

Chassis

- Automatic Transmission
- Brake Control System
- Steering
- VGRS (Variable Gear Ratio Steering) System
- Tire and Wheel



Chassis

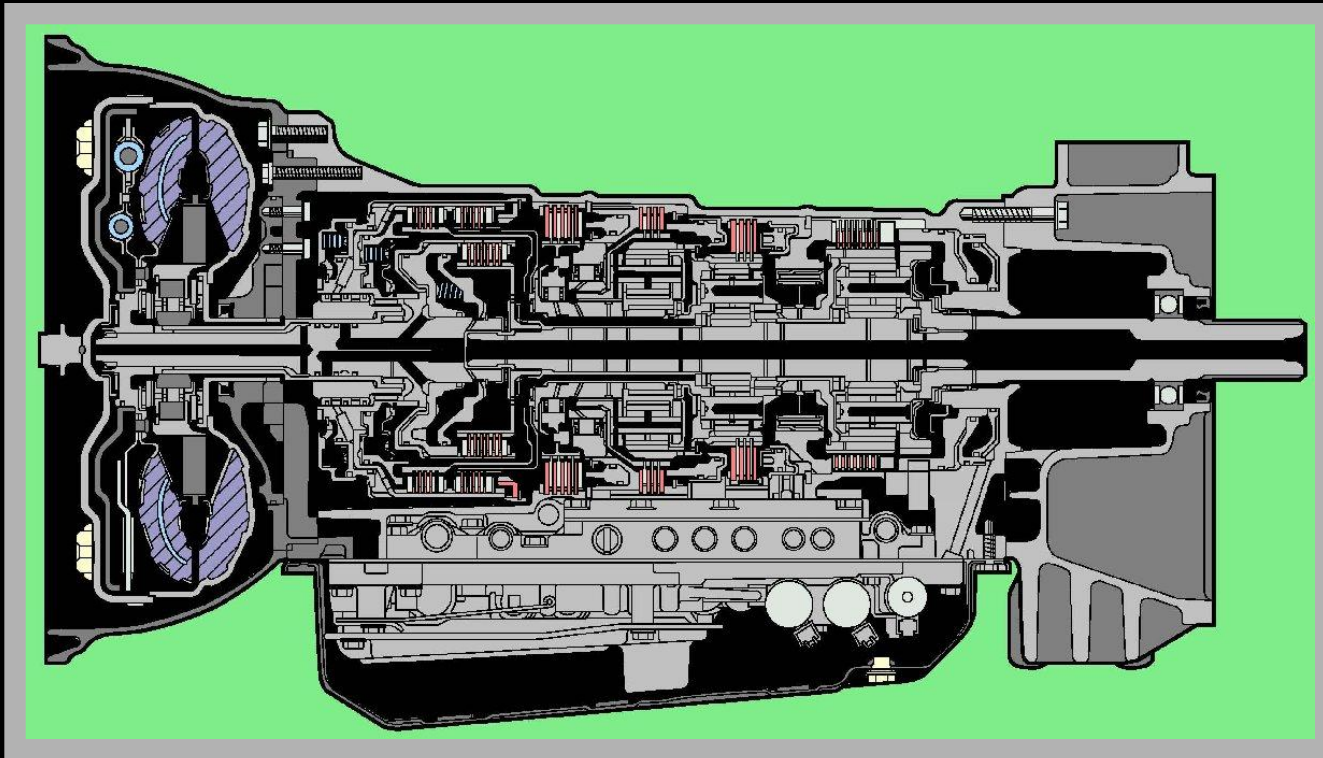
-A

-W

-Q

-V

- Automatic Transmission
 - A750F Automatic Transmission
 - A750F 5-speed automatic transmission (Super ECT) is newly added



Chassis

-A

-W

-Q

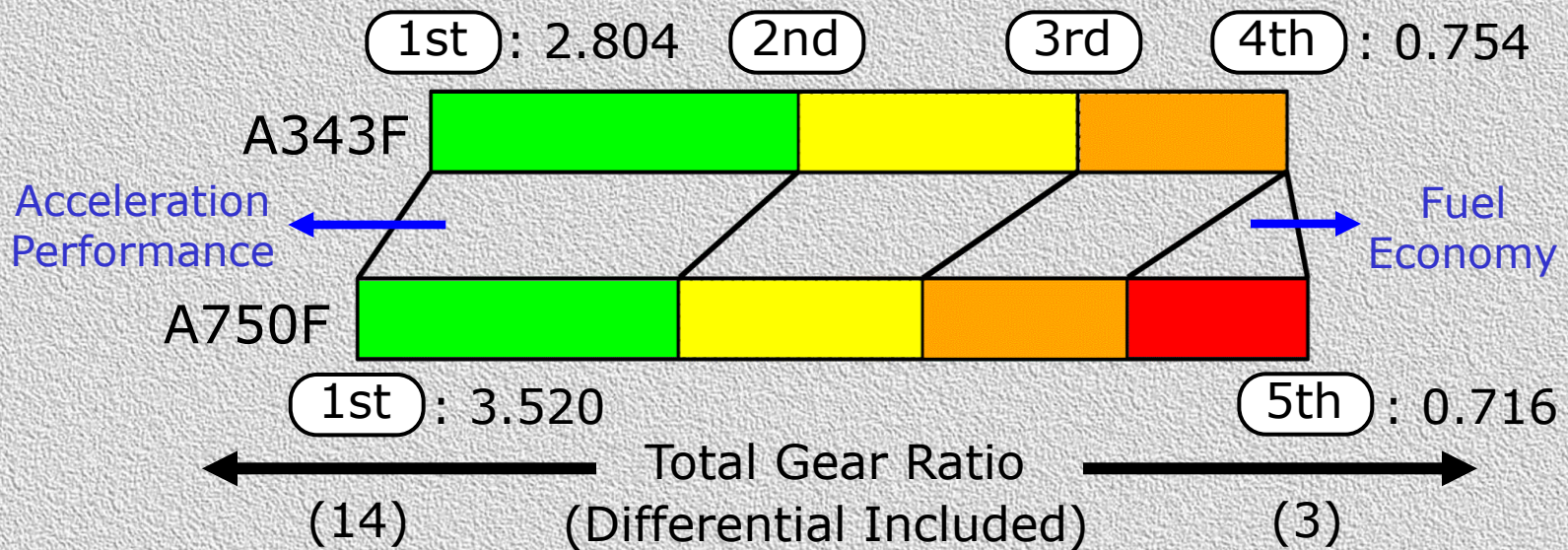
-V

■ Automatic Transmission

• A750F Automatic Transmission

- Fuel economy and dynamic performance have been improved

[Wide Gear Ratio]



Chassis

-A**-W****-Q****-V**

- Automatic Transmission
 - Specification

Model		'03 LX470	'02 LX470
Transmission Type		A750F	A343F
Gear Ratio	1st	3.520	2.804
	2nd	2.042	1.531
	3rd	1.400	1.000
	4th	1.000	0.754
	5th	0.716	—
	Reverse	3.224	2.393
Fluid Capacity [Liters (US qts, Lmp. qts)]		10.8 (11.4, 9.5)	12.0 (12.7, 10.6)
Fluid Type		ATF Type T-IV	ATF Type D-II or equivalent



Chassis

-A

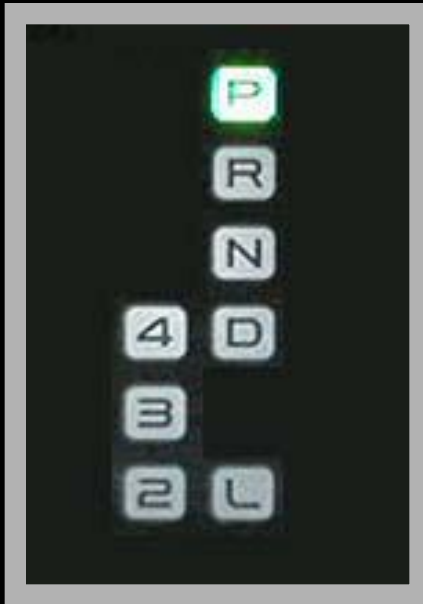
-W

-Q

-V

- Automatic Transmission
 - A750F Automatic Transmission
 - Gate type shift lever is newly used

[Shift Indicator Light]



Chassis

-A

-W

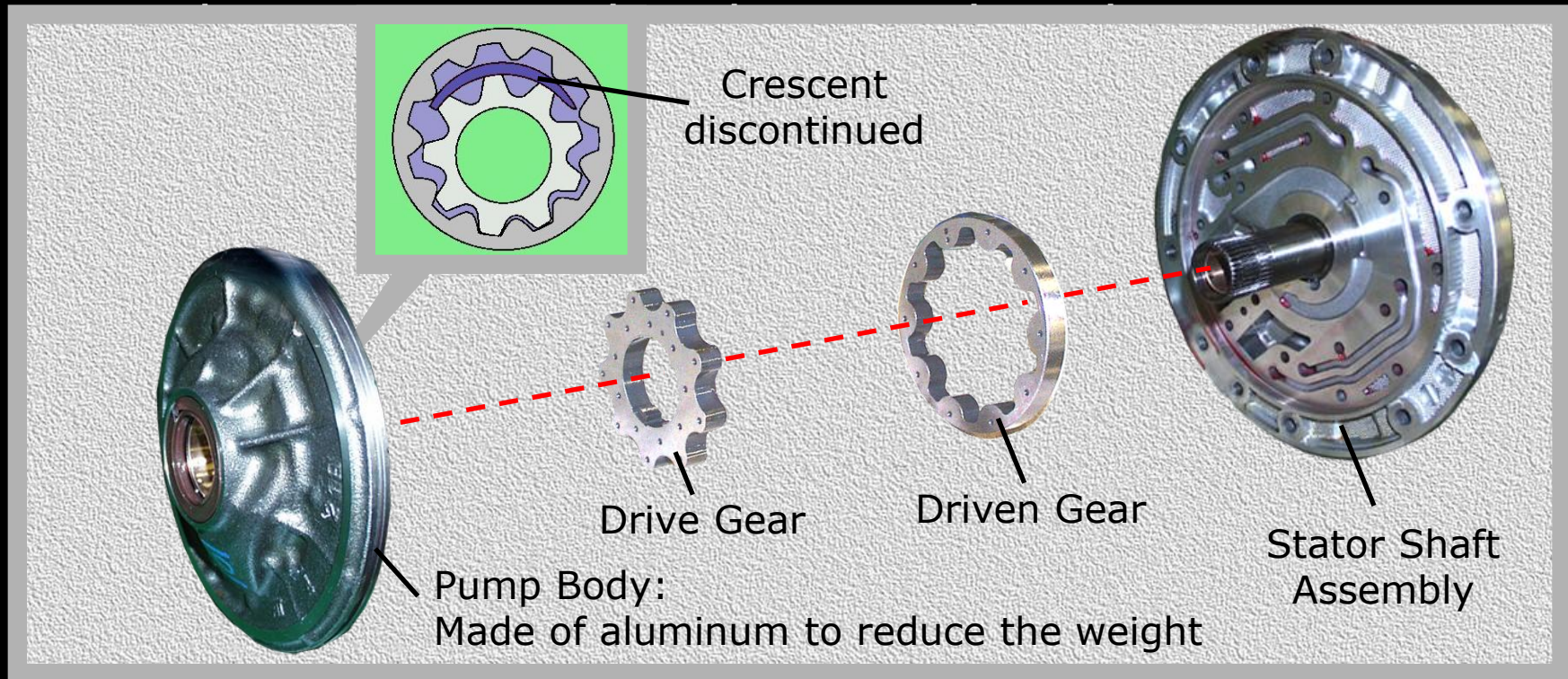
-Q

-V

■ Automatic Transmission

• Oil Pump

- The crescent has been discontinued. As a result oil pump has made more compact and the



Chassis

-A

-W

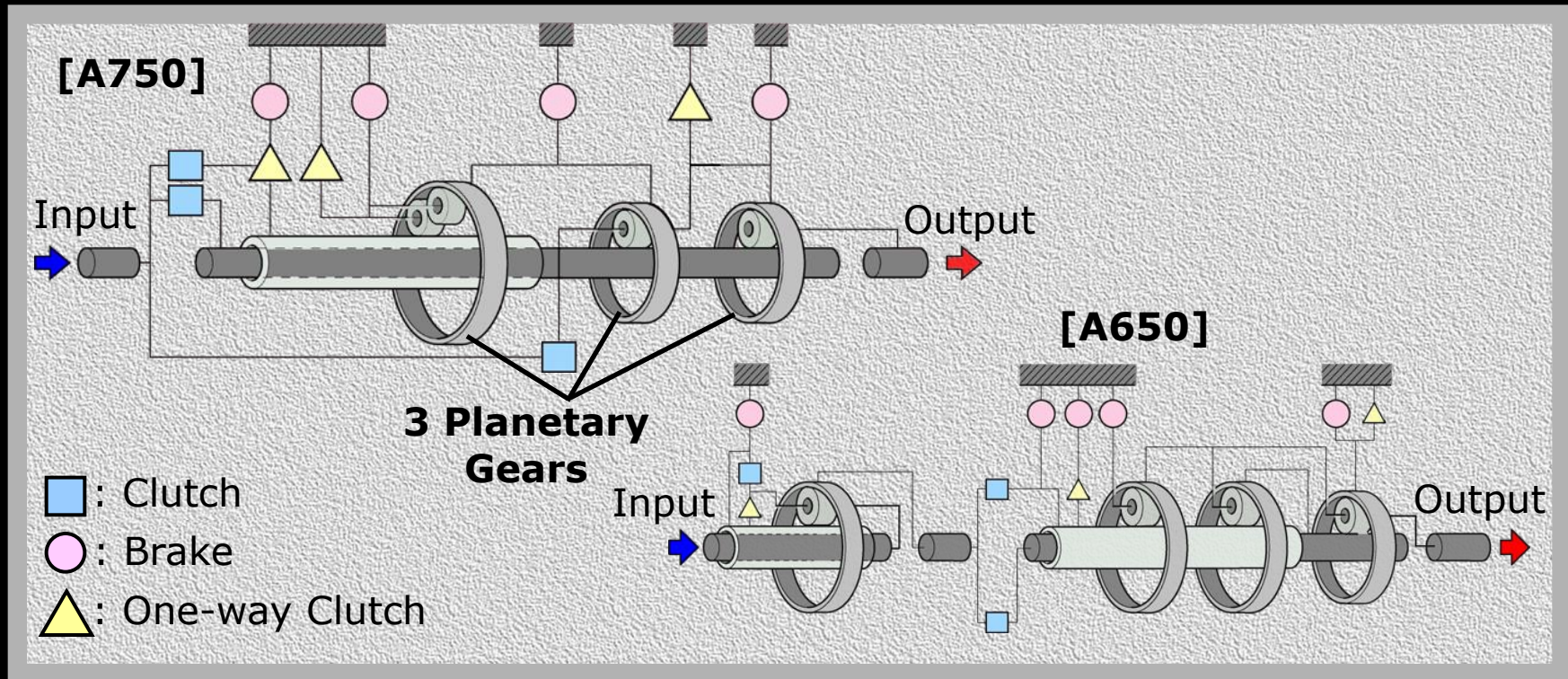
-Q

-V

■ Automatic Transmission

- Planetary Gear Unit

- The 5-speed configuration has been achieved without increasing the number of planetary gear



Chassis

-A

-W

-Q

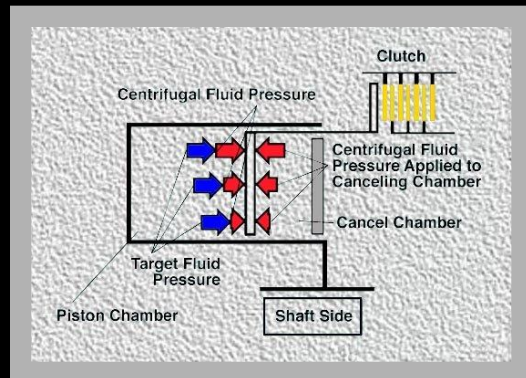
-V

■ Automatic Transmission

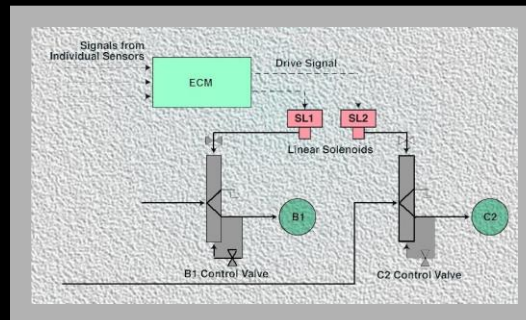
• Various Control

– A750F are performing the following controls

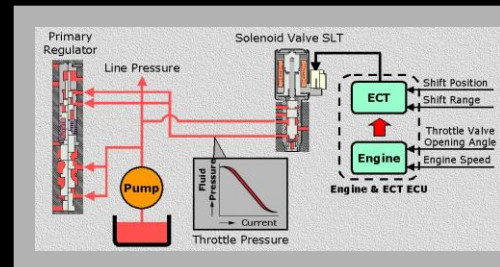
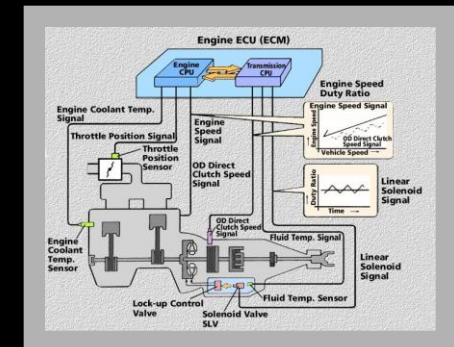
Centrifugal Fluid Pressure canceling



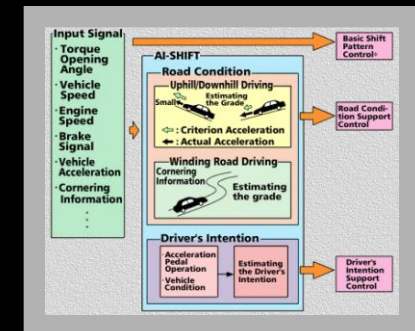
Clutch Pressure Control



Flex Lock-up Clutch Control



Line Pressure Optimal Control



AI (Artificial Intelligence)
-shift Control



Chassis

-A

-W

-Q

-V

■ Brake System

• Specification

- Front caliper type has been changed for -A and -W models

Destination		-A, -W	-Q, -V
Master Cylinder	Type	Single (Double Piston)	←
	Diameter [mm (in.)]	26.99 (1.06)	←
Brake Booster	Type	Hydraulic	←
Front Brake	Type	Ventilated Disc	←
	Caliper Type	S15+13	S14+12
	Wheel Cylinder Dia. [mm (in.)] (Front cylinder + Rear cylinder)	51.1 x 2 + 45.4 x 2 (2.01 x 2 + 1.79 x 2)	48.1 x 2 + 42.85 x 2 (1.89 x 2 + 1.69 x 2)
	Rotor Size (D x T) [mm (in.)]	313 x 32 (12.32 x 1.26)	←
Rear Brake	Type	Ventilated Disc	←
	Wheel Cylinder Dia. [mm (in.)]	48.1 (1.89)	←
	Rotor Size (D x T) [mm (in.)]	329.4 x 18 (12.97 x 0.71)	←



Chassis

-A

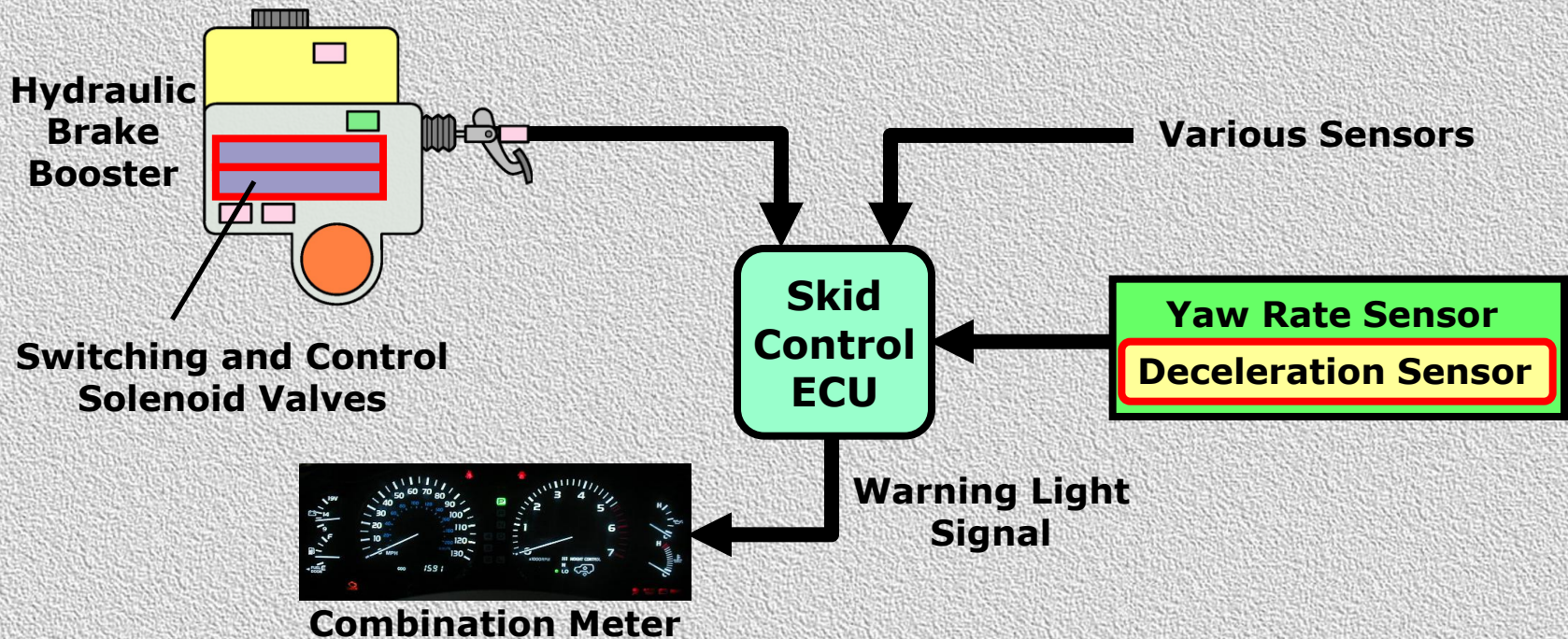
-W

-Q

-V

■ Brake Control System

- ABS with EBD, Brake Assist, A-TRAC & VSC System
 - The deceleration sensor and solenoid valves are changed



Chassis

-A

-W

-Q

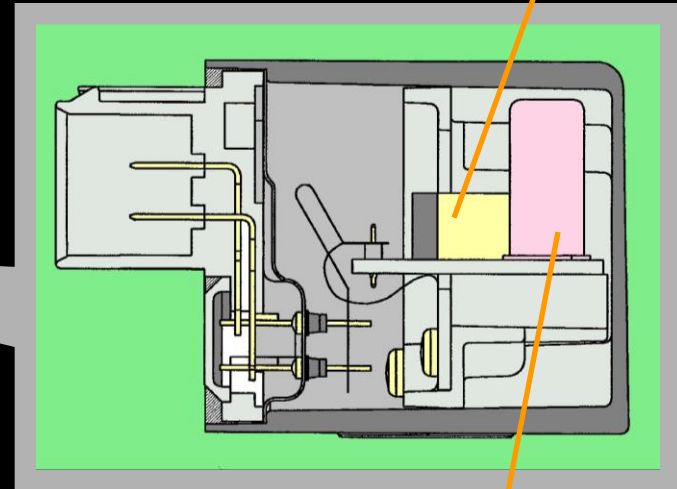
-V

■ Brake Control System

- Yaw Rate and Deceleration Sensor
 - Deceleration sensor has been integrated in the yaw rate sensor



Deceleration
Sensor (G Sensor)



Yaw Rate
Sensor



Chassis

-A

-W

-Q

-V

■ Brake Control System

- Switching and Control Solenoid Valves
 - The resistance value of the coil of the solenoid valve was changed for continuation operation time extension of the system

Solenoid Valve	Regulator cut solenoid Pressure holding solenoid (4-wheels)	Accumulator cut solenoid Master cylinder cut solenoid (FL/FR)	Continuation Operation Time
'03 LX470	Approx. 7.2 Ω	Approx. 4.3 Ω	3 minutes
'02 LX470	Approx. 5.0 Ω	Approx. 3.7 Ω	50 seconds

NOTE

When the voltage is 13 V:

New Model: 7.2 Ω x 7.2 Ω x 1.81 A = 23.58 W

Previous Model: 5 Ω x 5 Ω x 2.60 A = 33.8 W



Chassis

-A

-W

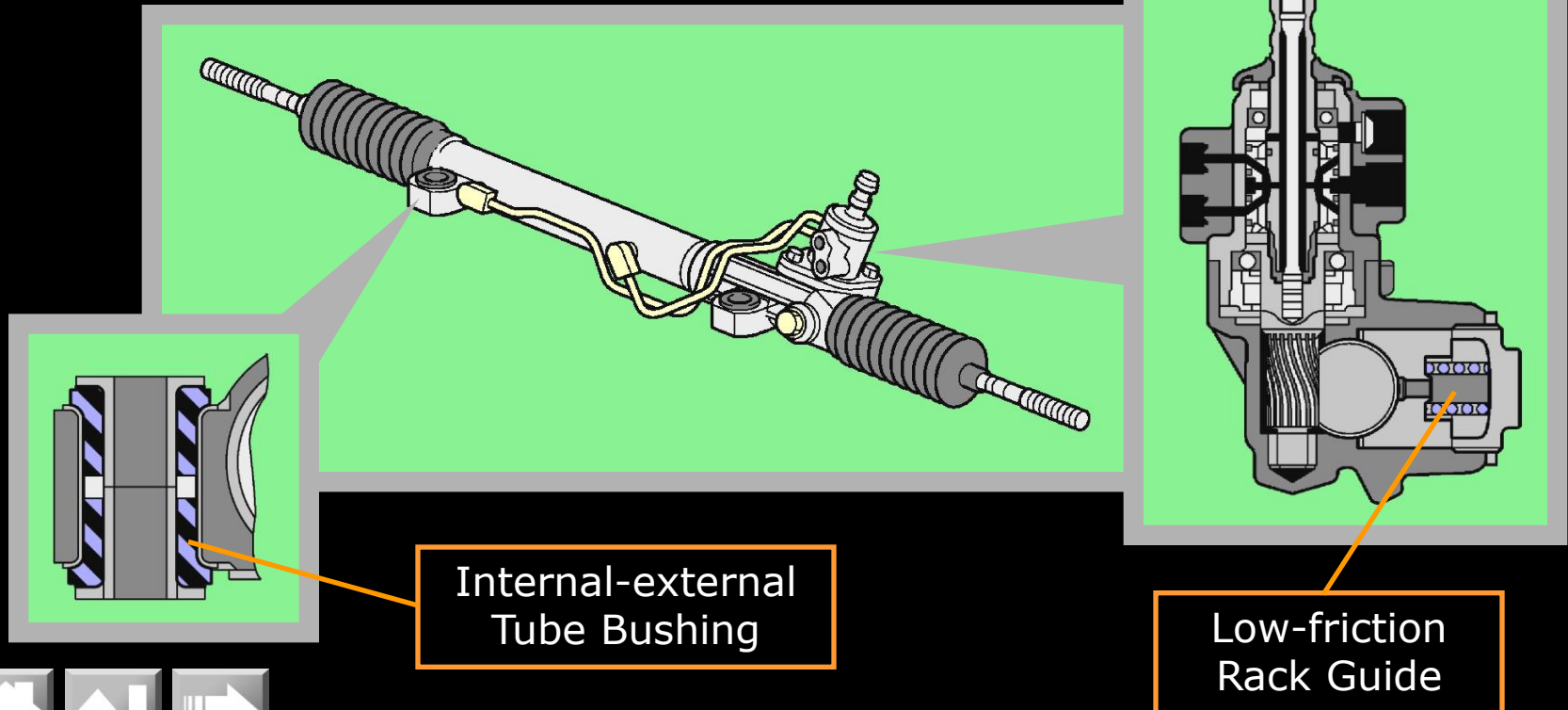
-Q

-V

■ Steering

• Overall

- Internal-external tube bushings and low friction rack guide have been adopted to facilitate a natural steering feeling



Chassis

-A

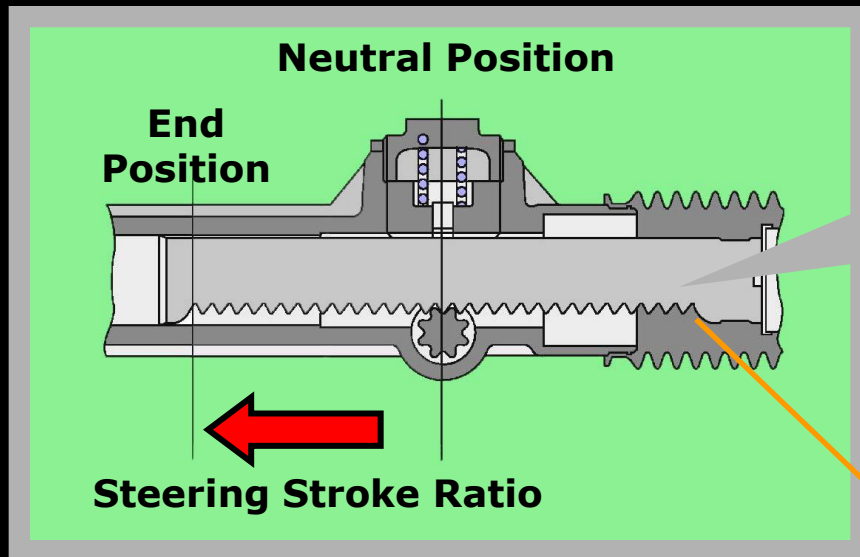
-W

-Q

-V

■ Steering

- Reverse Variable Gear Ratio Type Rack Bar
 - Gear ratio near the end position of the rack bar is shorter than near the neutral steering position



Hollow Type
Steering Rack Bar

Chassis

-A

-W

-Q

-V

- Steering
 - Specification

Item	'03 LX470 (w/ VGRS)	'02 LX470
Gear Ration (Overall)	12.4 – 18.0*	19.8
No. of Turns Lock to Lock	2.4 - 3.5*	3.8
Fluid Type	ATF Type DEXRON® II of III	←

*: The gear ratio and the number of lock-to-lock turns are made variable for the VGRS system



Chassis

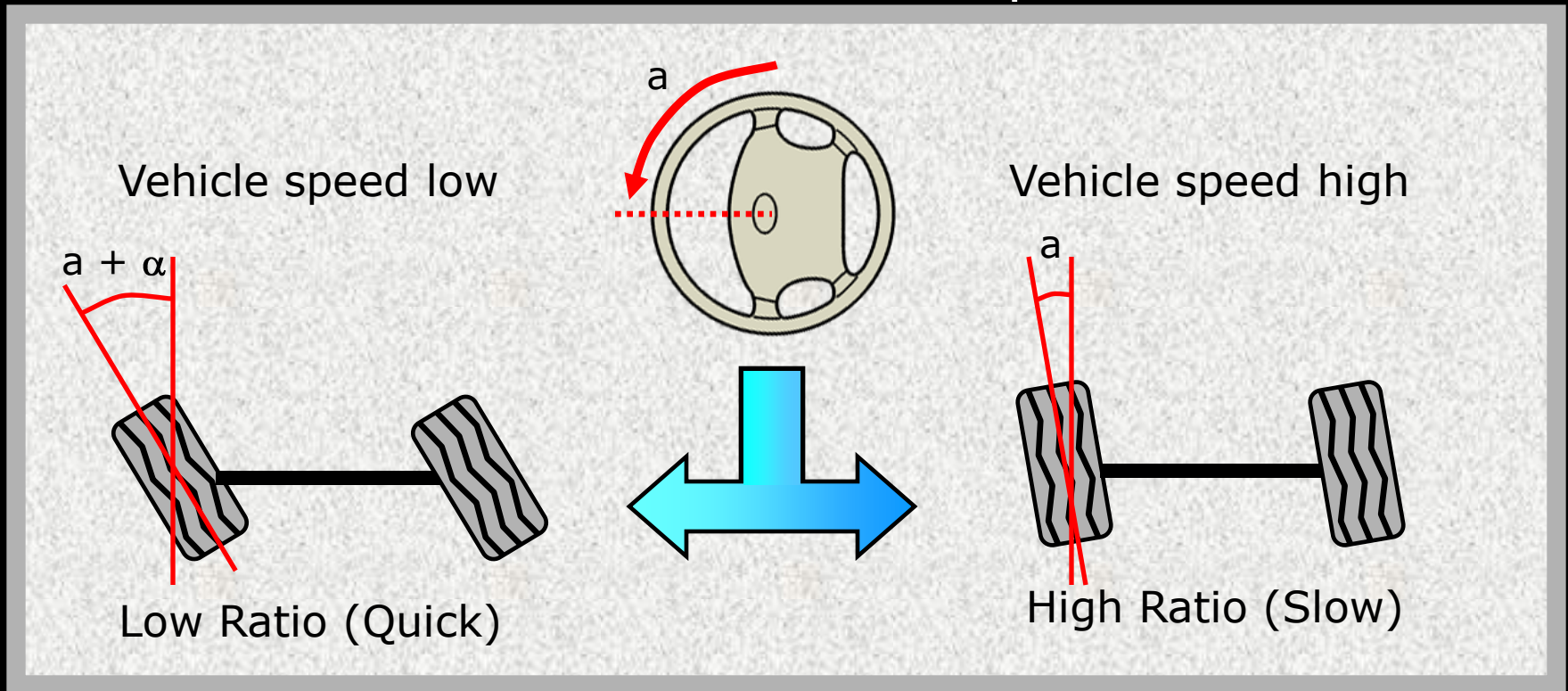
-A

-W

-Q

-V

- VGRS (Variable Gear Ratio Steering) System
 - General
 - The steering gear ratio will be changed in accordance with the vehicle speed



Chassis

-A

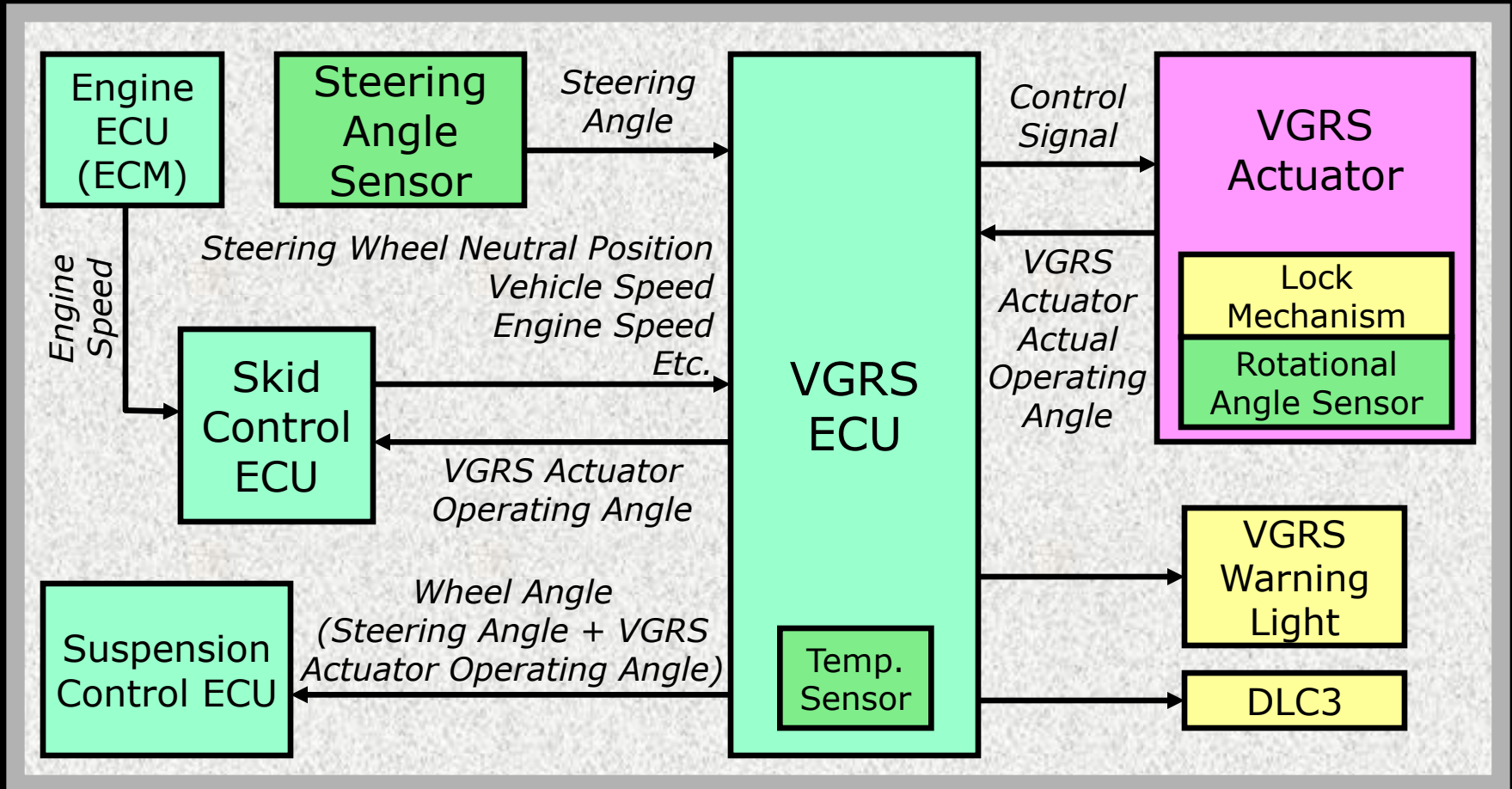
-W

-Q

-V

■ VGRS System

• System Diagram (Main Signal)



Chassis

-A

-W

-Q

-V

- VGRS System
 - Location

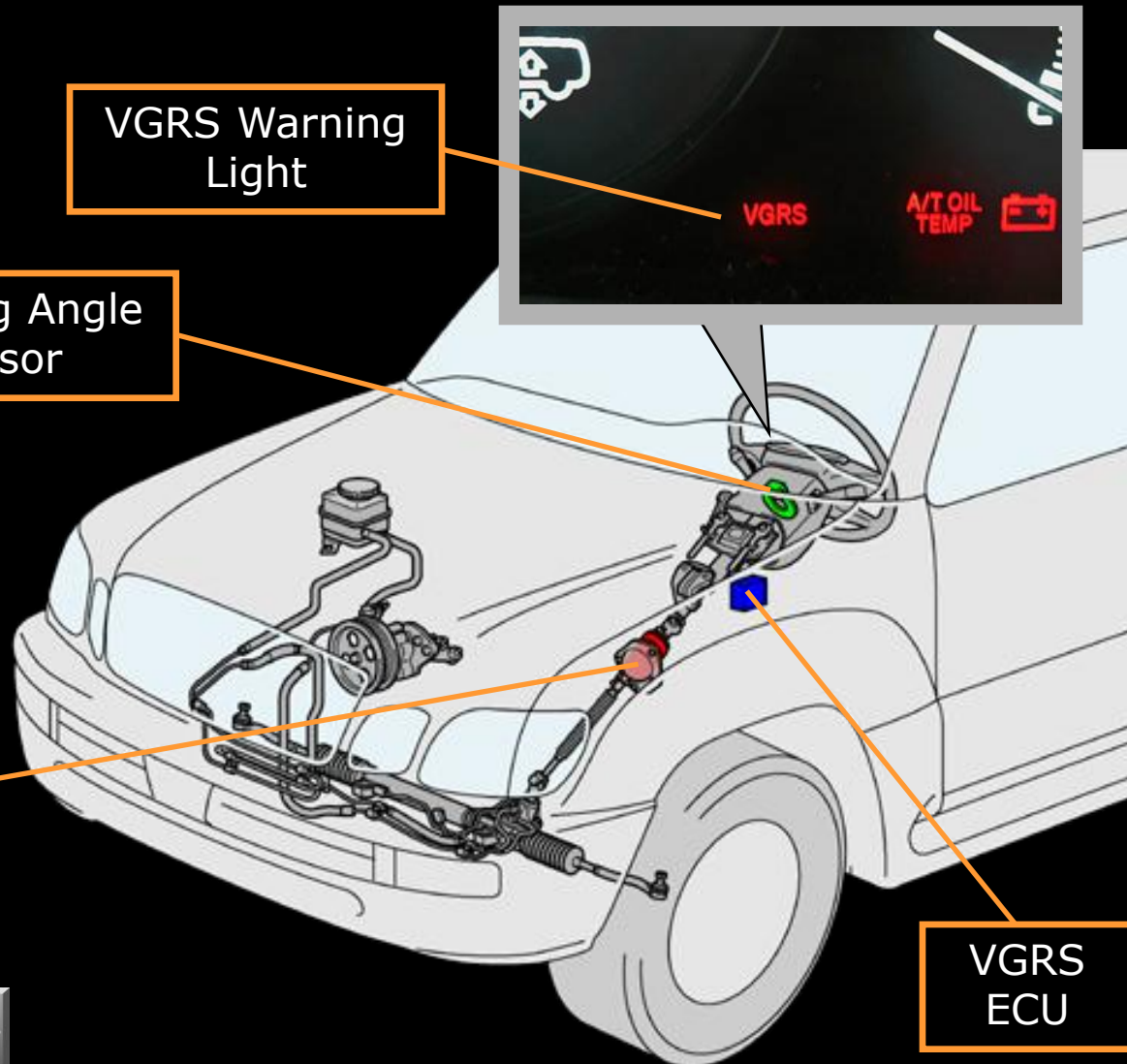
Combination Meter

VGRS Warning Light

Steering Angle Sensor

VGRS Actuator

VGRS ECU



Chassis

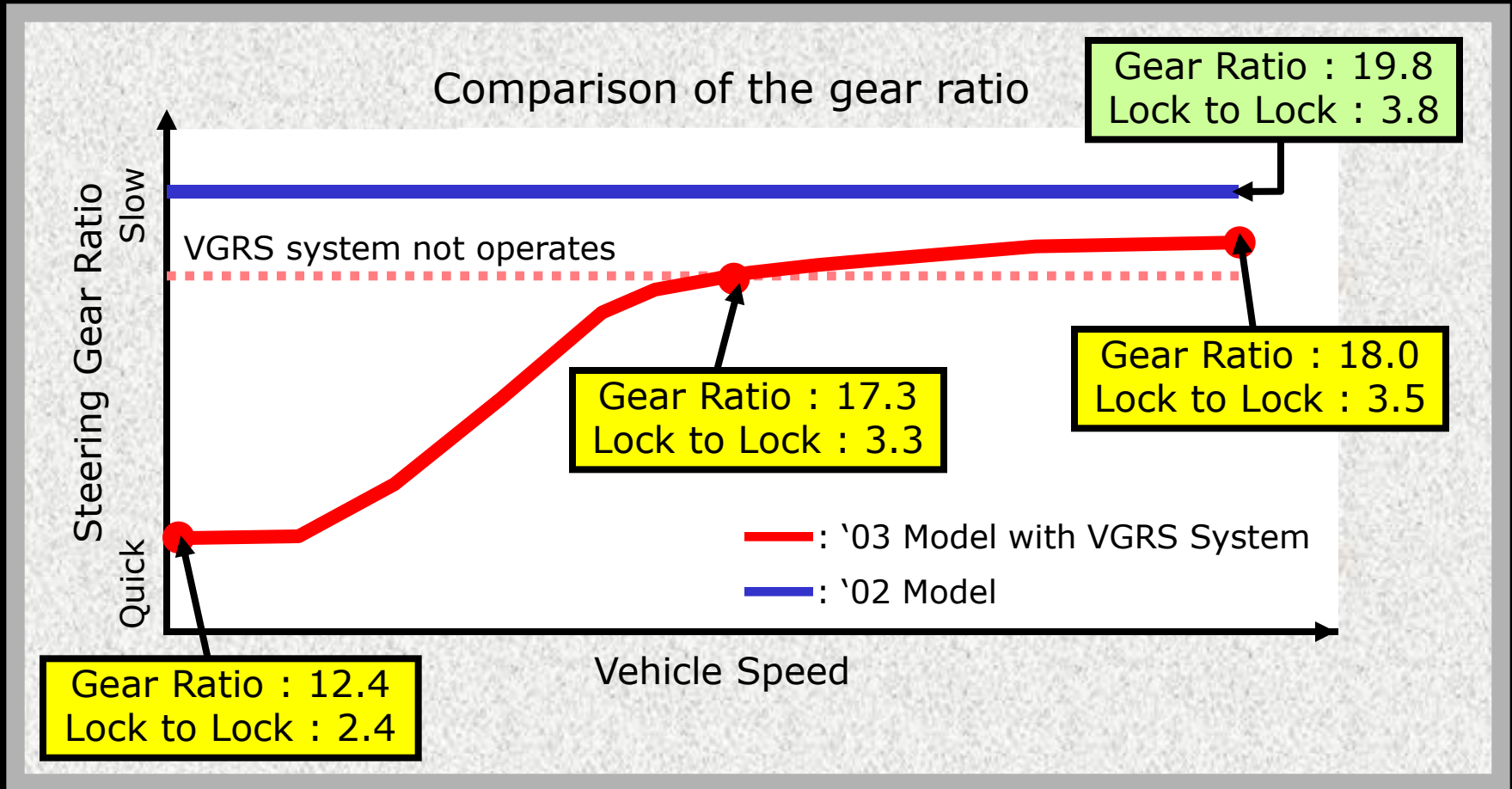
-A

-W

-Q

-V

- VGRS System
 - Steering Gear Ratio



Chassis

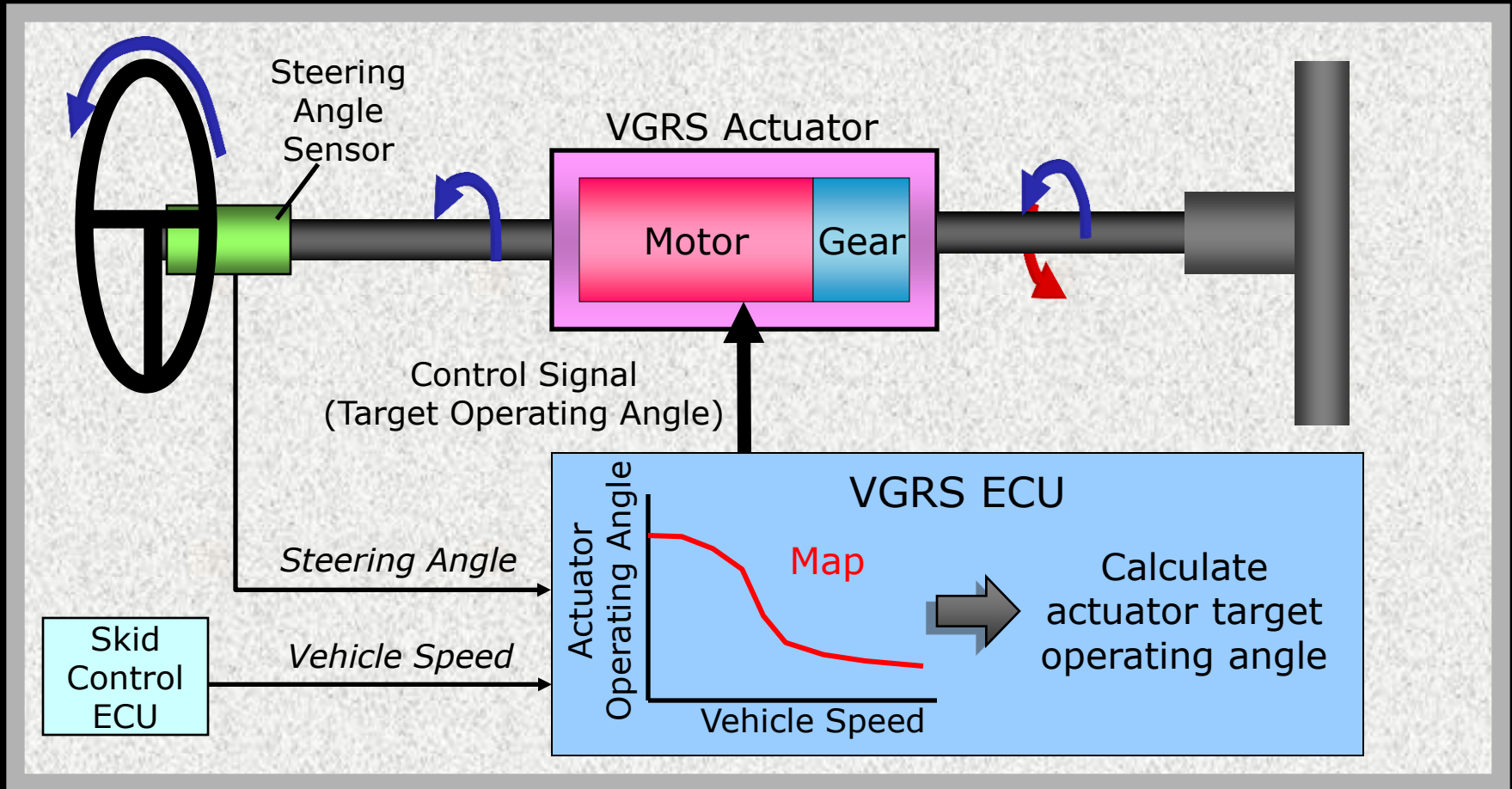
-A

-W

-Q

-V

- VGRS System
 - Normal Operation



Chassis

-A

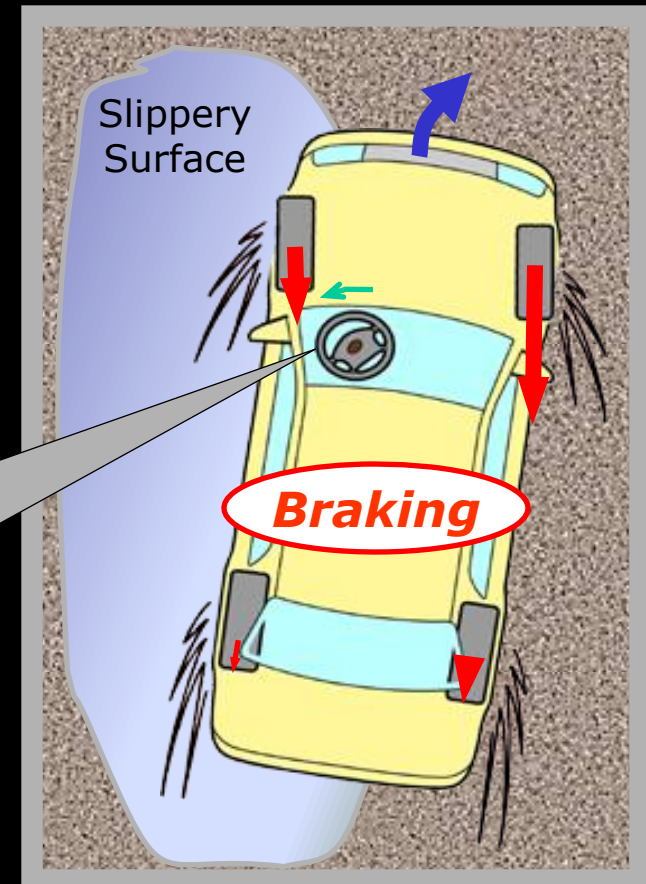
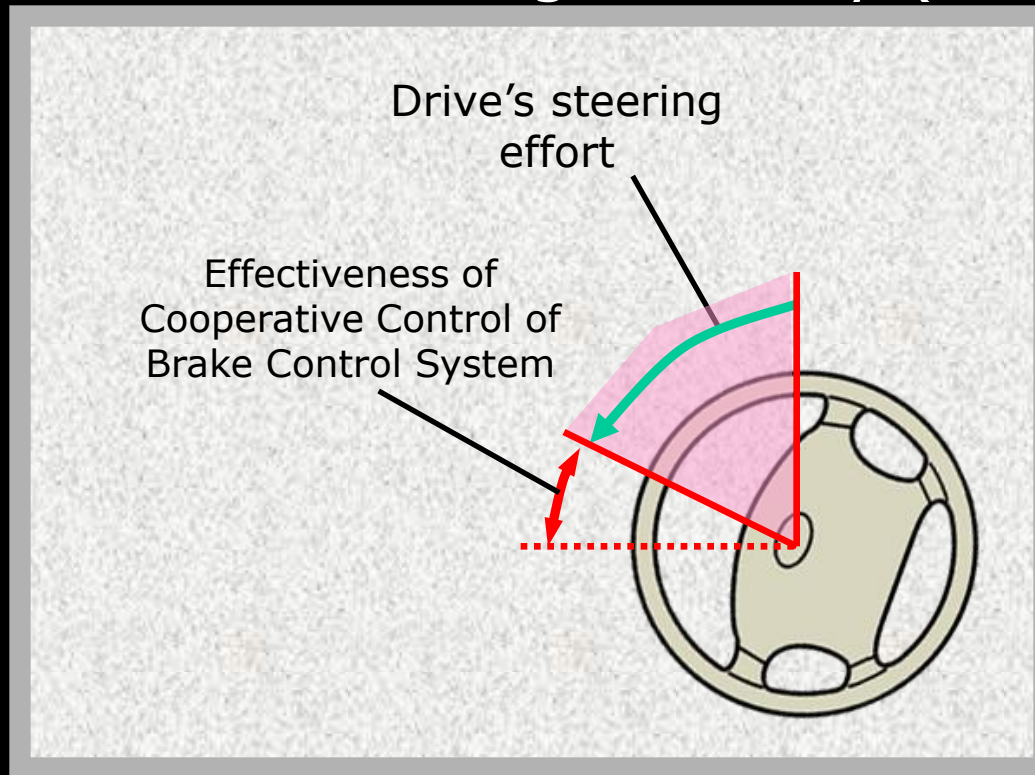
-W

-Q

-V

■ VGRS System

- Cooperative Control of Brake Control System
 - For example, in order to enable quicker steering when braking suddenly (VSC active)



Chassis

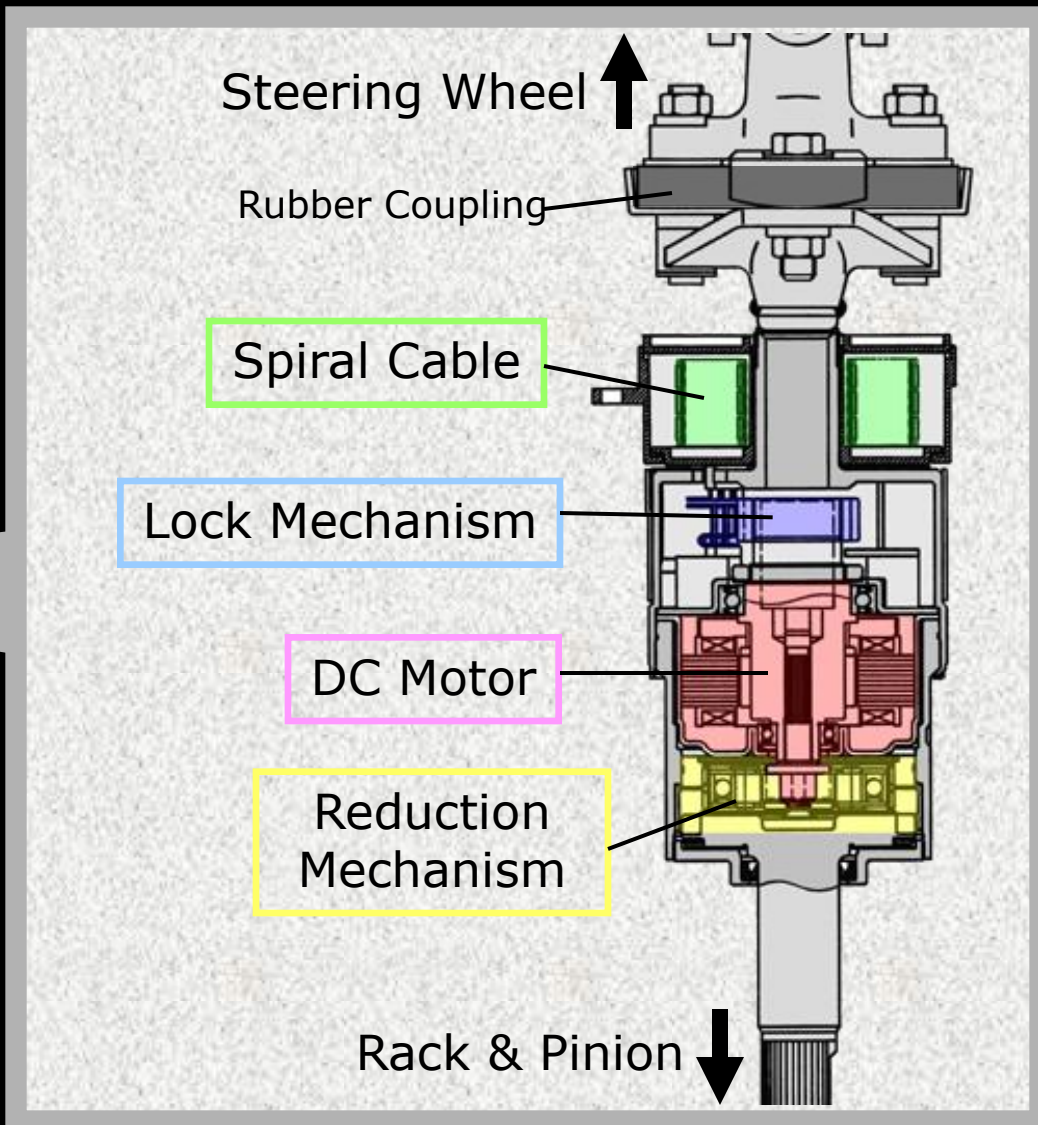
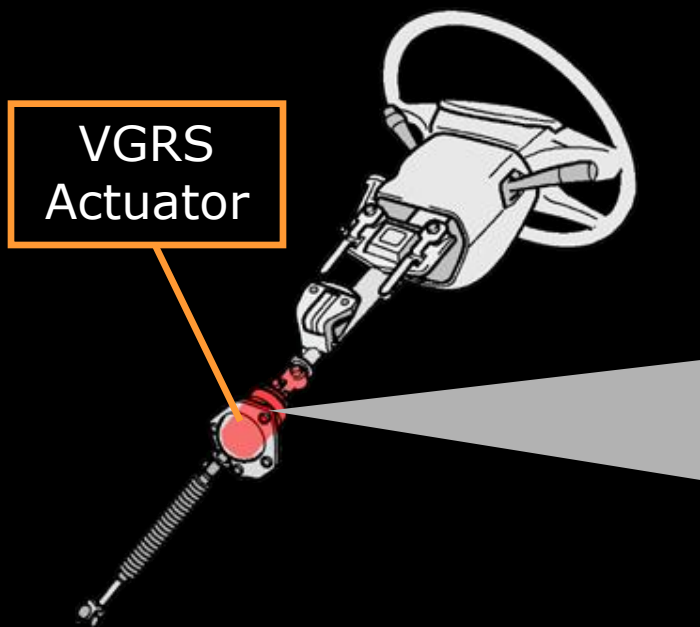
-A

-W

-Q

-V

- VGRS System
 - VGRS Actuator



Chassis

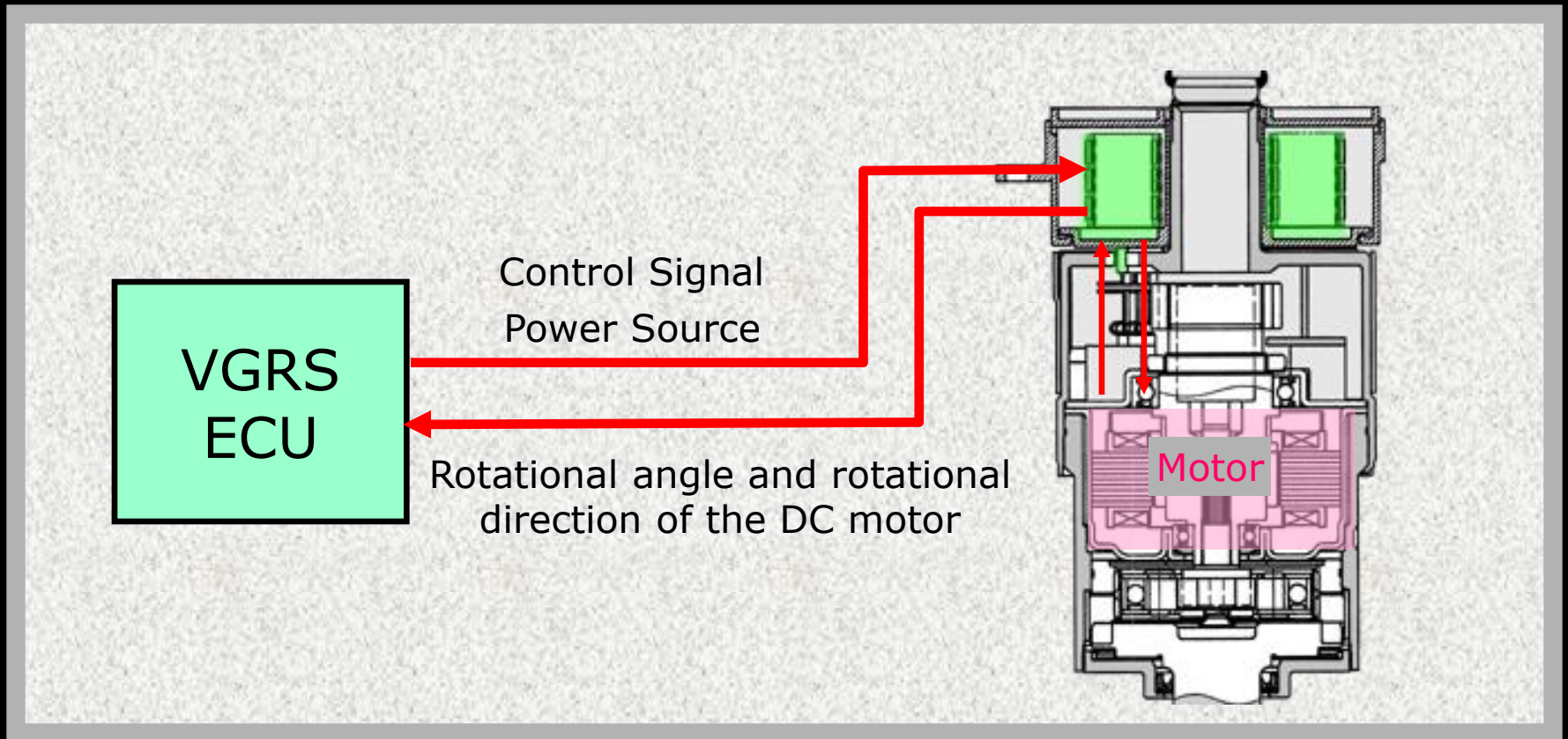
-A

-W

-Q

-V

- VGRS System
 - Spiral Cable
 - Flexible flat cable is used



Chassis

-A

-W

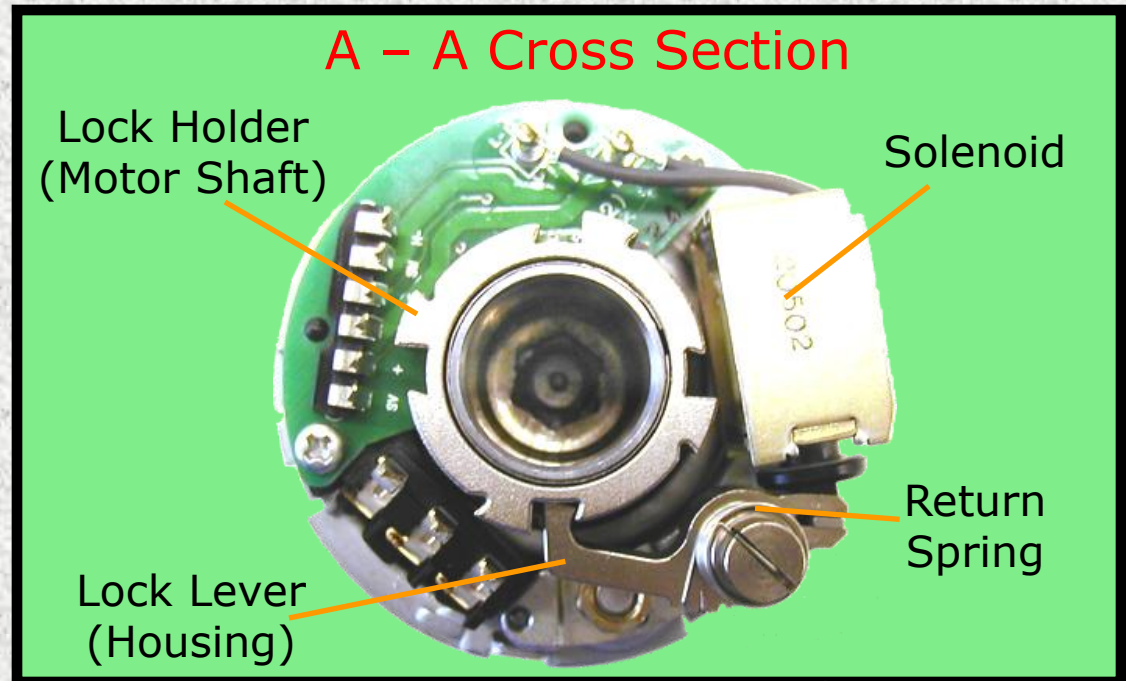
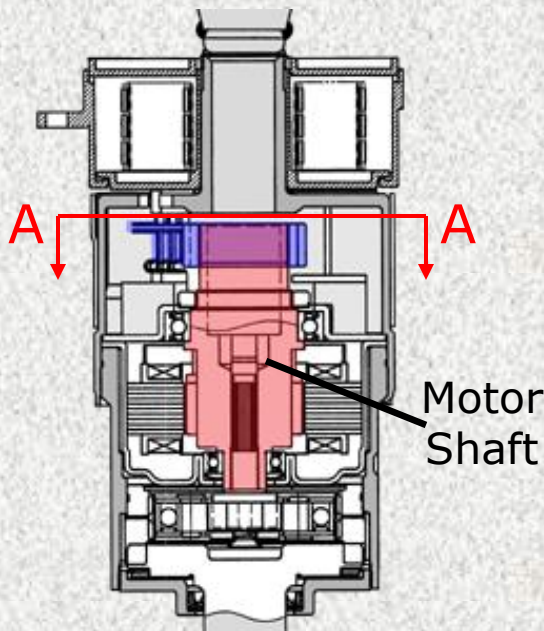
-Q

-V

■ VGRS System

• Lock Mechanism

- This mechanism locks the motor shaft, so that if the system will be failure



Chassis

-A

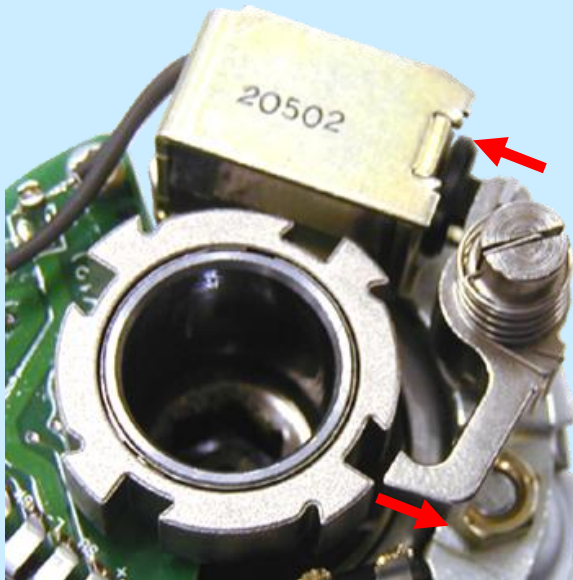
-W

-Q

-V

- VGRS System
 - Lock Mechanism

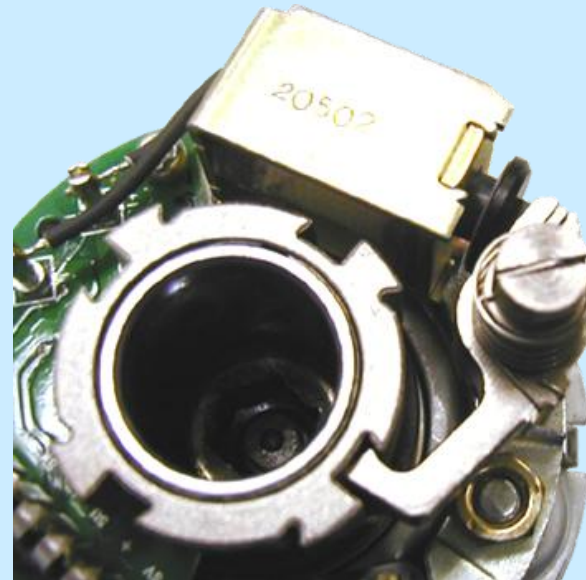
Solenoid "ON"



Unlock

- System is Normal

Solenoid "OFF"



Lock

- Engine is stopped
- System is failure (Fail Safe)



Chassis

-A

-W

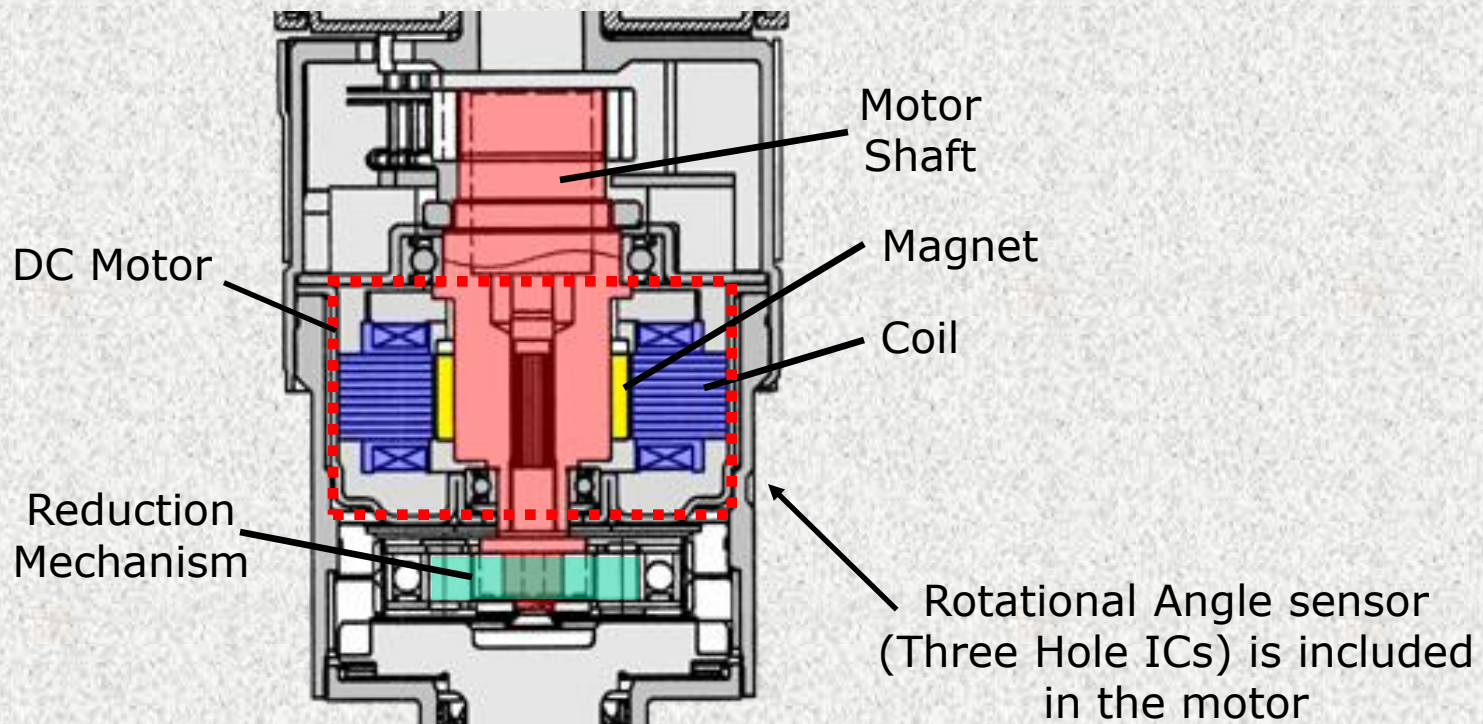
-Q

-V

■ VGRS System

• Motor

- A compact high-output low-noise DC brush-less motor is controlled by duty signal



Chassis

-A

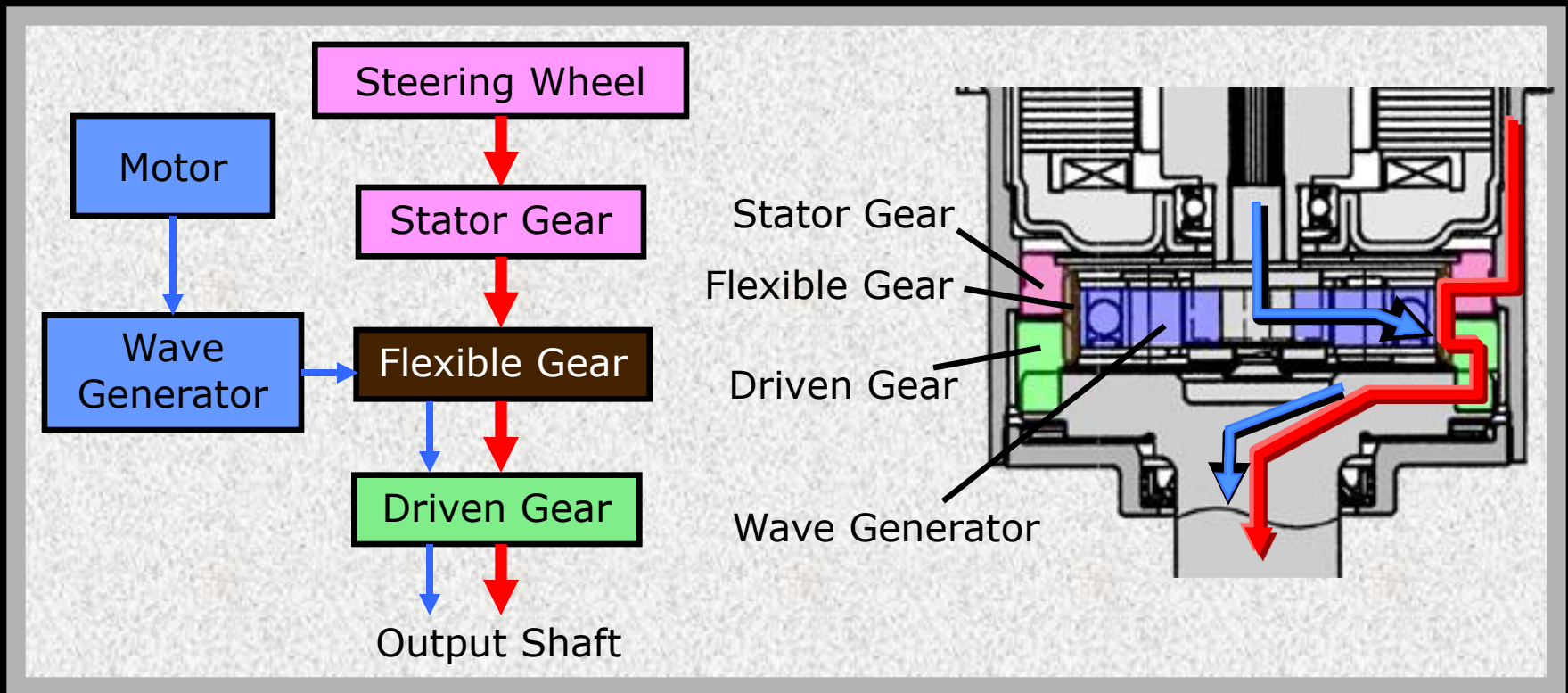
-W

-Q

-V

■ VGRS System

- Reduction Mechanism
 - The strain wave gearing type reduction mechanism is used



Chassis

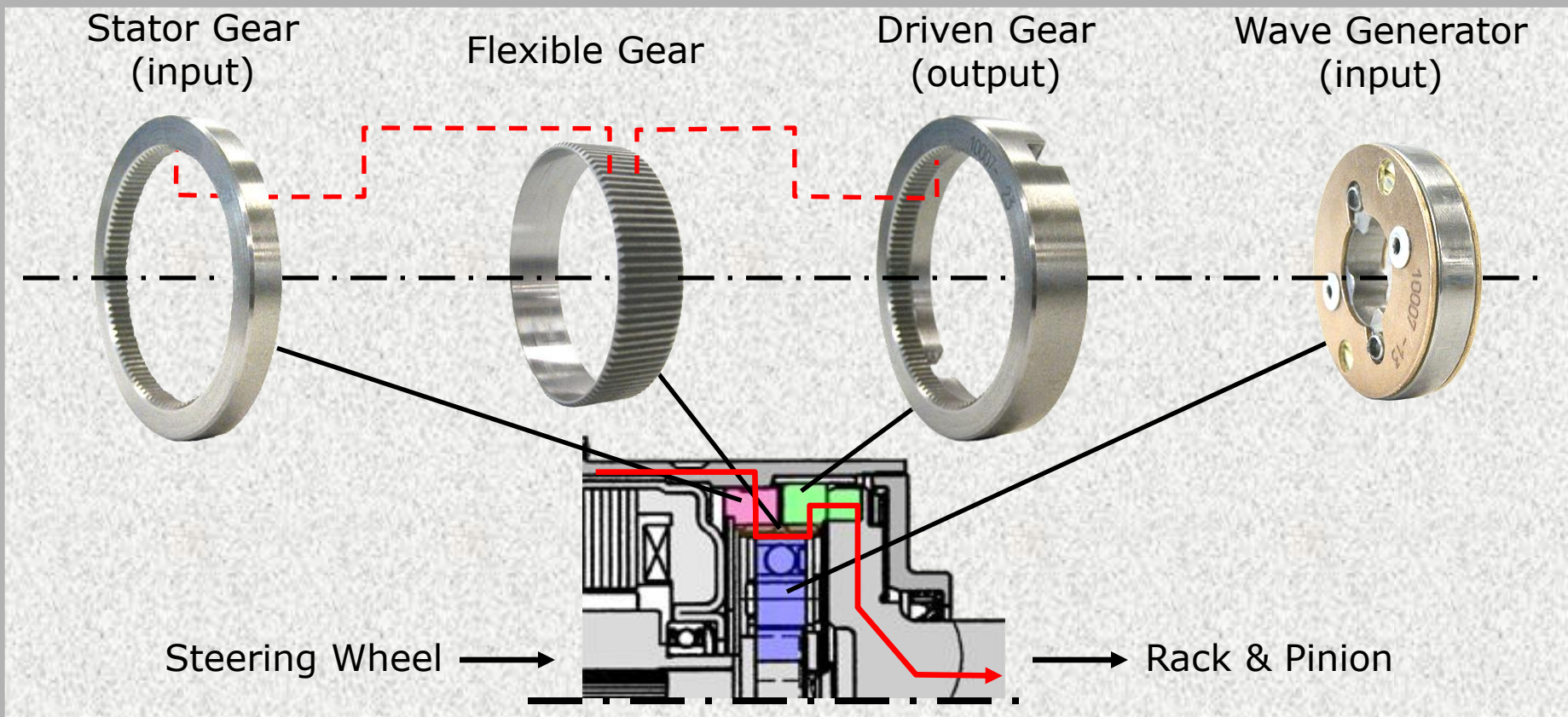
-A

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-Q

-V

- VGRS System
 - Reduction Mechanism – Components



Chassis

-A

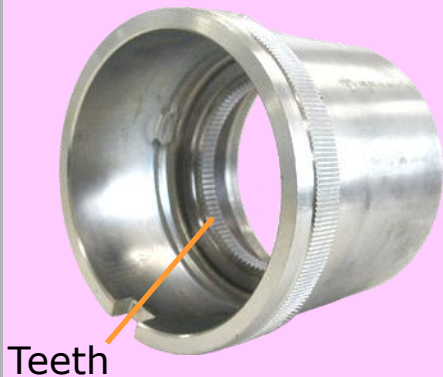
-W

-Q

-V

- VGRS System
 - Reduction Mechanism – Components

Stator Gear
(input)



Coupled to the housing of the VGRS actuator

Number of teeth: **102**

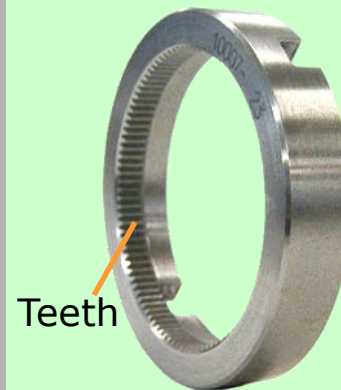
Flexible Gear



Flexible metal body
Gear teeth are meshed with the inside of both stator gear and driven gear

Number of teeth: **100**

Driven Gear
(output)



Coupled to the output shaft of the VGRS actuator

Number of teeth: **100**

Wave Generator
(input)



Consists an oval-shaped cam and bearing
Rotated by the DC motor

-

The difference of number of teeth

Chassis

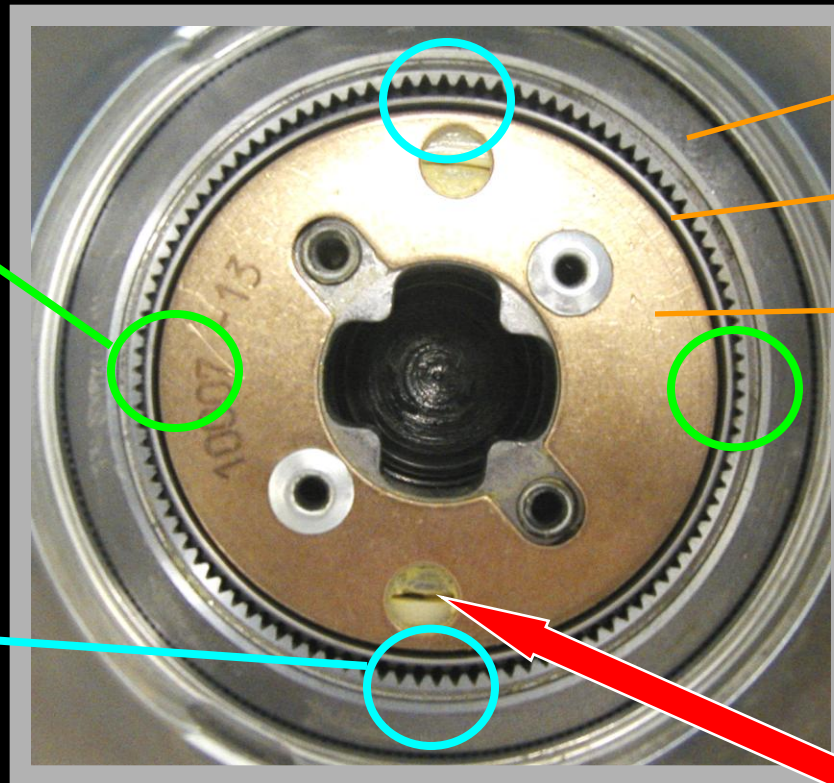
-A

-W

-Q

-V

- VGRS System
 - Reduction Mechanism
 - Construction



Stator Gear

Flexible Gear

Wave Generator

View from stator gear side
(Steering wheel side)

Ball Bearing is
between flexible gear
and wave generator



Chassis

-A

-W

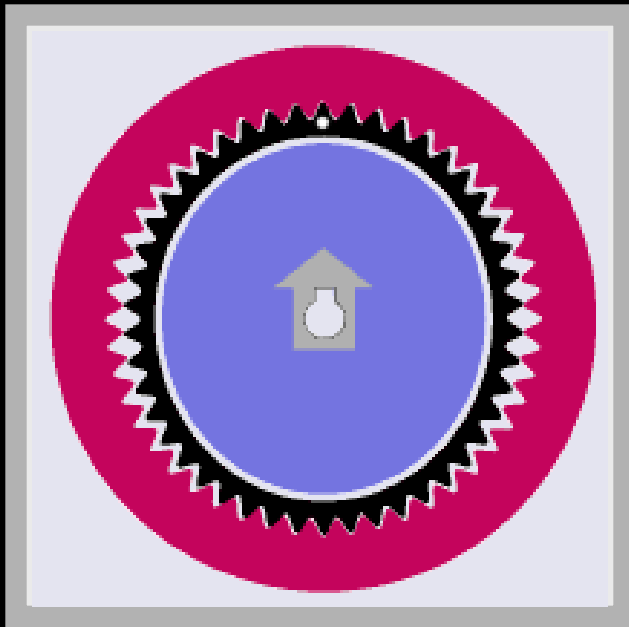
-Q

-V

■ VGRS System

• Reduction Mechanism

– Operation of strain wave gearing



View from stator gear side
(stator gear fixed)

The flexible gear is flexed into an oval shape by wave generator

The teeth of flexible gear meshes with the teeth of stator gear and driven gear

The wave generator rotates

The meshed area of the flexible gear and stator gear and driven gear moves in sequence

The wave generator makes one turn

The flexible gear moves by 2 teeth because the flexible gear has 2 fewer teeth than the stator gear

The driven gear and flexible gear have the same number of teeth, so their rotational movements are identical

The driven gear moves by 2 teeth (=Actuator output)



Reference

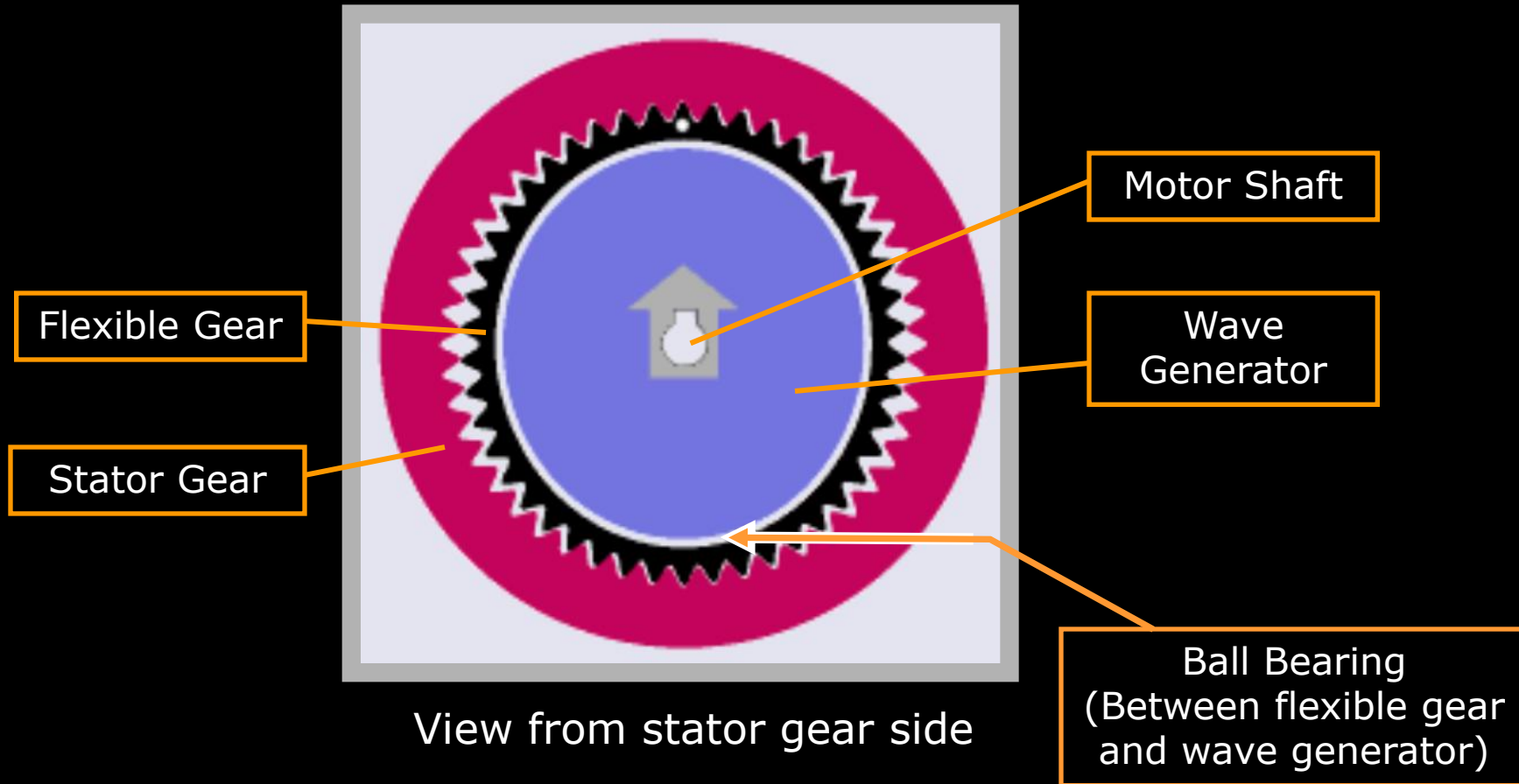
-A

-W

-Q

-V

- VGRS System
 - Reduction Mechanism



Chassis

-A

-W

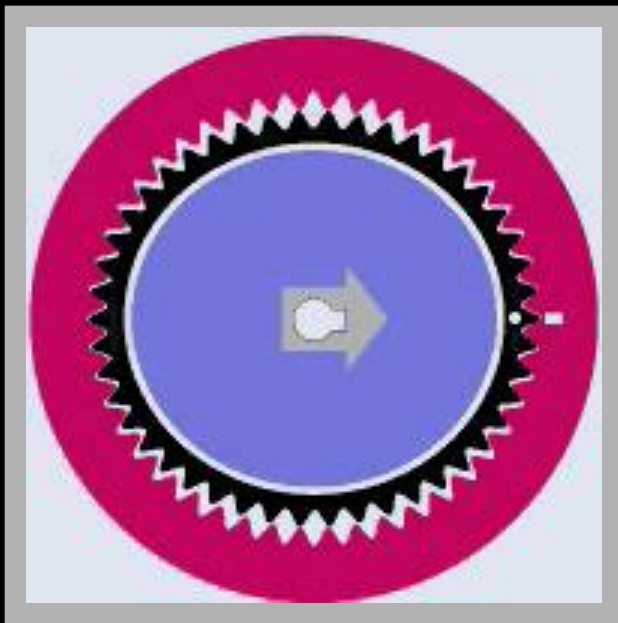
-Q

-V

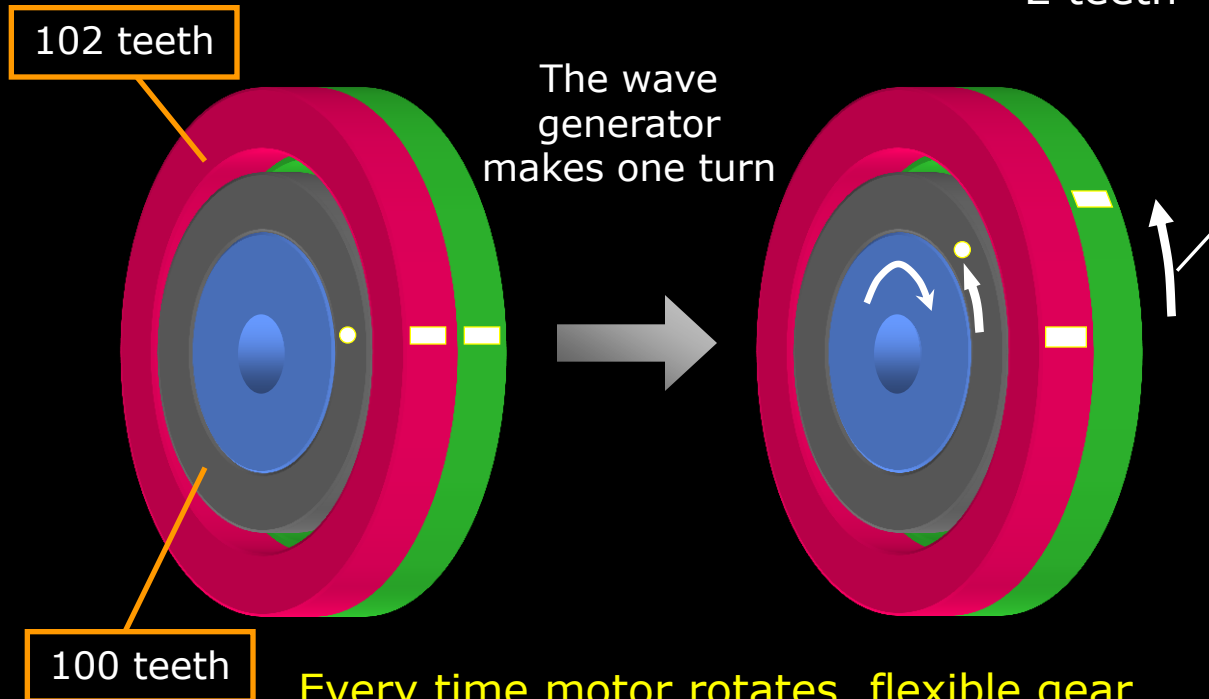
■ VGRS System

• Reduction Mechanism

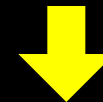
– Operation of strain wave gearing



↑ Click Picture ↑



Every time motor rotates, flexible gear and stator gear shifts by two teeth



The shift is used as actuator output



Chassis

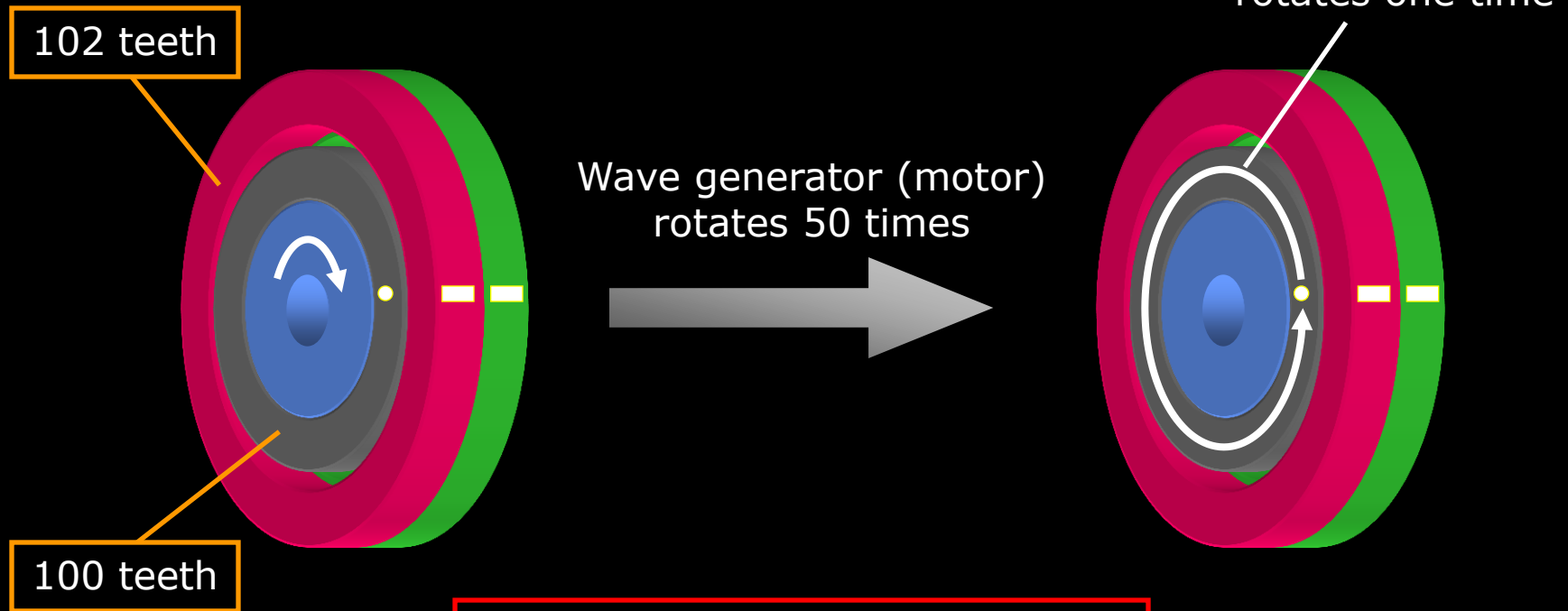
-A

-W

-Q

-V

- VGRS System
 - Reduction Mechanism
 - Gear ratio



Gear Ratio 50 : 1
Motor Flexible
 Gear



Chassis

-A

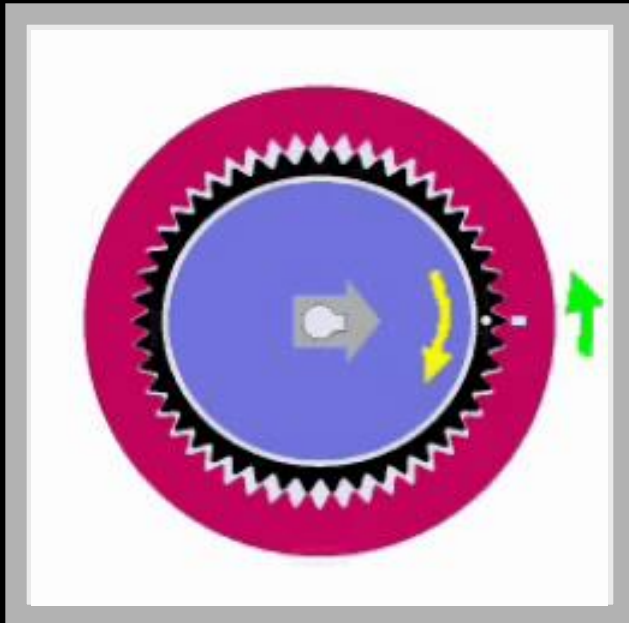
-W

-Q

-V

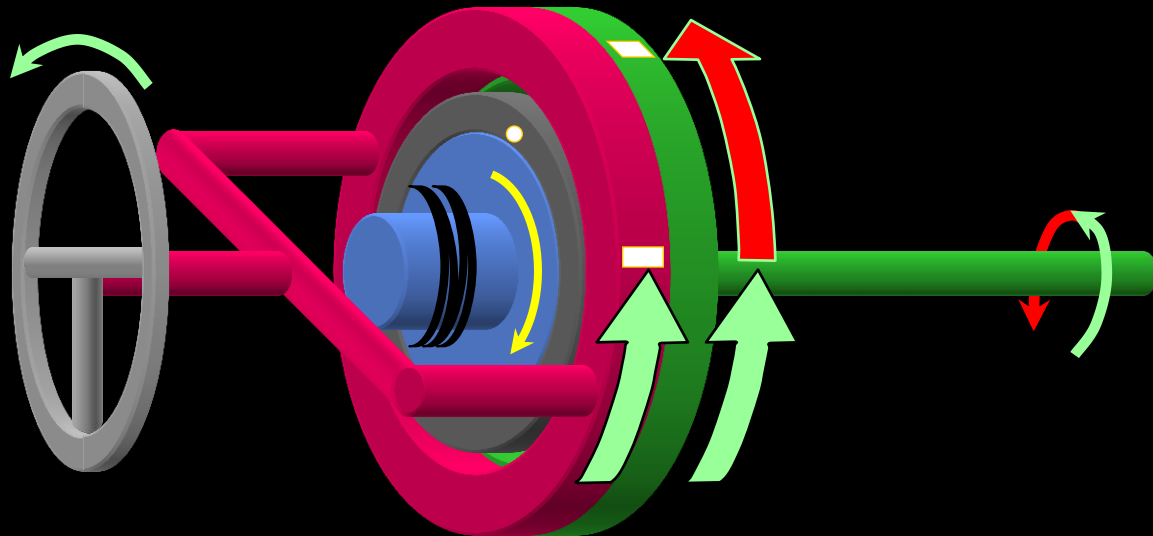
■ VGRS System

- Operation (Turn the left when vehicle speed is low)
 - The motor rotates the clockwise and adds steering angle



↑ Click Picture ↑

Steering wheel 1 rev.



Chassis

-A

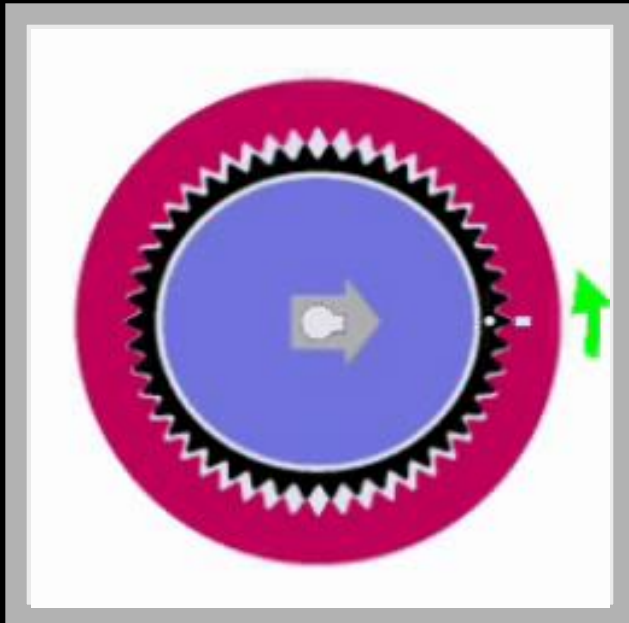
-W

-Q

-V

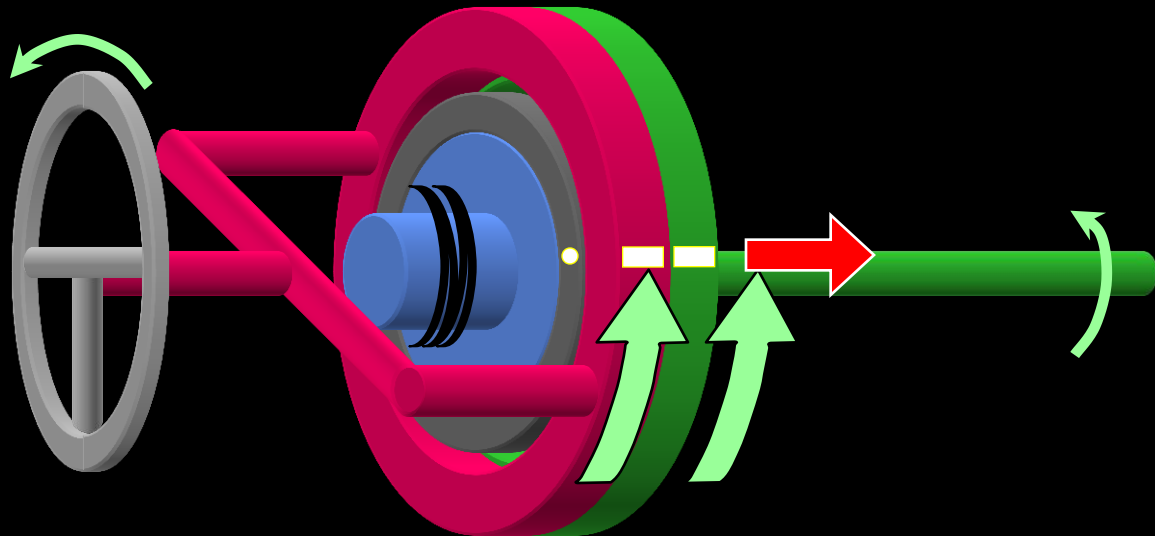
■ VGRS System

- Operation (Turn the left when vehicle speed is mid.)
 - The motor does not operate and no assist



↑ Click Picture ↑

Motor 0 rev. / Steering wheel 1 rev.



Chassis

-A

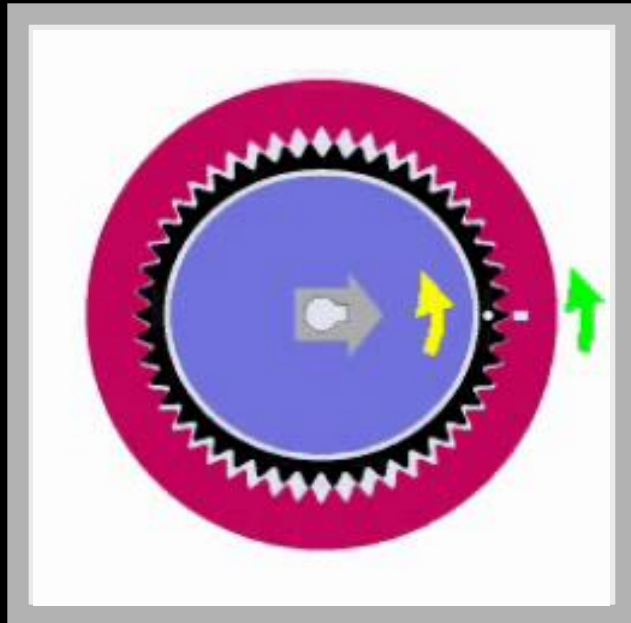
-W

-Q

-V

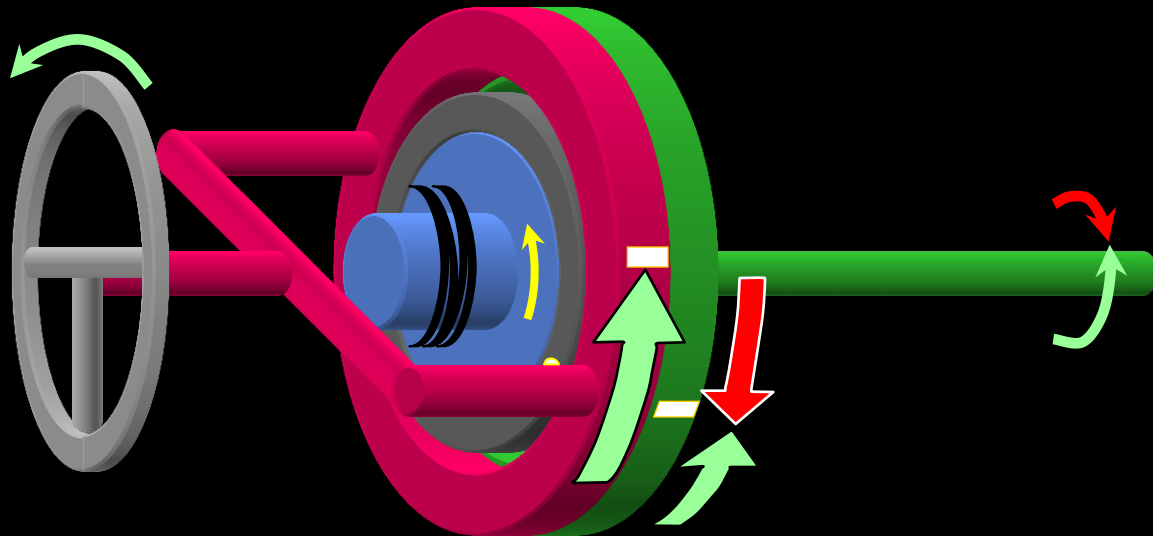
■ VGRS System

- Operation (Turn the left when vehicle speed is high)
 - The motor rotates the counterclockwise and reduces steering angle



↑ Click Picture ↑

Steering wheel 1 rev.



Chassis

-A

-W

-Q

-V

■ VGRS System

- VGRS Warning Light

- VGRS warning light comes ON when the system is malfunction



Chassis

-A

-W

-Q

-V

- VGRS System
 - VGRS ECU (Fail-safe 1)

Malfunction Parts	Fail-safe Operation	VGRS Warning Light	DTC Memory Condition
Steering Angle Sensor Malfunction	System stop (Lock mechanism)	○	○
DC Motor Malfunction			
VGRS ECU Malfunction			
DC Motor Circuit Malfunction			
Lock Mechanism Circuit Malfunction			
Vehicle Speed Signal Malfunction			
Skid Control ECU Communication Signal Malfunction			



■ VGRS System

• VGRS ECU (Fail-safe 2)

Malfunction Parts	Fail-safe Operation	VGRS Warning Light	DTC Memory Condition
DC Motor Overheat (approx. 100°C * ¹)	First, the control is stopped; then, the control resume after the system resumes its normal operation	✕	✕
VGRS ECU Overheat (approx. 100°C)			
PIG Power Source Drop Voltage Malfunction			
VGRS Actuator Malfunction * ²			

*¹: The temperature presumed from the motor drive current

*²: Specific examples

- 1) When the steering operated while the output of the power steering pump is unstable, immediately after starting a cold engine
- 2) If the driver attempts to operate the steering wheel further after is has been steered entirely to the rock end



Chassis

-A

-W

-Q

-V

- VGRS System
 - Diagnosis
 - DTCs 1/3

DTCs	Detection item
C1511 / 11	Steering Angle Sensor Malfunction
C1515 / 15	VGRS Actuator Neutral Position undone
C1516 / 16	
C1521 / 21	VGRS Actuator Malfunction
C1522 / 22	
C1527 / 27	
C1528 / 28	
C1531 / 31	VGRS ECU Malfunction
C1532 / 32	
C1533 / 33	



Chassis

-A

-W

-Q

-V

- VGRS System
 - Diagnosis
 - DTCs 2/3

DTCs	Detection item
C1541 / 41	Skid Control System Malfunction
C1549 / 49	Skid Control System Communication Malfunction
C1551 / 51	IG Power Source Voltage Malfunction
C1552 / 52	DC Motor Power Source Voltage Malfunction
C1554 / 54	Power Source Relay failure
C1555 / 55	Predriver Source Relay Failure



Chassis

-A

-W

-Q

-V

- VGRS System
 - Diagnosis
 - DTCs 3/3

DTCs	Detection item
C1561 / 61	Lock Mechanism Malfunction
C1567 / 67	Lock Mechanism Insertion Malfunction
C1568 / 68	Lock Holder Deviation Detection
C1569 / 69	Lock Mechanism Release Incomplete

Test Mode

C1571	Vehicle Speed Sensor Malfunction (FLO)
C1572	Vehicle Speed Sensor Malfunction (FRO)
C1575	Steering Angle Sensor Malfunction
C1576	DC Motor Revolution Angle Sensor Malfunction



Chassis

-A

-W

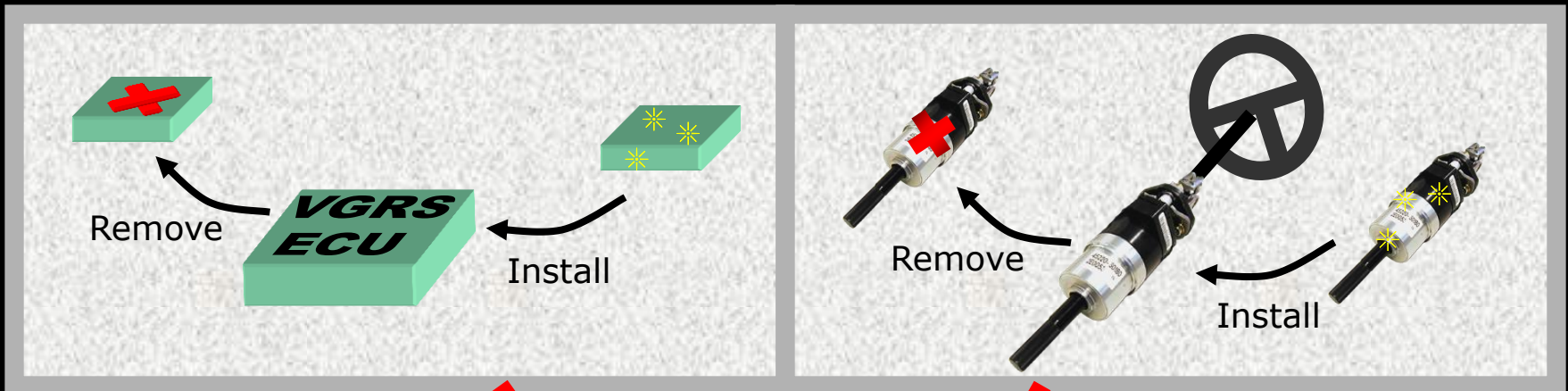
-Q

-V

■ VGRS System

- Initialize

- Initialize VGRS ECU, after exchange VGRS ECU or VGRS actuator



Initialize VGRS ECU

When the VGRS ECU initialize is undone, the DTC (C1515 or C1516) is memorized



Chassis

-A

-W

-Q

-V

■ Tire and Wheel

- Tire and Wheel Size

- Tire and wheel size have been changed

Model	-A	-W, -Q, -V	'02 LX470
Size	275/60R 18 8JJ	275/65R 17 8JJ	275/70R16 8JJ
Wheel Material	Aluminum	←	←

