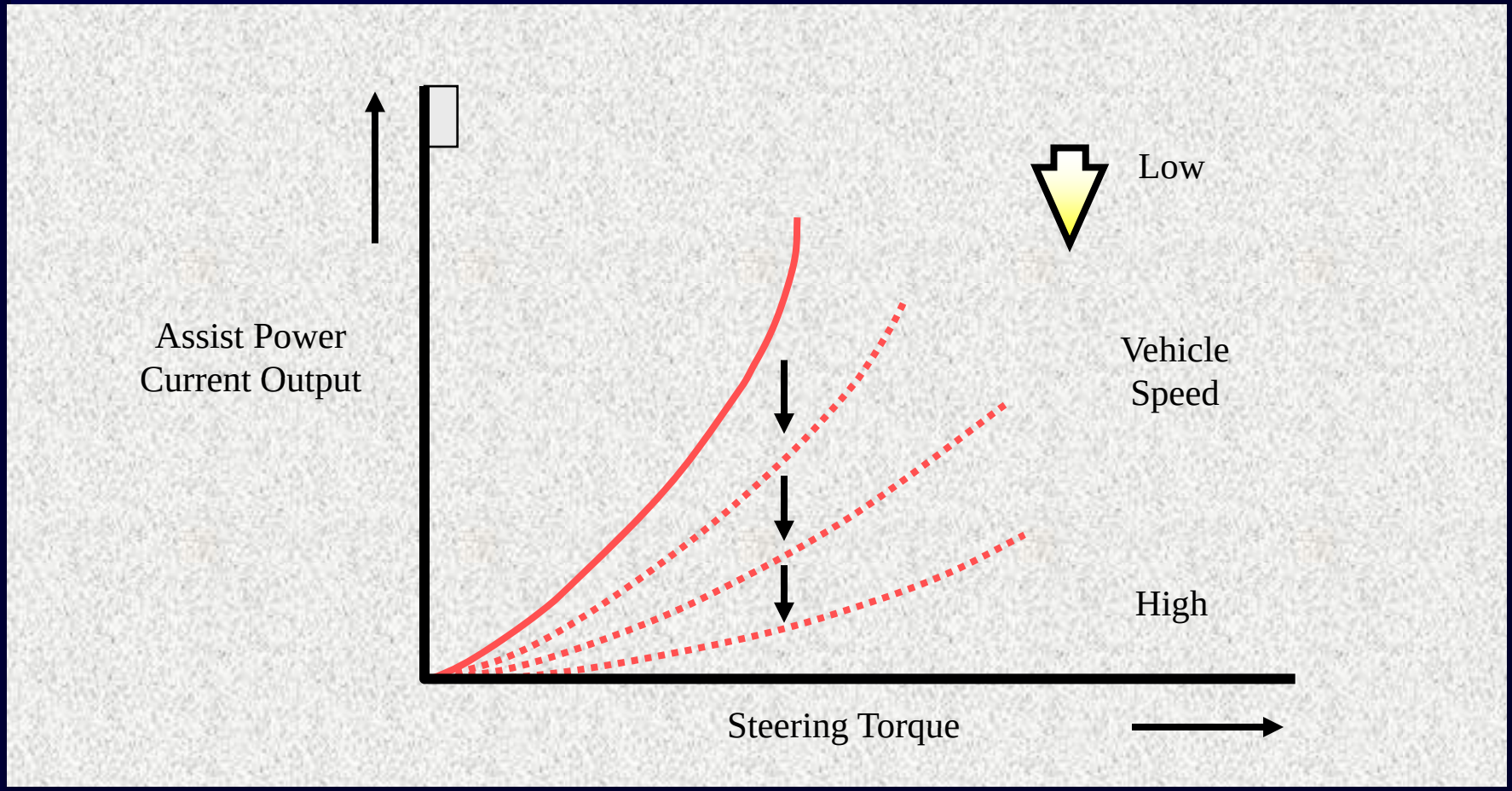
Steering

- Rotation Angle Sensor (Resolver Type)
  - Detects the rotation angle of the motor for preventing torque fluctuations



Steering

- EPS Operation
  - Relationship between the steering torque and the assist power current output



Steering

- EPS Operation
  - There are the following functions in assist control

Item	Function
Basic Control	Calculates the assist current from the steering torque value and the vehicle speed, and actuates the motor
Inertia Compensation Control	Improves the starting movement of the motor when the driver starts to turn the steering wheel
Recovery Control	During the short interval between the time the driver fully turns the steering wheel and the wheels try to recover, this control assists the recovery force
Damper Control	Regulates the amount of assist when the driver turns the steering wheel while driving at high speeds, thus damping the changes in the yaw rate of the vehicle body
Voltage Boost Control	Boosts the battery voltage in the EPS ECU. It maintains 0 volts when the driver does not turn the steering wheel or the vehicle is being driven straight. It effects variable control between 27 to 34 volts in accordance with the load, when the driver is turning the steering wheel.
System Overheat Protection Control	Estimates the motor temp. based on the amperage and the current duration . If the temp. exceeds the standard, it limits the amperage to prevent the motor from overheating

Steering

- Diagnosis
  - When malfunction occurs in EPS system, EPS ECU controls following control;
    - Turns on P/S warning light and fail-safe operation

DTC No.	Detection Item	P/S
C1511 / 11	Torque sensor malfunction	Illuminate
C1512 / 11		
C1513 / 11		
C1515 / 15	Torque sensor zero point adjustment undone	Illuminate
C1516 / 16	Torque sensor zero point adjustment incomplete	Illuminate
C1521 / 25	Motor malfunction	Illuminate
C1522 / 25		
C1523 / 24		
C1524 / 24		
C1525 / 17	Rotation angle sensor output initialization undone	Illuminate
C1526 / 18	Rotation angle sensor output initialization incomplete	Illuminate
C1528 / 12	Motor rotation angle sensor malfunction	Illuminate

Steering

Diagnosis

DTC No.	Detection Item	P/S
C1531 / 25	ECU malfunction	Illuminate
C1532 / 25		
C1533 / 25		
C1534 / 25		
C1541 / 13	Vehicle speed signal malfunction	Illuminate
C1551 / 25	IG power source voltage malfunction	Illuminate
C1552 / 22	PIG power supply voltage malfunction	Illuminate
C1554 / 23	Power supply relay failure	Illuminate
C1555 / 25	Motor relay welding failure	Illuminate
C1567 / 44	*Lost communication with VGRS ECU?*	Illuminate
C1581 / 26	Assist map number un-writing	Illuminate
U0073 / 49	Control module communication bus off	Illuminate
U0104 / 45	Lost communication with cruise control module	—
U0105 / 41	Lost communication with fuel injector control module	—

Steering

Diagnosis

DTC No.	Detection Item	P/S
U0121 / 42	Lost communication with anti-lock brake system (ABS) control module	Illuminate
U0122 / 42		—
U0130 / 44	Lost communication with steering effort control module	—
U0405 / 45		—

Steering

Fail-safe

DTC No.	Detection Item	Fail-safe Operation
C1511 / 11	Torque sensor malfunction	Prohibit steering assist control
C1512 / 11		
C1513 / 11		
C1521 / 25	Motor malfunction	Prohibit steering assist control
C1522 / 25		
C1523 / 24		
C1524 / 24		
C1528 / 12	Motor rotation angle sensor malfunction	Prohibit steering assist control
C1531 / 25	EPS ECU malfunction	Prohibit steering assist control
C1532 / 25		
C1533 / 25		Protection function which EPS ECU is canceled. And steering assist control is continued
C1534 / 25		Amount of power assist is fixed for a 62.5 mph (100 km/h)

Steering

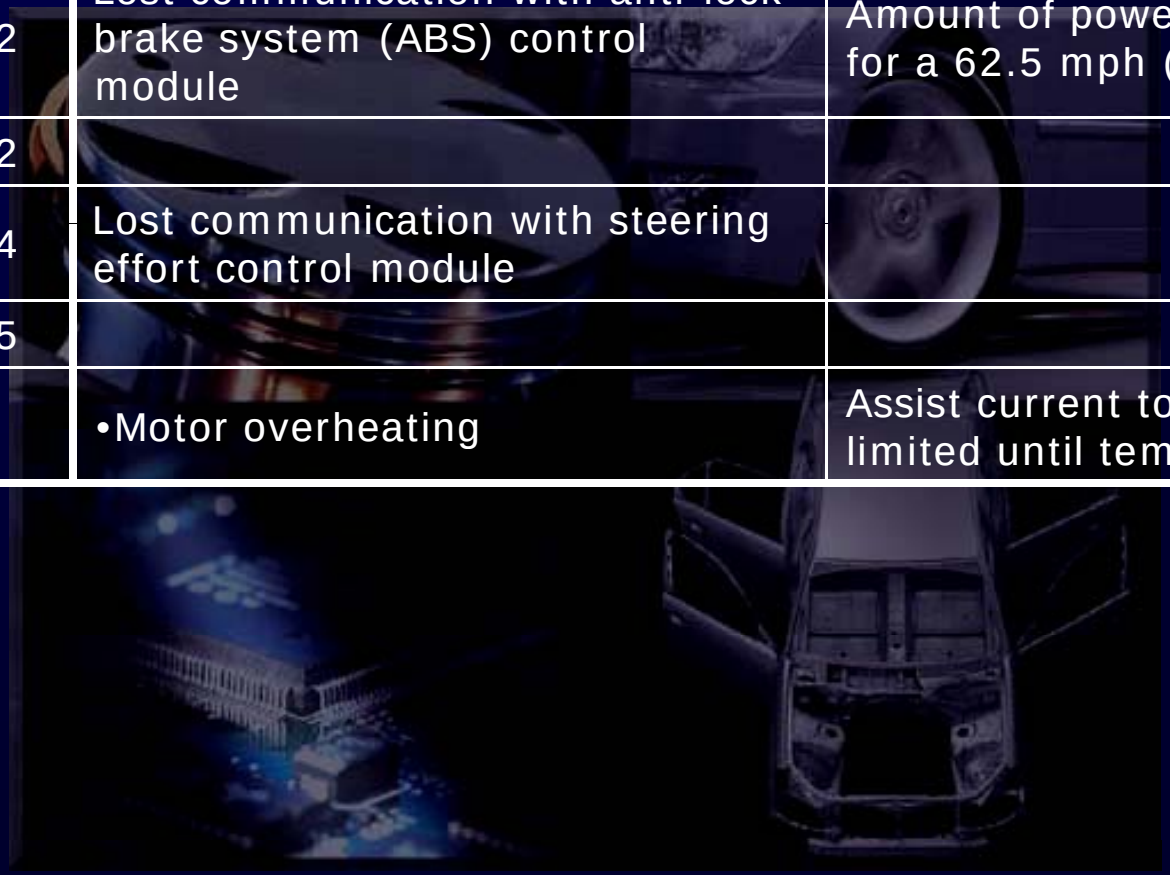
Fail-safe

DTC No.	Detection Item	Fail-safe Operation
C1541 / 13	Vehicle speed signal malfunction	Amount of power assist is fixed for a 62.5 mph (100 km/h)
C1551 / 25	IG power source voltage malfunction	Prohibit steering assist control
C1552 / 22	PIG power supply voltage malfunction	Prohibit steering assist control
C1554 / 23	Power supply relay failure	Prohibit steering assist control
C1555 / 25	Motor relay welding failure	Prohibit steering assist control
C1567 / 44	*Lost communication with VGRS ECU?*	
C1581 / 26	Assist map number un-writing	
U0073 / 49	Control module communication bus off	Amount of power assist is fixed for a 62.5 mph (100 km/h)
U0104 / 45	Lost communication with cruise control module	
U0105 / 41	Lost communication with fuel injector control module	Prohibit steering assist control

Steering

Fail-safe

DTC No.	Detection Item	Fail-safe Operation
U0121 / 42	Lost communication with anti-lock brake system (ABS) control module	Amount of power assist is fixed for a 62.5 mph (100 km/h)
U0122 / 42		
U0130 / 44	Lost communication with steering effort control module	
U0405 / 45		
—	•Motor overheating	Assist current to the motor is limited until temperature falls

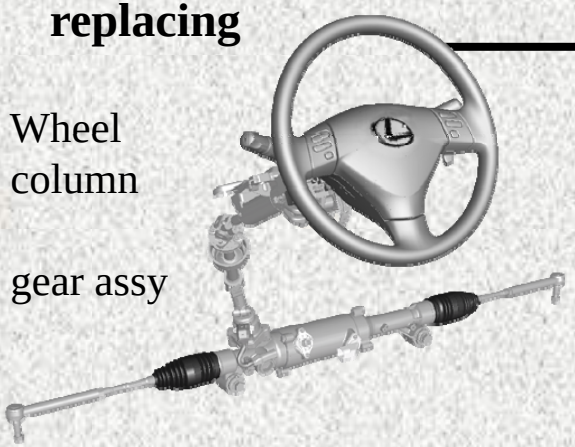


Service Point (Steering)

- Initialization and Calibration
  - Perform the initialization and calibration of EPS system in the following cases

Remove, install or replacing

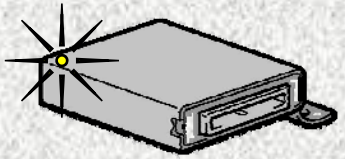
- Steering Wheel
- Steering column assy
- Steering gear assy



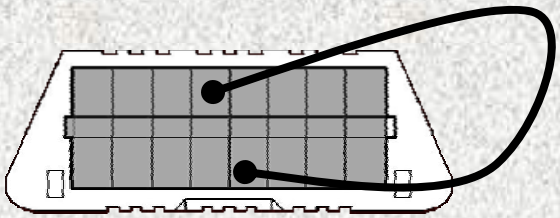
Using the Hand-held Tester or Intelligent Tester-II

Click!

EPS ECU



Replace the new one



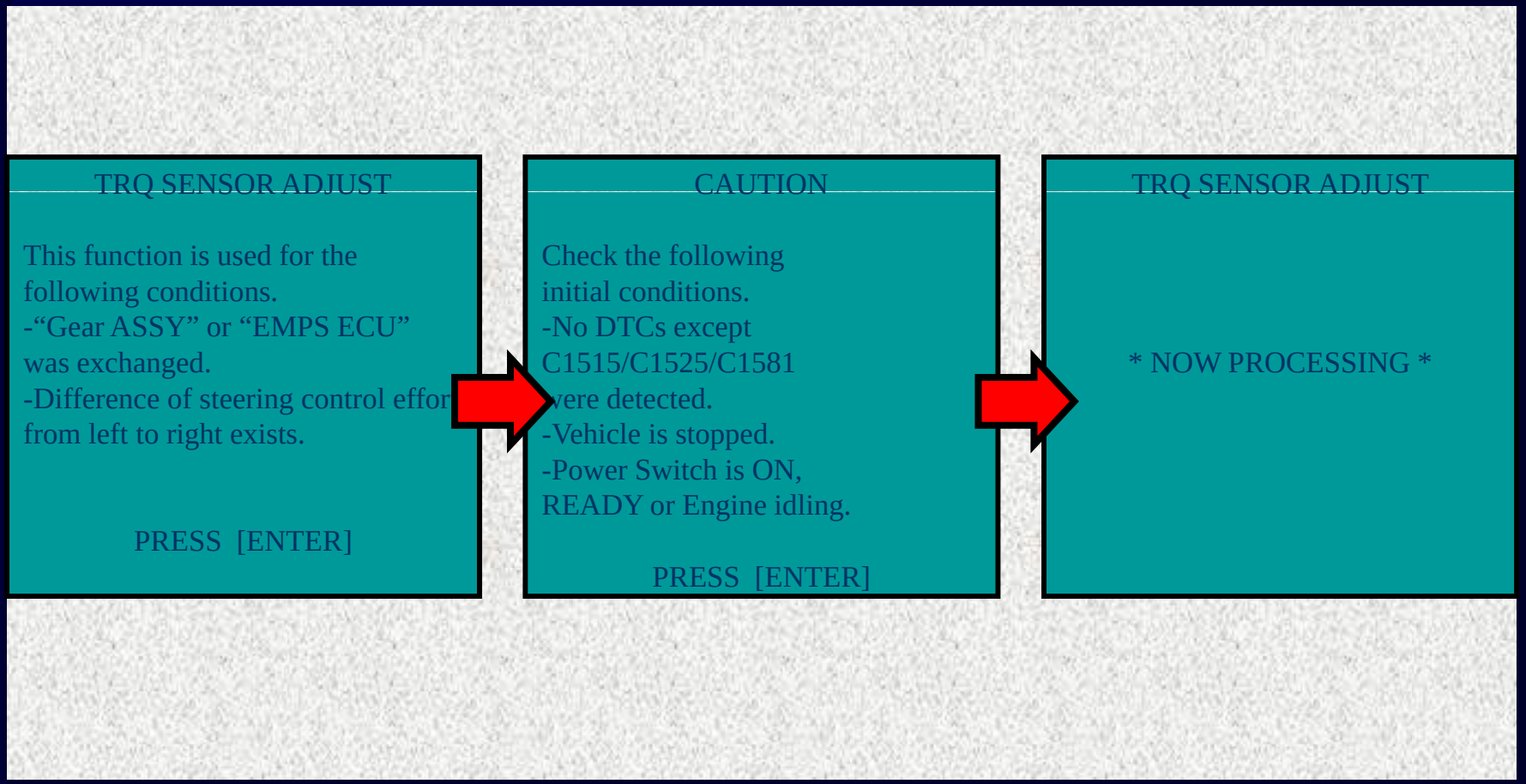
Using the SST

NOTE: These operation cannot be performed when the DTCs are outputted except C1515 / C1525

Click!

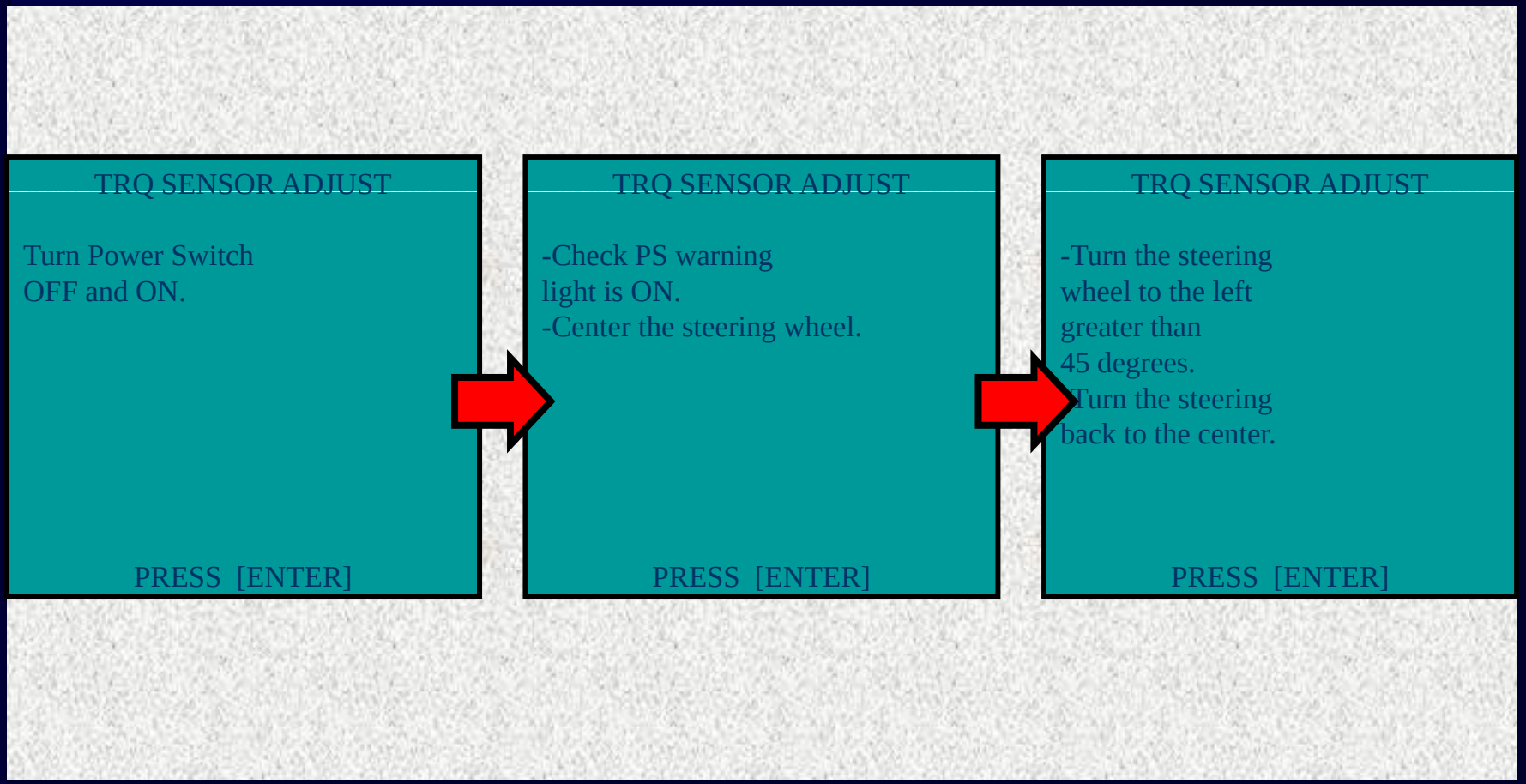
Service Point (Steering)

- Initialization and Calibration
  - Using the Hand-held tester



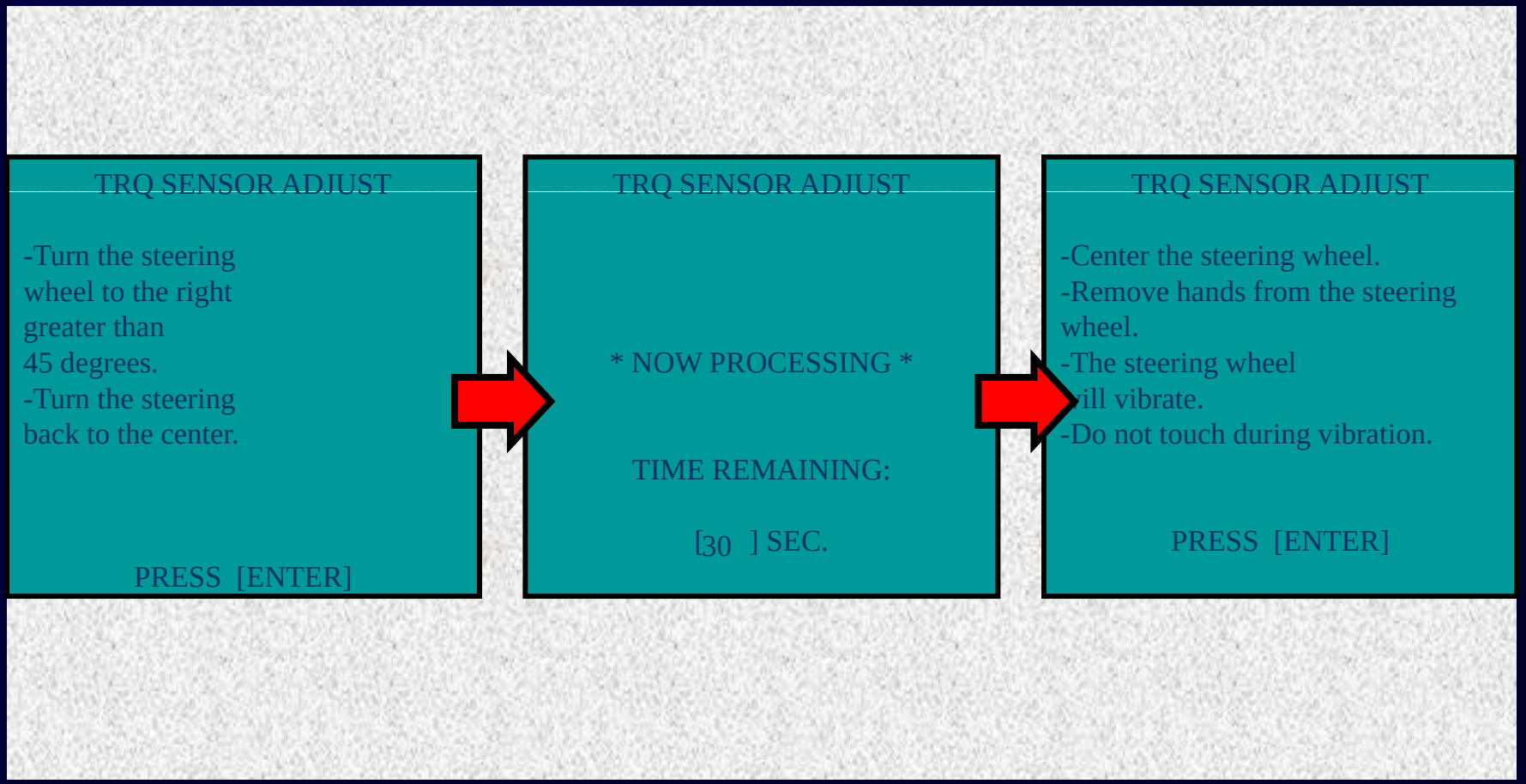
Service Point (Steering)

- Initialization and Calibration
  - Using the Hand-held tester



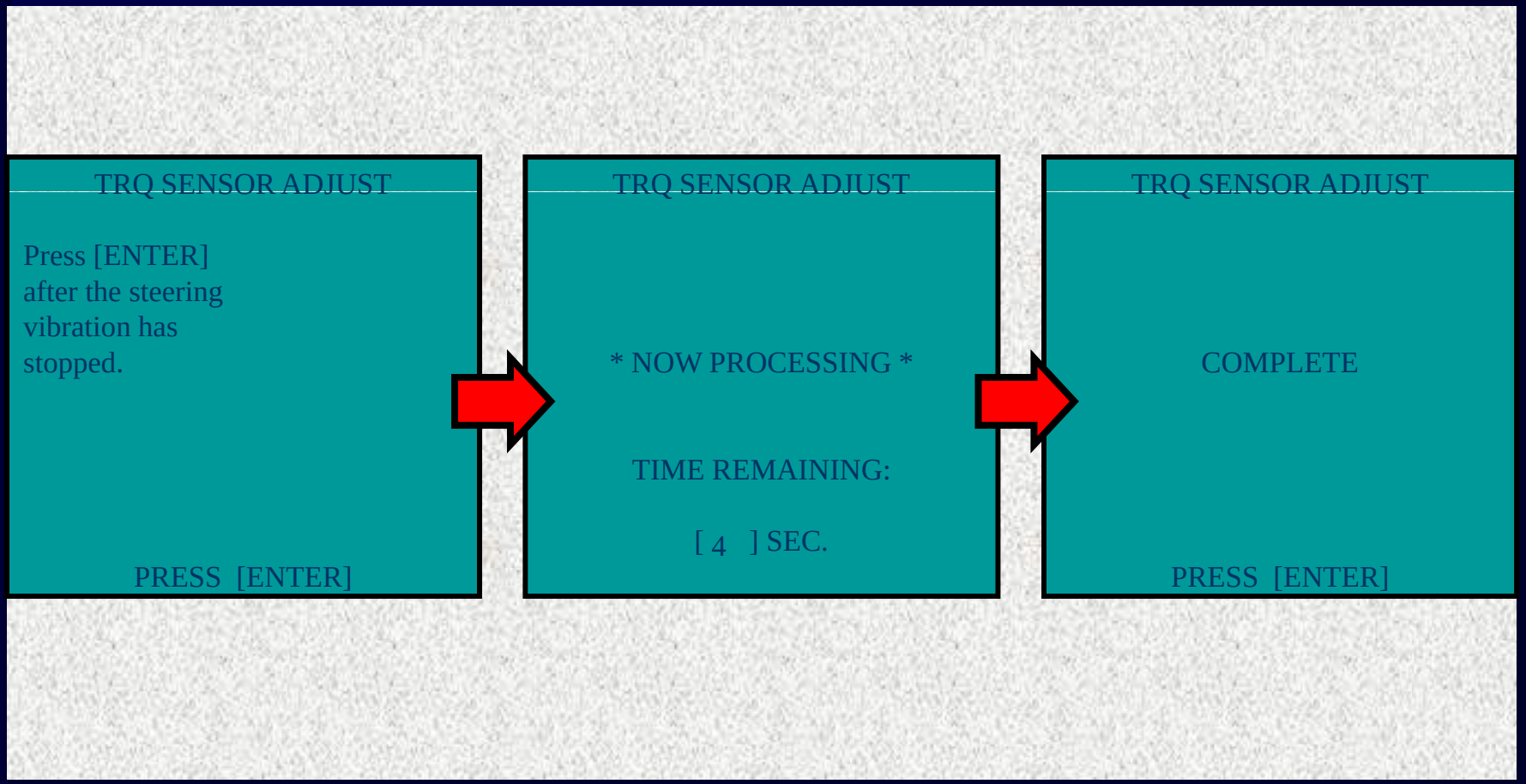
Service Point (Steering)

- Initialization and Calibration
  - Using the Hand-held tester



Service Point (Steering)

- Initialization and Calibration
  - Using the Hand-held tester

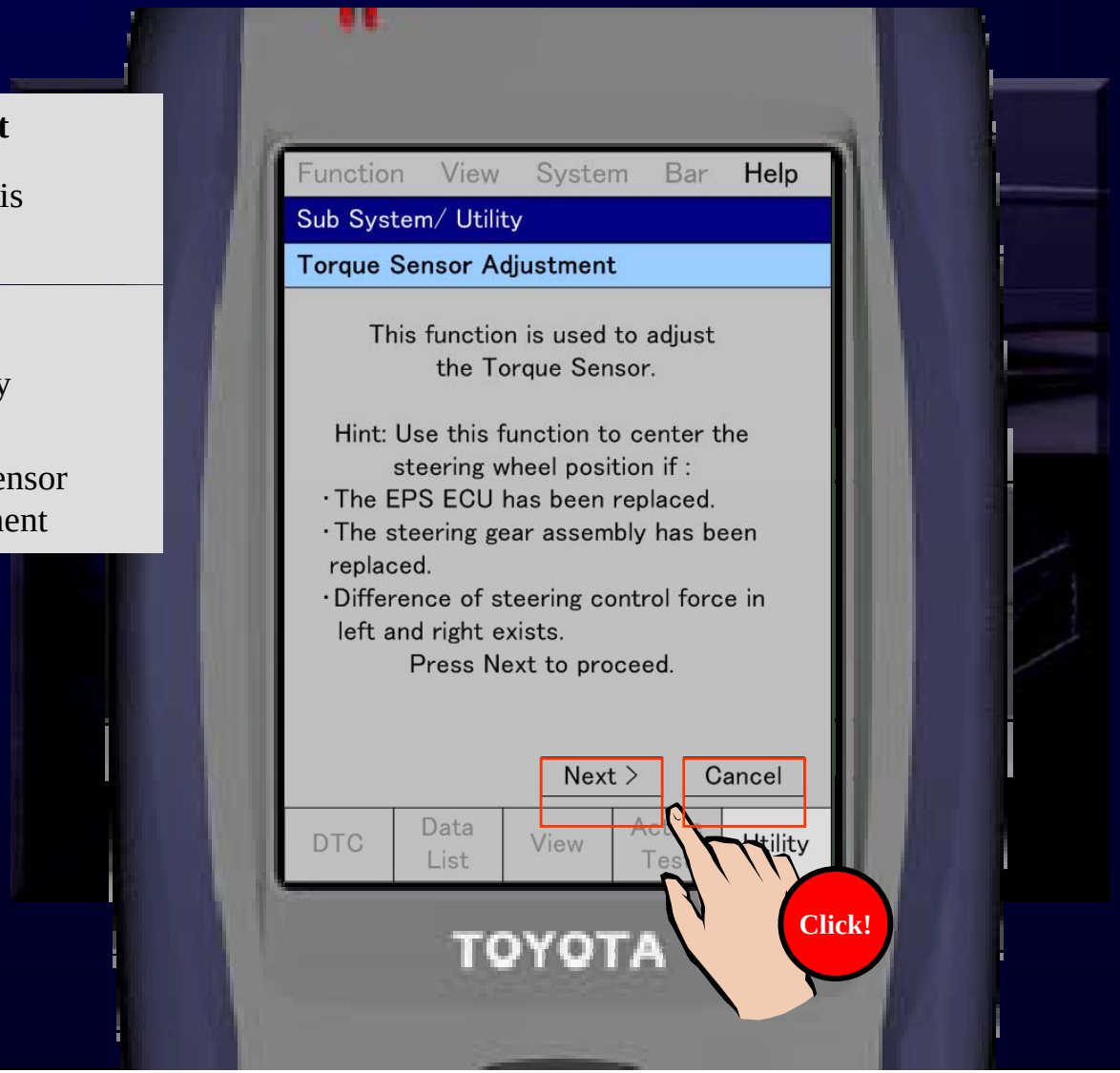


Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II

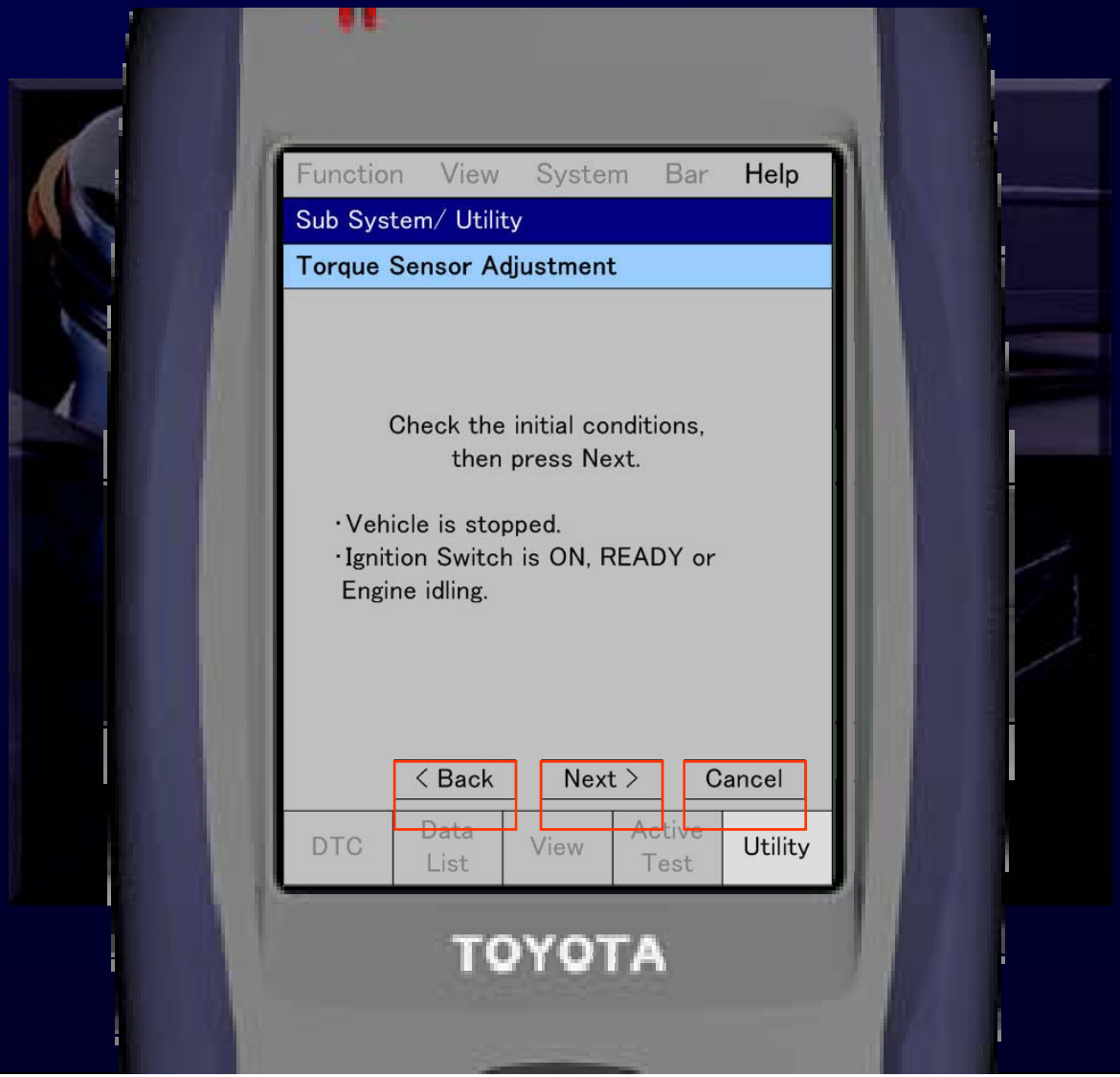
Select

Chassis
↓
EPS
↓
Utility
↓
Torque Sensor Adjustment



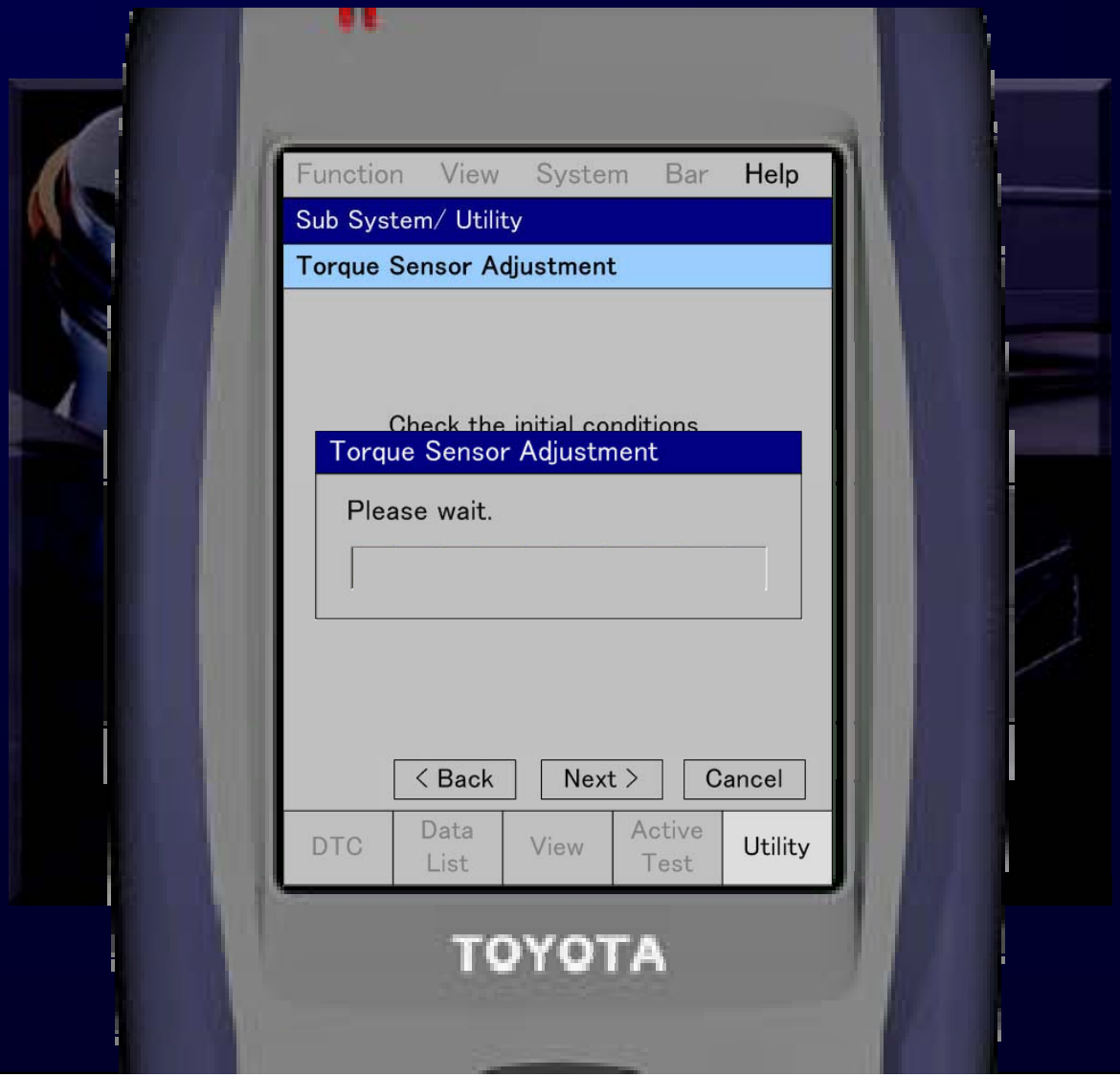
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II

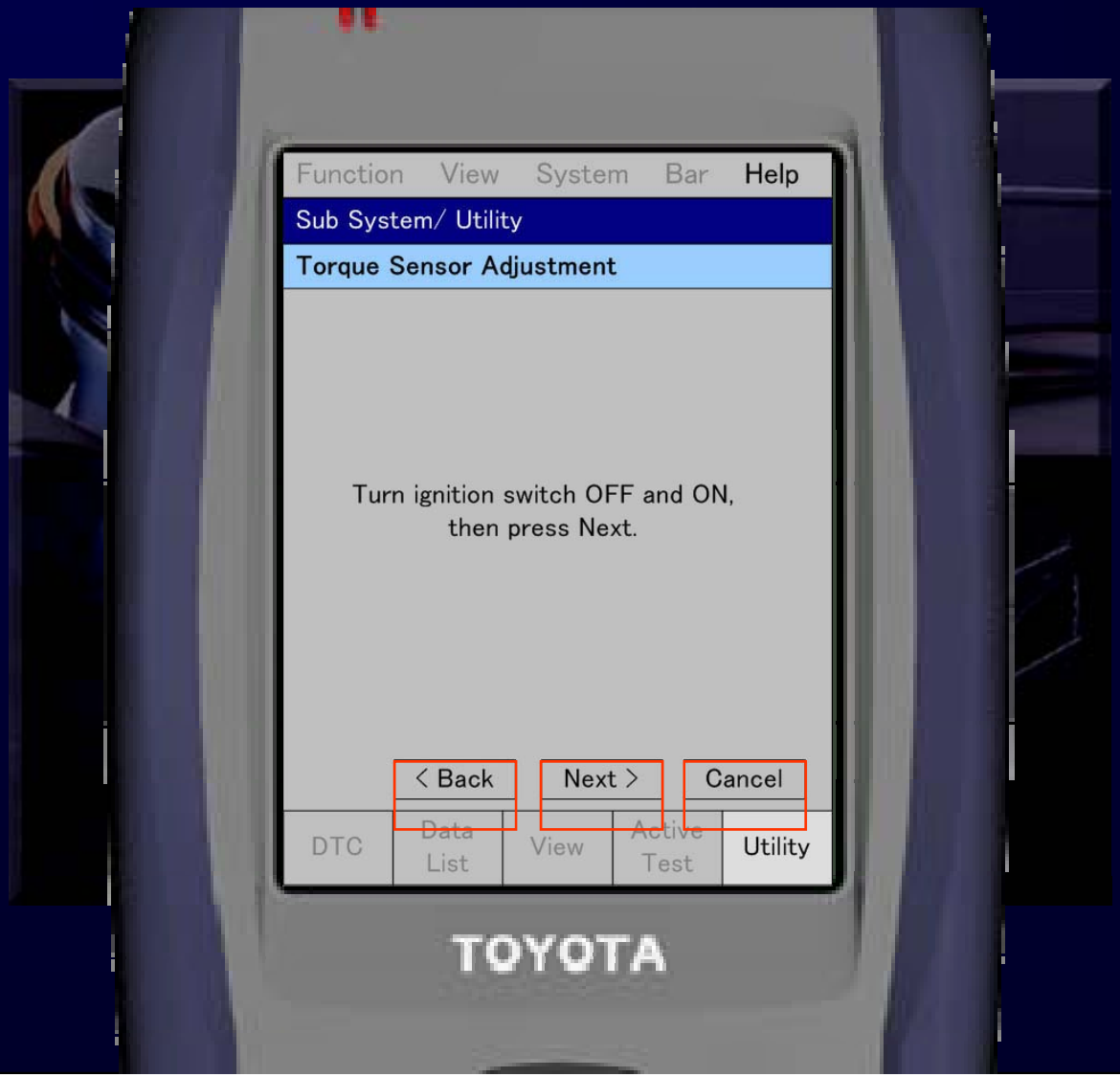


Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II

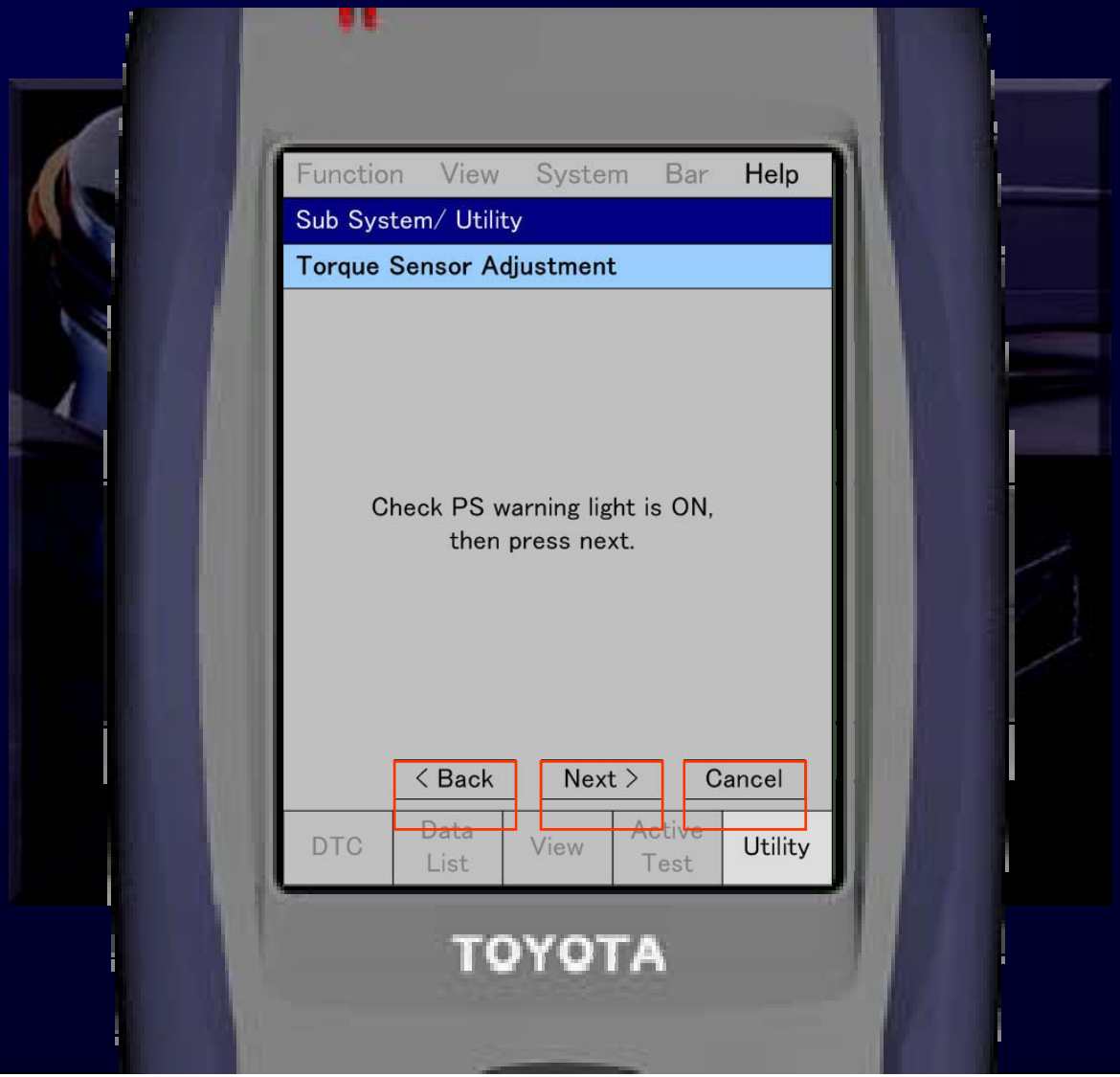
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



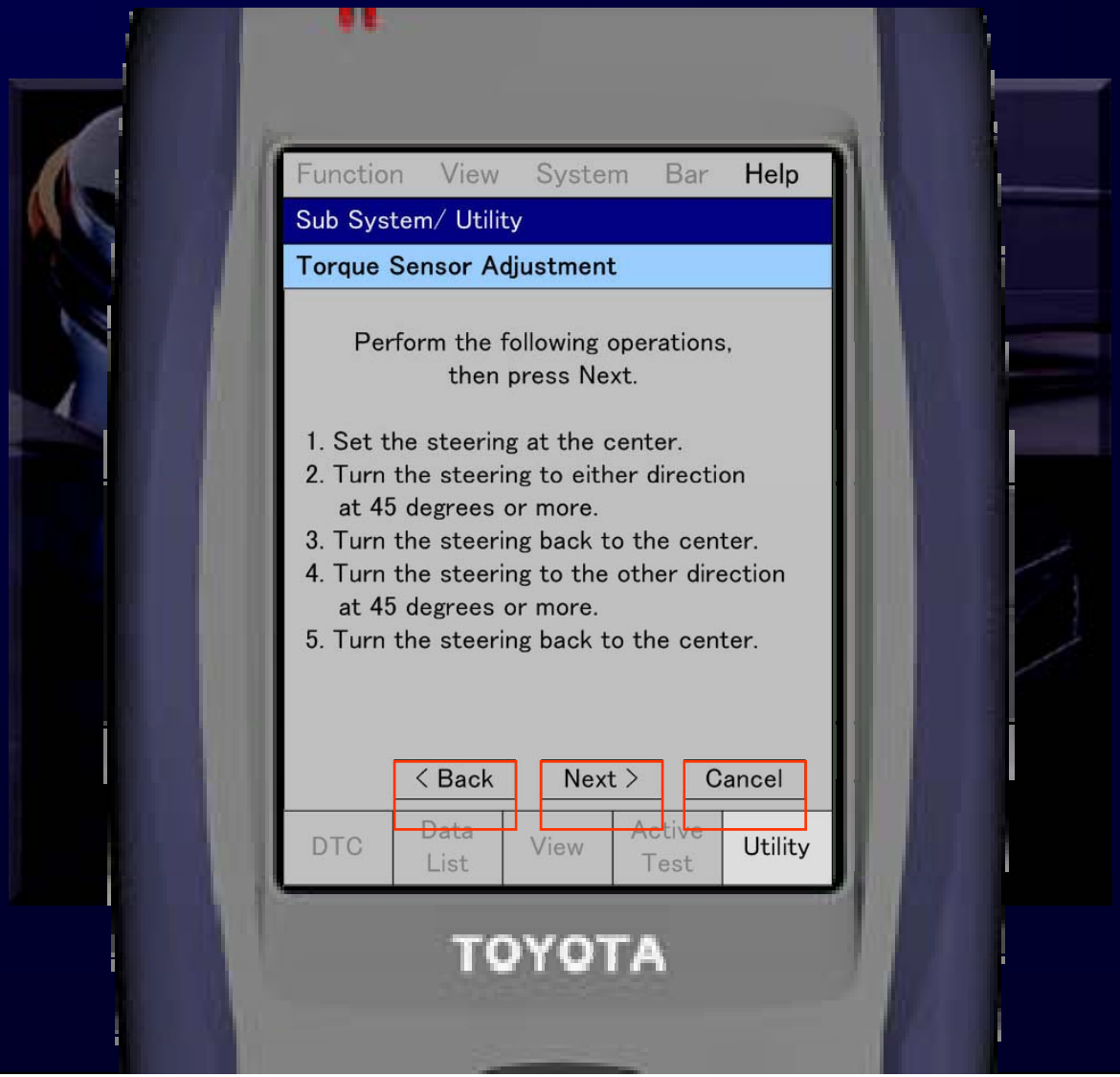
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



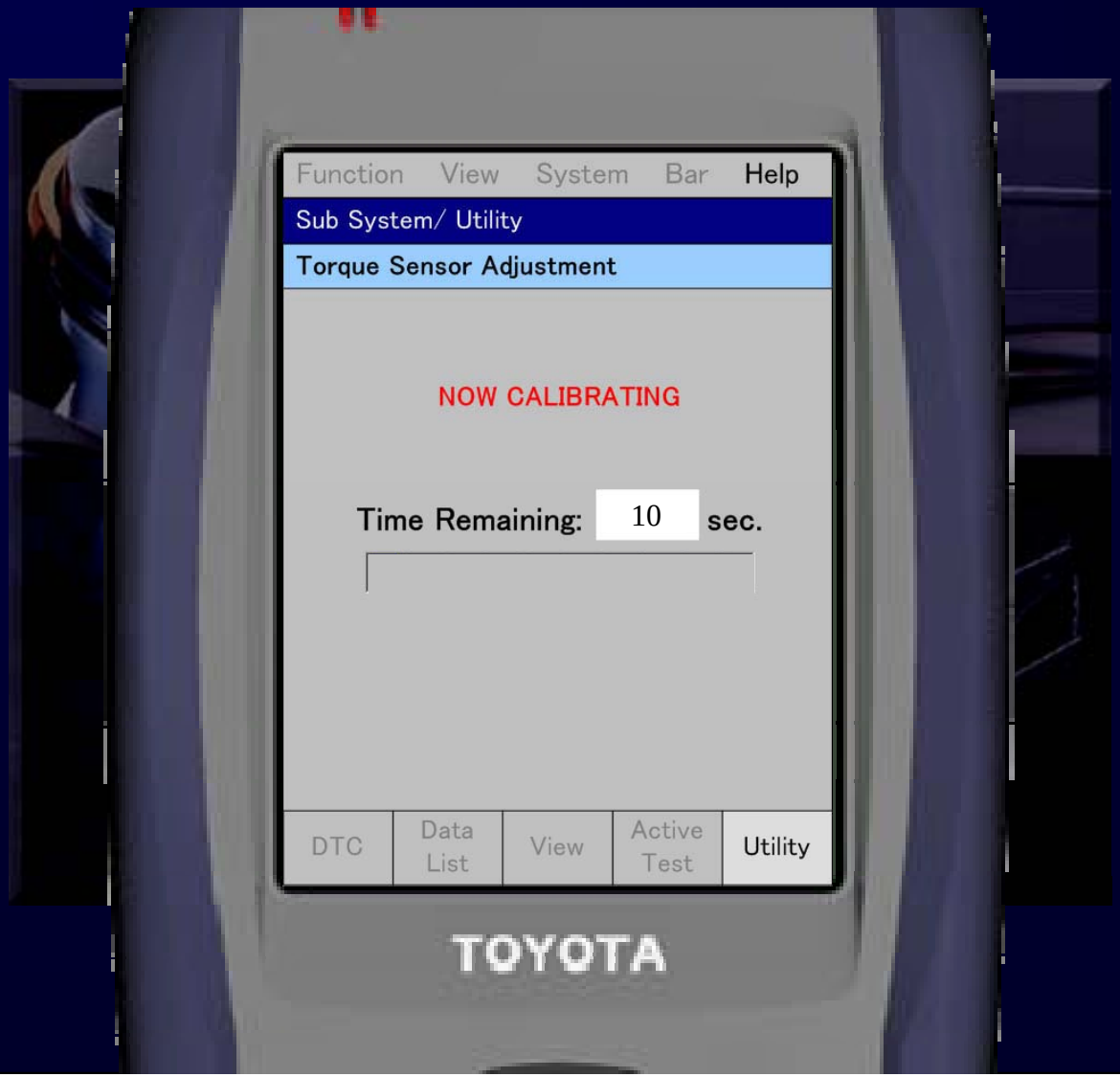
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



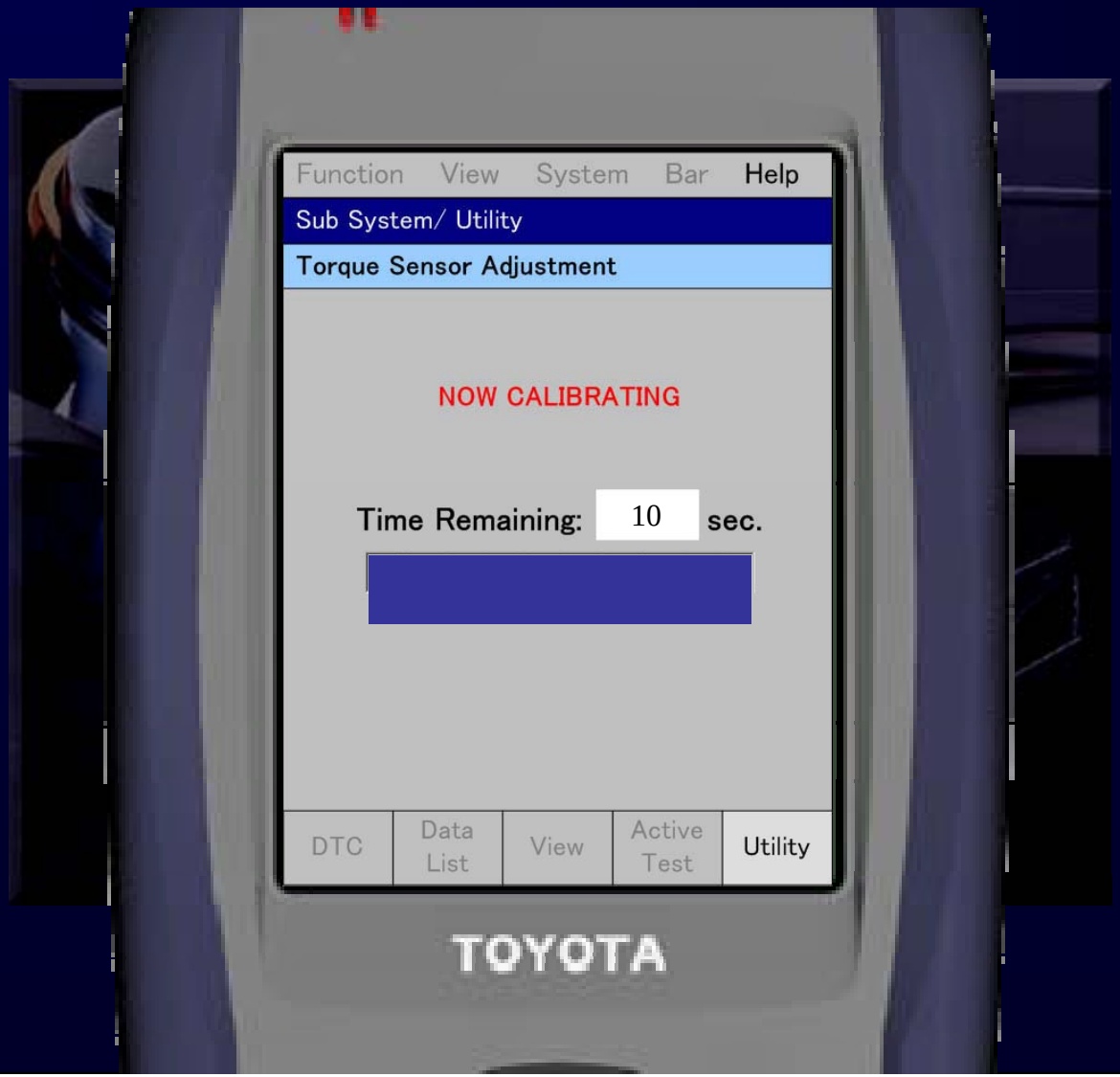
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



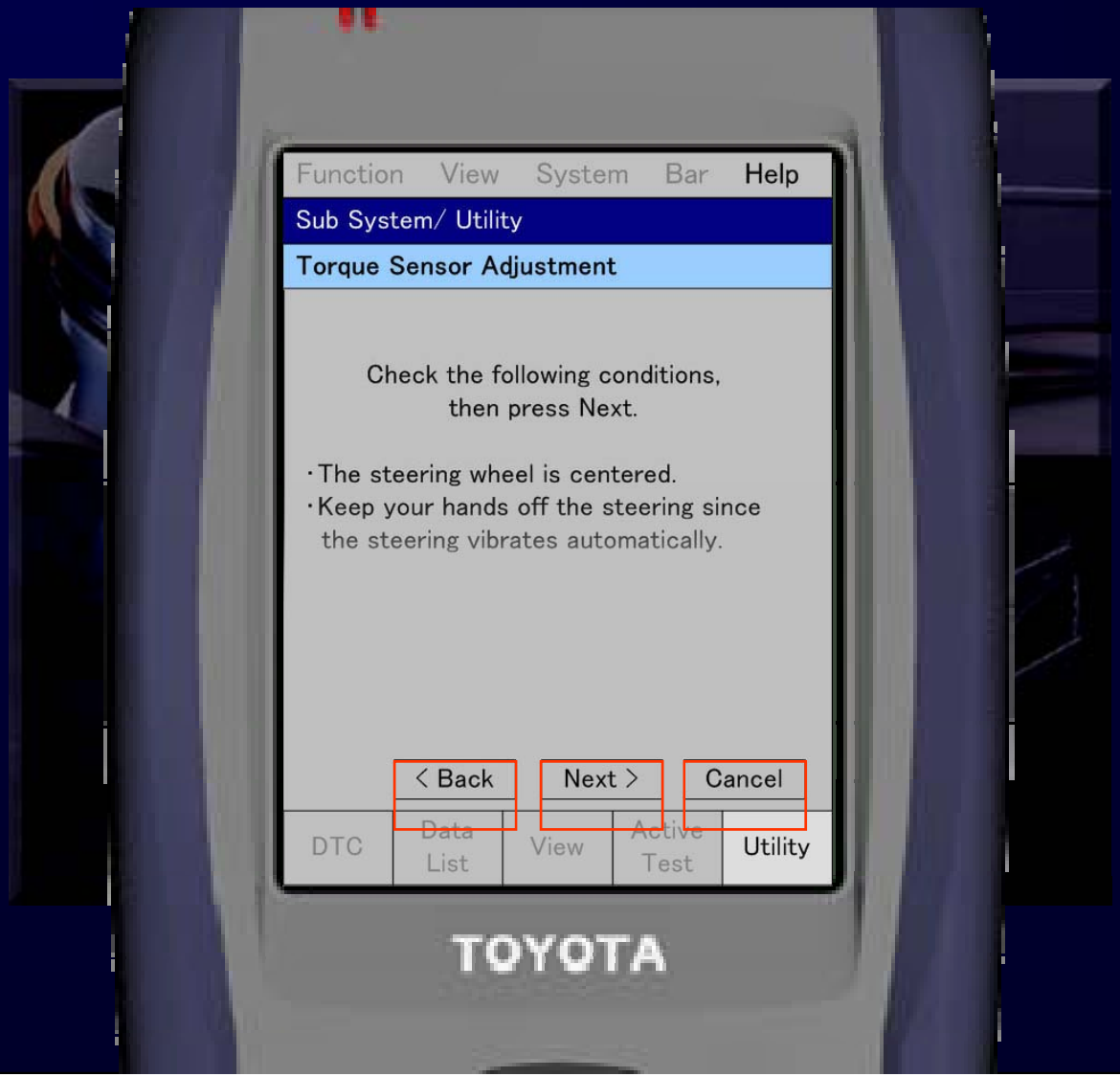
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



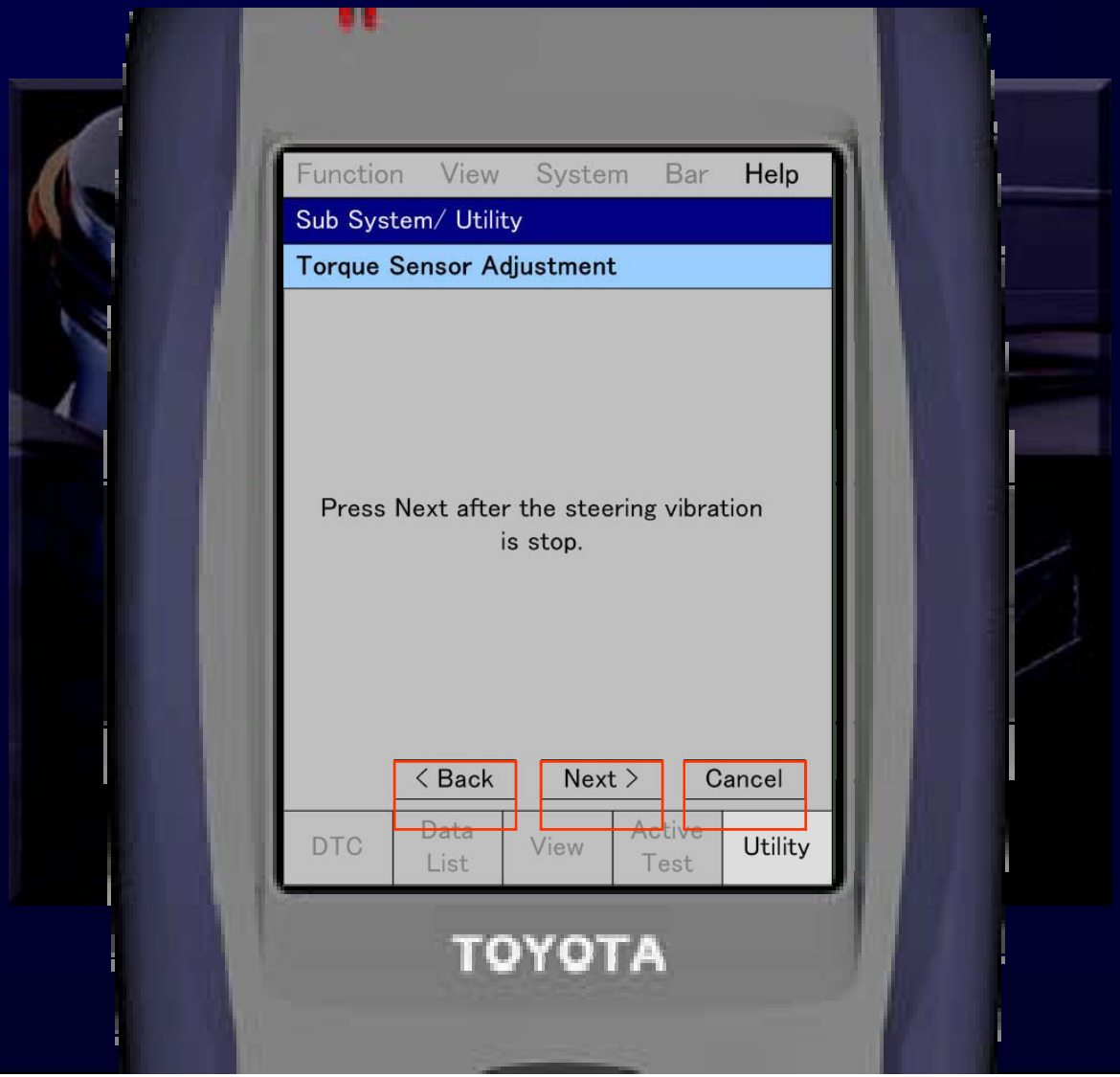
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



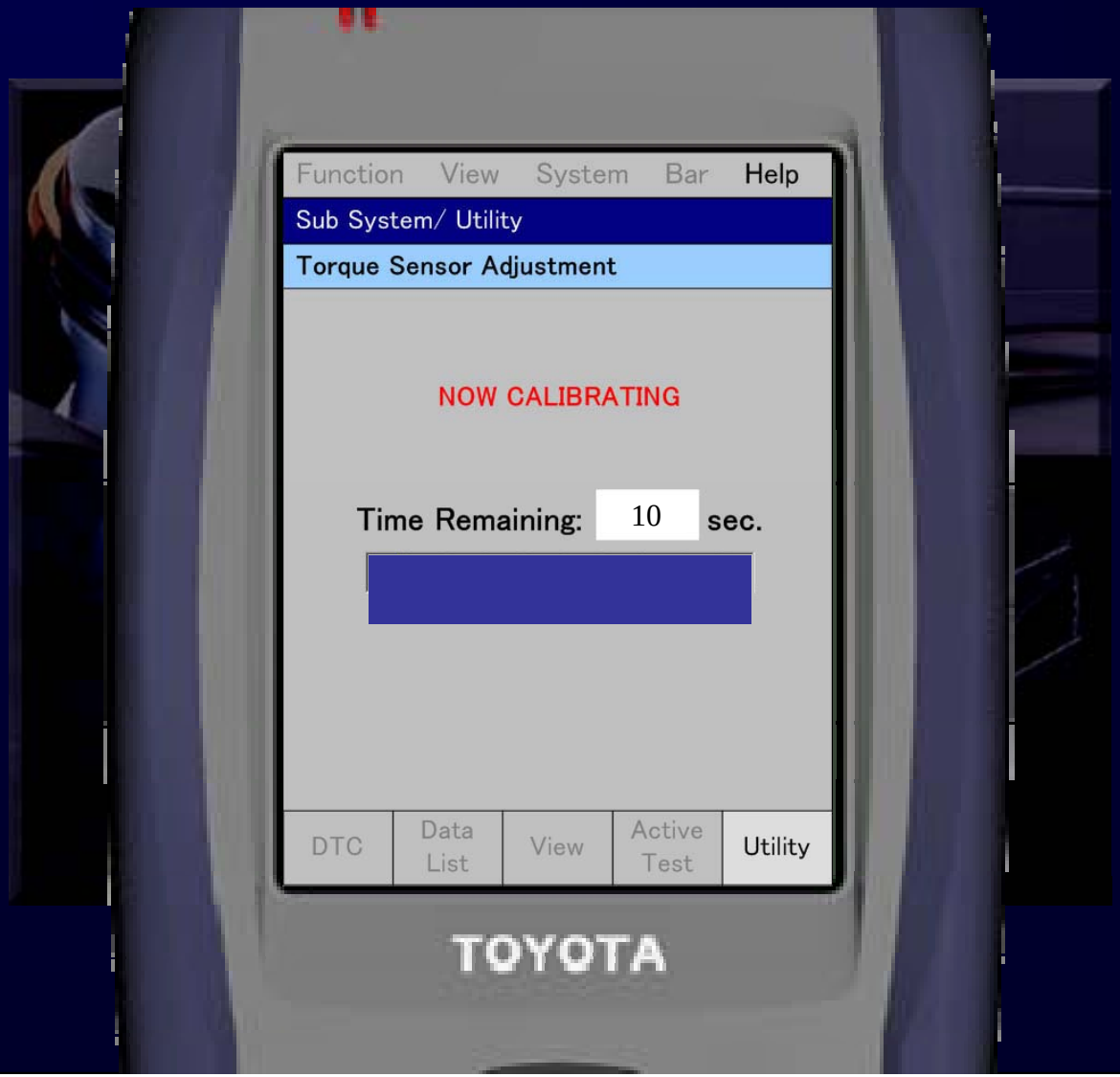
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



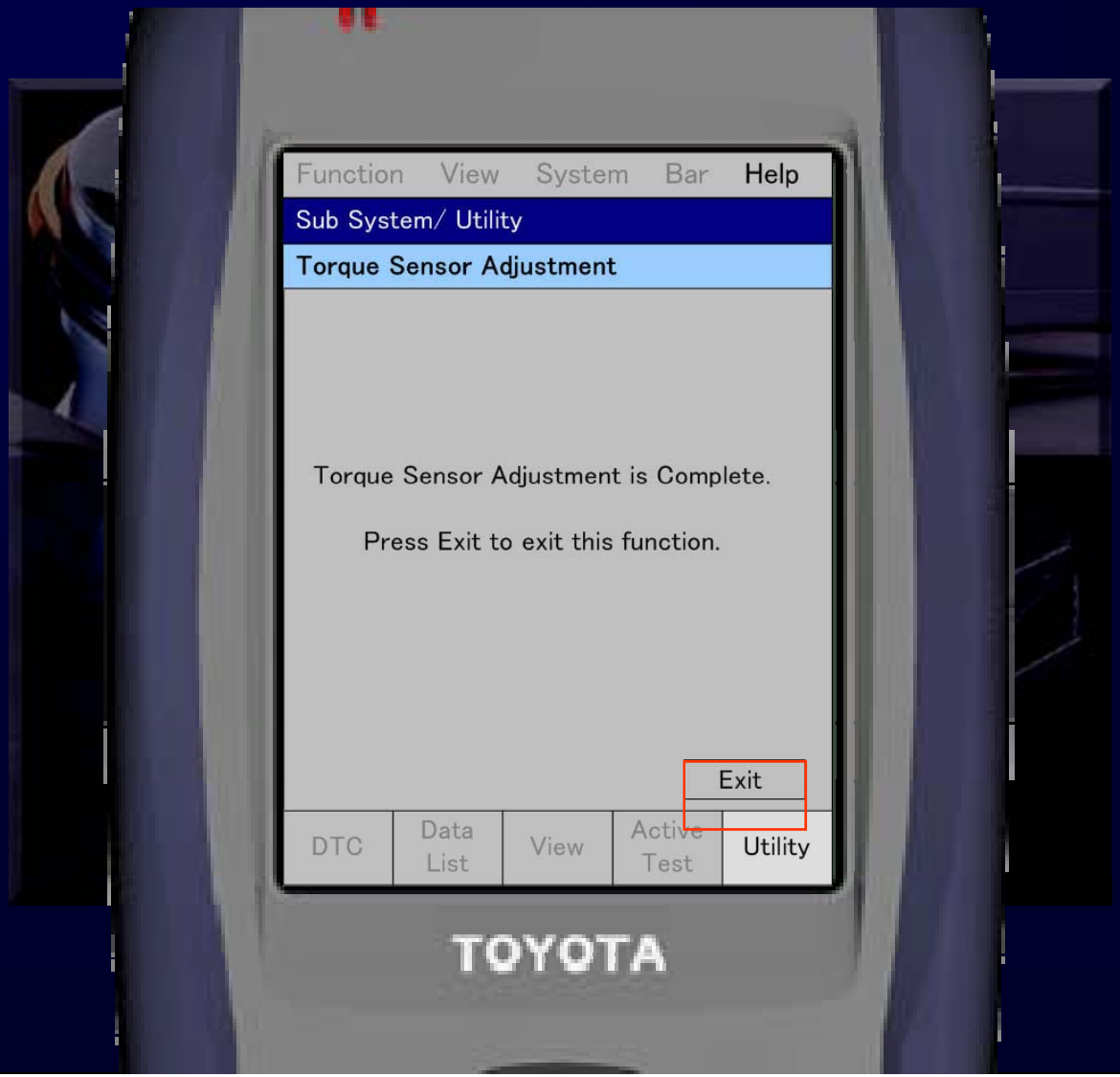
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



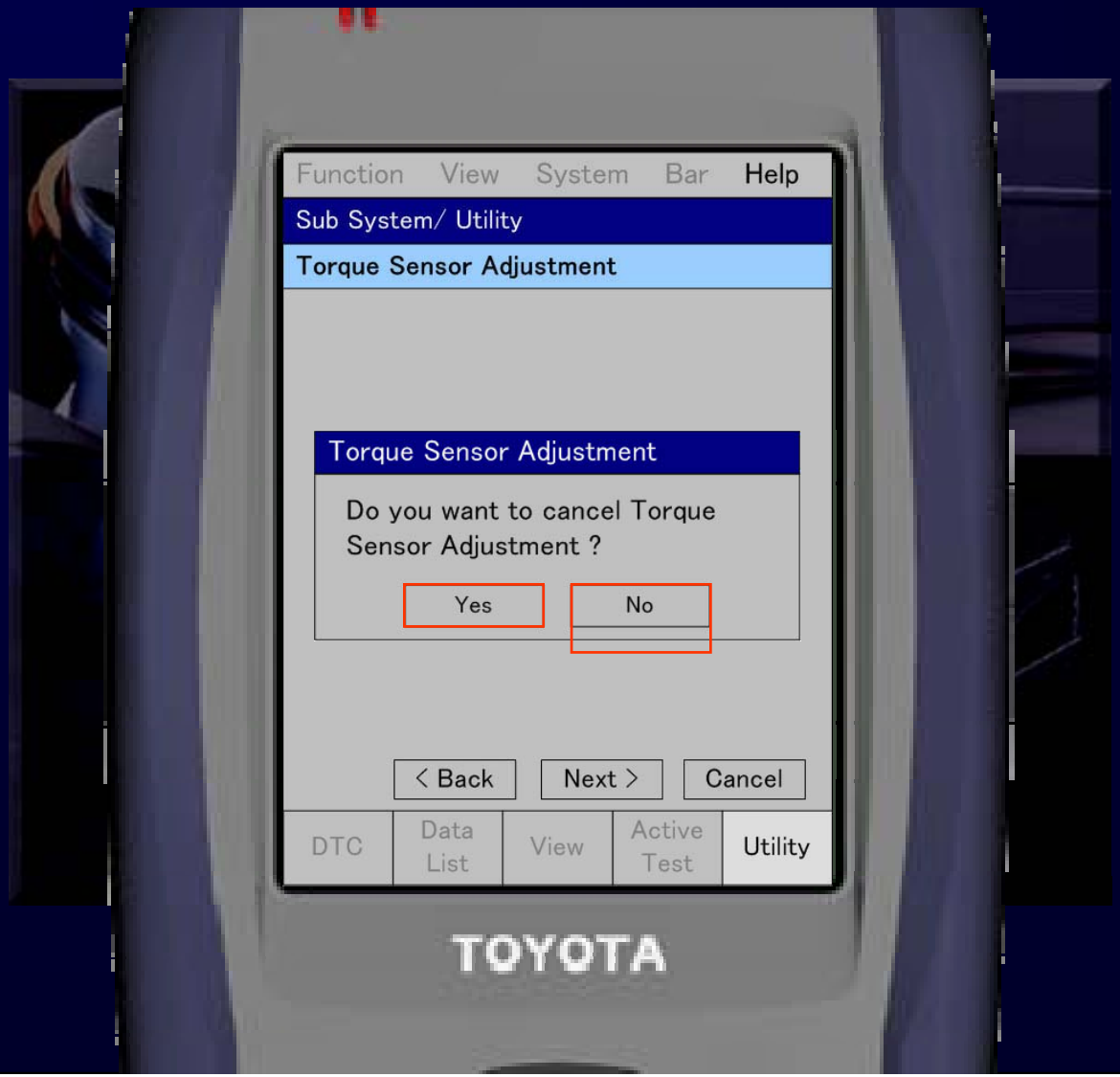
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



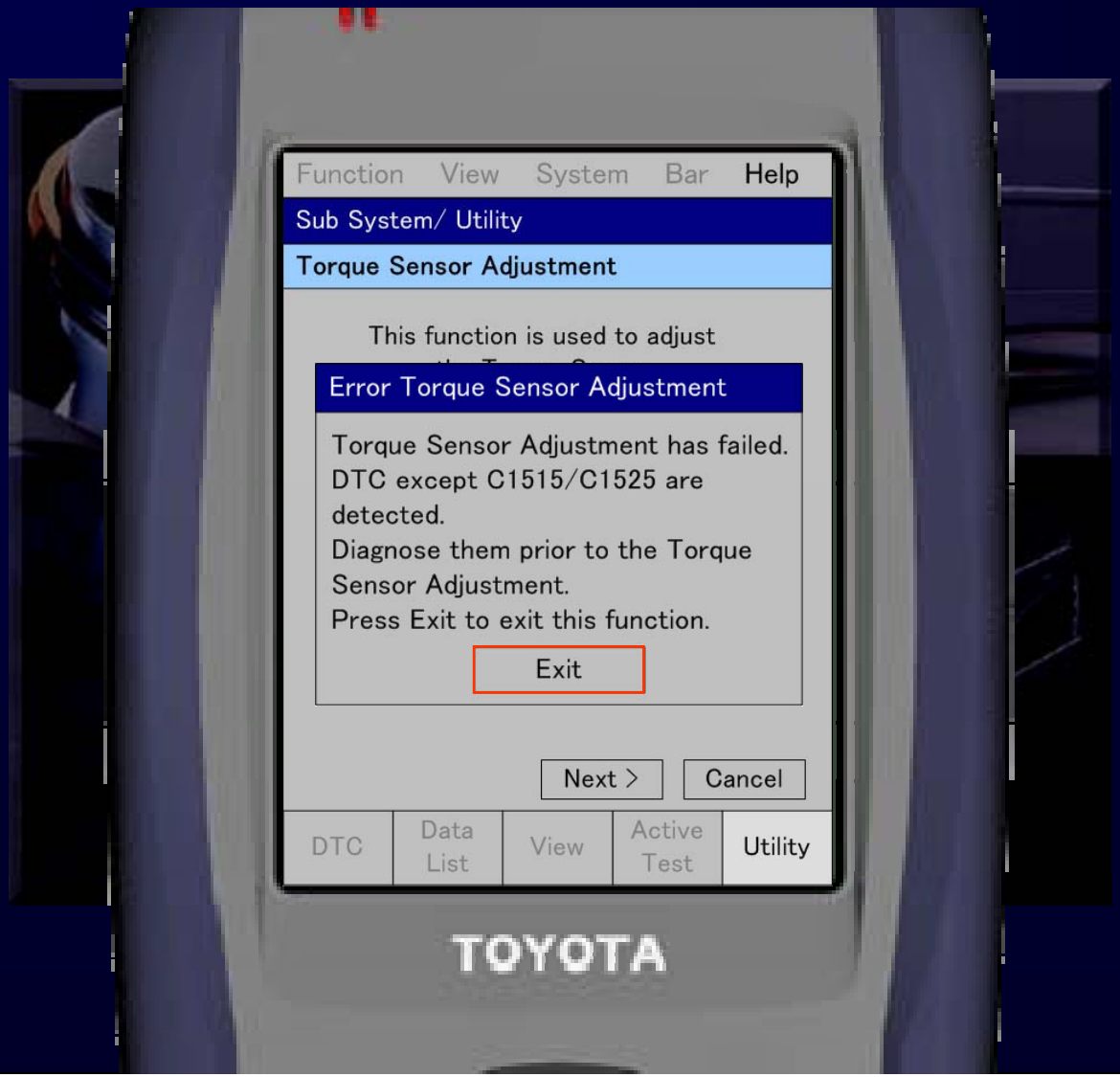
Service Point (Steering)

- Initialization and Calibration
  - Using the intelligent tester-II



Service Point (Steering)

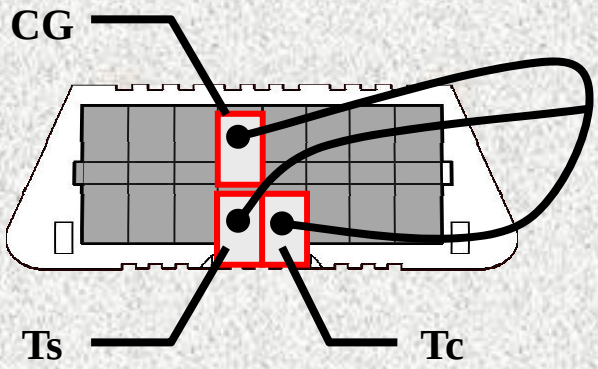
- Initialization and Calibration
  - If DTCs are outputted except C1515 / C1525



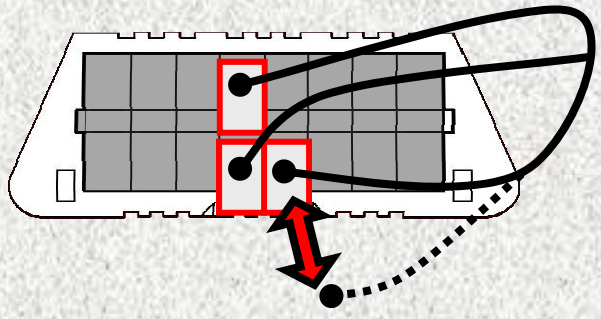
Service Point (Steering)

- Initialization and Calibration
  - Using the SST (09083-18040)
    1. Initialization of EPS ECU

1. Connect terminals Tc,Ts and CG and turn the ignition switch to ON



2. Disconnect and connect terminal Tc 20 times within 20sec.



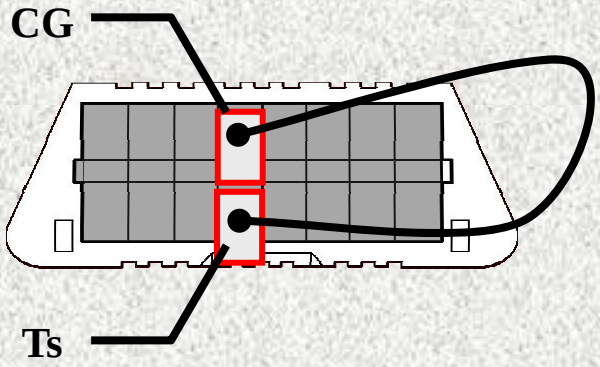
3. Confirm the P/S warning light indicates

4. Turn the ignition switch to OFF

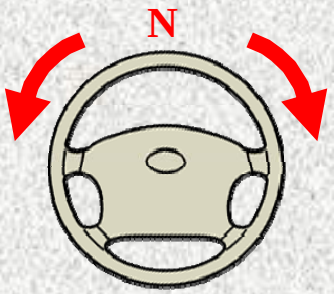
Service Point (Steering)

- Initialization and Calibration
  - Using the SST (09083-18040)
    2. Calibration of motor rotation angle sensor

1. Connect terminals Ts and CG and turn the ignition switch to ON



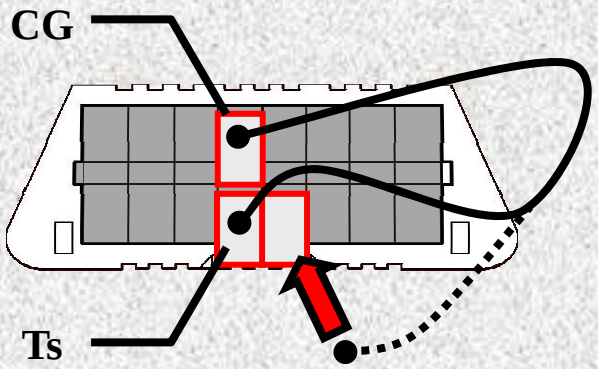
2. Turn the steering 45 degree or more (both side)



Service Point (Steering)

- Initialization and Calibration
  - Using the SST (09083-18040)
    3. Calibration of torque sensor

1. Connect terminal Tc after calibration of motor rotation angle sensor



2. Confirm the P/S warning light blinks

3. Disconnect SST and turn the ignition switch to OFF