

PRE-CHECK

1. VGRS SYSTEM DESCRIPTION

The VGRS (Variable Gear Ratio Steering) system controls the steering angle in accordance with the vehicle speed. The system is controlled by the VGRS ECU which operates the VGRS actuator mounted on the steering intermediate shaft. The operating angle of the actuator is added to the steering angle of the intermediate shaft in order to vary the turning angle of the front wheels in accordance with the vehicle speed.

When the VGRS system is operating normally, the steering wheel can be turned approximately 2.4 turns from lock to lock, with the engine running and the vehicle stopped.

When the system detects a fault, the VGRS ECU illuminates the VGRS warning light to inform the driver that the system is not operating.

CAUTION:

There may be conditions that will cause the steering wheel to be off center.

Refer to page [DI-809](#) for further details.

2. DIAGNOSIS SYSTEM

- (a) Inspect the battery voltage.

Battery voltage: 11 to 14 V

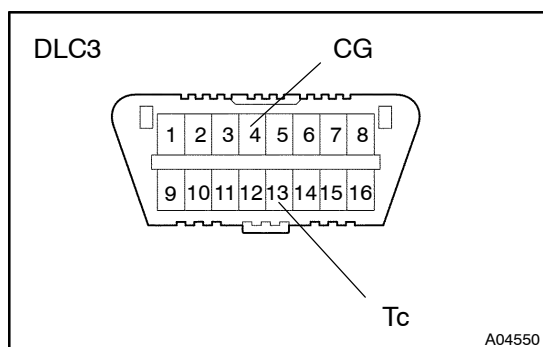
If voltage is below 11 V, recharge the battery before proceeding.

- (b) Check the warning light.

With the ignition switch ON, the light should illuminate for 2 seconds and then go out. If the light remains on after 2 seconds, check for DTCs.

HINT:

If the light does not illuminate, proceed to troubleshooting for the VGRS warning light circuit (See page [DI-874](#)).

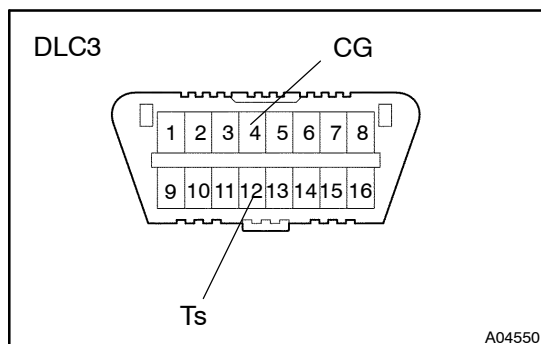
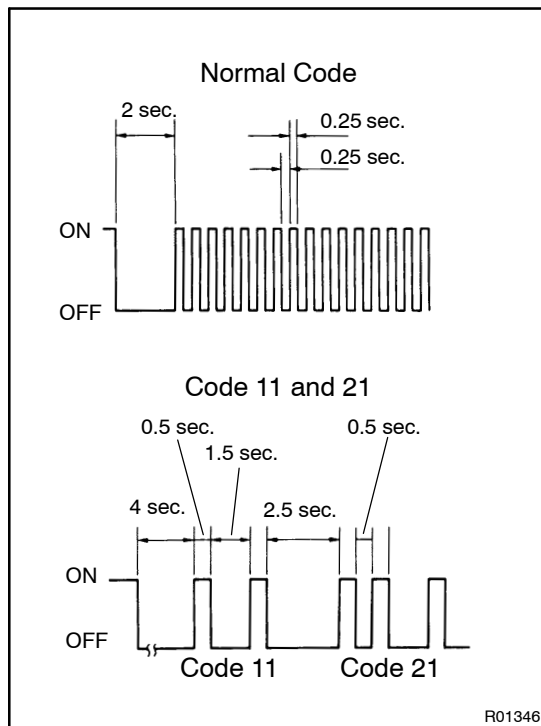


3. DTC CHECK (USING SST CHECK WIRE)

- (a) Checking DTCs using a SST check wire.

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- (1) Using the SST, connect terminals Tc and CG of DLC3.
- (2) Turn the ignition switch ON.



- (3) Read and record any DTCs from the VGRS warning light on the combination meter. Refer to the chart on the left for examples of a normal code and codes 11 and 21.

HINT:

If the VGRS warning light does not blink any DTC codes or the normal code, inspect the warning light circuit.

Trouble Area	See page
Tc and CG terminal circuit	DI-876
VGRS warning light circuit	DI-874

- (4) Refer to the Diagnostic Trouble Code Chart (See page [DI-820](#)) for DTC information.

- (b) Clearing the DTCs using the SST check wire.

- (1) Turn the ignition switch ON.
- (2) Using the SST, connect terminals Ts and CG of DLC3.

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- (3) Disconnect and connect the SST check wire from the CG terminal 4 times or more in 8 seconds.
- (4) Check that the VGRS warning light blinks a normal code.

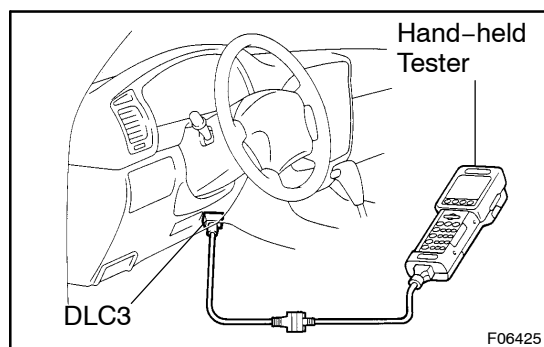
HINT:

If the fault has not been repaired, the code may still be displayed.

- (5) Turn the ignition switch OFF.
- (6) Remove the SST check wire from DLC3.
- (7) Perform the zero point calibration for the deceleration sensor and yaw rate sensor (See page [DI-606](#)).

HINT:

When clearing the VGRS codes, the deceleration sensor and yaw rate sensor memory is also cleared. Therefore it is necessary to complete the zero point calibration (See page [DI-606](#)).



4. DTC CHECK (USING HAND-HELD TESTER)

- (a) Checking DTCs using the Hand-held tester.
- (1) Connect the hand-held tester to DLC3.
 - (2) Turn the ignition switch ON.
 - (3) Read the DTCs following the prompts on the tester screen.

HINT:

Refer to the hand-held tester operator's manual for further details.

- (b) Clearing the DTCs using the hand-held tester.

- (1) Connect the hand-held tester to DLC3.
- (2) Turn the ignition switch ON.
- (3) Erase the DTCs following the prompts on the tester screen.

HINT:

Refer to the hand-held tester operator's manual for further details.

5. DATA LIST

With the hand-held tester connected to DLC3 and the ignition turned ON, the VGRS data list can be displayed. Follow the prompts on the tester screen to access the Data List.

Item	Measurement Item / Range (Display)	Normal Condition	Diagnostic Note
STEERING POS1	Steering sensor 1 reading / min.: -1862 deg, 1877deg	-1682 to 1877 deg	Turn the steering wheel changes the value
STEERING POS2	Steering sensor 2 reading / min.: -1862 deg, 1877deg	-1682 to 1877 deg	Turn the steering wheel changes the value
STR SENS1	Steering sensor 1 / HIGH or LOW	High or Low	Turn the steering wheel switches high or low
STR SENS2	Steering sensor 2 / HIGH or LOW	High or Low	Turn the steering wheel switches high or low
STR SENS3	Steering sensor 3 / HIGH or LOW	High or Low	Turn the steering wheel switches high or low
SPD (VSC)	Speed sensor reading / min.: 0 km/h, max.: 255 km/h	Actual vehicle speed	Speed indicated on speedometer
WHEEL SPD RR	Wheel speed sensor (RR) reading / min.: 0 km/h, max.: 255 km/h	Actual vehicle speed	Speed indicated on speedometer
WHEEL SPD RL	Wheel speed sensor (RL) reading / min.: 0 km/h, max.: 255 km/h	Actual vehicle speed	Speed indicated on speedometer
ENGINE REV (RPM)	Revolution sensor / LESS 300 or MORE 300	Less than 300	Engine stop
		More than 300	Engine running
MTR SOU CUR	Motor power source actual current / min.: 0 A, max.: 127.5 A	Less than 10 A	When not turning the steering wheel
		Less than 60 A	When turning the steering wheel
MTR SOU CUR EST	Estimated motor power source actual current / min.: 0 A, max.: 127.5 A	Less than 10 A	When not turning the steering wheel
		Less than 60 A	When turning the steering wheel
PIG SOURCE VOL	PIG source voltage / min.: 0 V, max.: 22.5 V	9 to 16 V	IG switch ON (Engine stop)
IG SOURCE VOL	IG source voltage / min.: 0 V, max.: 22.5 V	9 to 16 V	IG switch ON (Engine stop)

MTR CUR EST	Motor estimation current / min.: 0 A, max.: 127.5 V	Less than 10 A	When not turning the steering wheel
		Less than 60 A	When turning the steering wheel
TERMINAL VOL U	Terminal voltage U / min.: 0 V, max.: 25.5 V	0 to 16 V	Turn the steering wheel changes the value (When the engine running and VGRS system operates)
TERMINAL VOL V	Terminal voltage V / min.: 0 V, max.: 25.5 V	0 to 16 V	Turn the steering wheel changes the value (When the engine running and VGRS system operates)
TERMINAL VOL W	Terminal voltage W / min.: 0 V, max.: 25.5 V	0 to 16 V	Turn the steering wheel changes the value (When the engine running and VGRS system operates)
ACTUATOR POS	Actuator position / min.: -286 deg, max.: 288 deg	-286 to 288 deg	Turn the steering wheel changes the value (When the engine running and VGRS warning light goes off)
MTR REV ANG U	Motor revolution angle sensor output U HIGH or LOW	High or Low	Turn the steering wheel changes the value (When the engine running and VGRS warning light goes off)
MTR REV ANG V	Motor revolution angle sensor output V HIGH or LOW	High or Low	Turn the steering wheel changes the value (When the engine running and VGRS warning light goes off)
MTR REV ANG W	Motor revolution angle sensor output W HIGH or LOW	High or Low	Turn the steering wheel changes the value (When the engine running and VGRS warning light goes off)
STR ANG VEL	Steering wheel angle velocity / min.: -1862 deg, max.: 1877 deg / sec.	-1862 to 1877 deg / sec.	Turn the steering wheel changes the value (When the engine running and VGRS warning light goes off)
LOCK OUTPUT VOL	Lock motor output voltage / min.: 0 V, max.: 22.5V	9 to 16 V	IG switch ON (Engine stop)
THERMISTOR TEMP	Thermistor temperature / min.: -50 °C, max.: 205 °C	-50 to 205 °C	When the VGRS system operates
ACT TARGET ANGL	Actuator target angle / min.: -286 deg, max.: 288 deg	-286 to 288 deg	When the VGRS system operates
ACT REV SPD	Actuator revolution speed / min.: -1862 deg, max.: 1877 deg / sec.	-1862 to 1877 deg / sec.	When the VGRS system operates
DUTY VAL	Command value DUTY / min.: 0 %, max.: 100 %	0 to 100%	When the VGRS system operates
LOCK DUTY VAL	Command value DUTY for actuator lock control / min.: 0 %, max.: 100 %	Less than 10%	IG switch ON
STRAIGHT ANG FLG *1	Straight steering angle valid flag / INVALID or VALID	VALID or INVALID	Immediately after connecting the battery terminal
ACT DEV ANGL	Actuator deviation angle / min.: -286 deg, max.: 288 deg	-286 to 288 deg	When the VGRS system operates

ACT TEMP EST	Actuator estimation temperature / min.: -50 °C, max.: 205 °C	-50 to 205 °C	When the VGRS system operates
MTR OVERHEAT *2	Record of continuous overheat preventive control / Rec or Unrec	Rec or Unrec	-
MTR LOW POWER *2	Record of low motor power source voltage / Rec or Unrec	Rec or Unrec	-
MTR HIGH POWER *2	Record of high motor power source voltage / Rec or Unrec	Rec or Unrec	-
FLO MALFUNCTION *2	Record of wheel speed malfunction (left) / Rec or Unrec	Rec or Unrec	-
FRO MALFUNCTION *2	Record of wheel speed malfunction (right) / Rec or Unrec	Rec or Unrec	-
TEST MODE	Test mode / NORMAL or TEST	NORMAL : Normal mode TEST : During test mode	-
#CODES	Number of DTC recorded / min.: 0, max.: 255	Min.: 0, max.: 39	-

***1: NOTICE:**

This data must read valid before proceeding with any steering adjustments. If invalid, perform steering angle sensor initialization procedure, or if VGRS actuator or VGRS ECU has been replaced, perform VGRS system calibration (steering angle adjust).

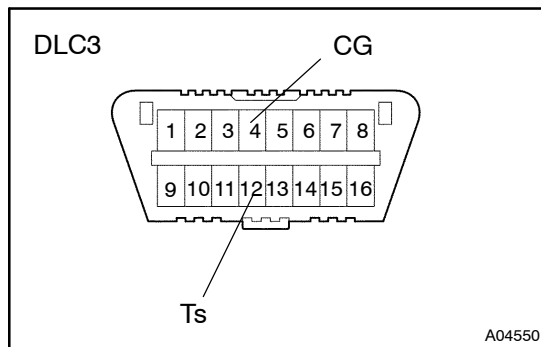
***2: HINT:**

When Rec is listed, reset to Unrec by going to the VGRS menu on the hand-held tester, select records clearance, and follow the prompts.

6. FREEZE FRAME DATA

The VGRS ECU stores memorized data when a trouble code is set and can be viewed using the hand-held tester.

Hand-held tester display	Measurement Item	Value
STEERING POS 1	Steering position 1 (parallel)	-1862 to 1877
SPD (VSC)	Vehicle speed (VSC ECU)	Speed indicated on speedometer
ENGINE REV (RPM)	Engine revolution	Less than 300 or More than 300
MTR SOURCE CUR	Motor power source actual current	0 to 127.5
MTR SOU CUR EST	The estimated motor current	0 to 127.5
PIG SOURCE VOL	PIG-power source voltage	0 to 22.5
IG SOURCE VOL	IG-power source voltage	0 to 22.5
ACTUATOR POS	Actuator position	-286 to 288
STR ANGLE VEL	Steering wheel angle velocity	-1862 to 1877
LOCK OUTPUT VOL	Lock motor output voltage	0 to 22.5
ACT TARGET ANGLE	Actuator target angle	-286 to 288
ACT REV SPD	Actuator revolution speed	-1862 to 1877
DUTY VAL	Command value DUTY	0 to 100
LOCK DUTY VAL	Command value DUTY for actuator lock control	0 to 100



7. VGRS SENSOR SIGNAL CHECK (TEST MODE)

HINT:

- Before entering Test Mode, check and repair any current VGRS DTCs.
- When entering test mode, the 4 sensor check DTCs are recorded at once. When the ECU judges the sensor normal during the test procedure, the DTC will be eliminated.

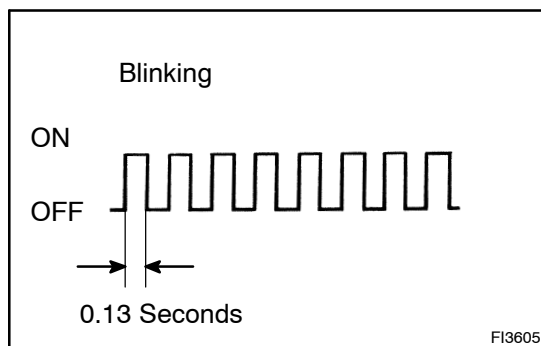
(a) Procedure for Sensor Test Mode using a SST check wire.
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- (1) Make sure the ignition switch is OFF.
- (2) Using the SST check wire, connect terminals Ts and CG of DLC3.
- (3) Turn the ignition switch ON.

- (4) Check that the VGRS warning light is blinking.

HINT:

If the VGRS warning light does not blink, inspect the warning light or Ts terminal circuits.



Trouble Area	See page
Ts and CG terminal circuit	DI-878
VGRS warning light circuit	DI-874

- (5) Start the engine.
- (6) Turn the steering wheel lock to lock.

NOTICE:

- **Check for any unusual feeling in the steering wheel operation.**
- **Slowly turn the steering wheel from lock to lock. check that it rotates approximately 2.4 turns.**

HINT:

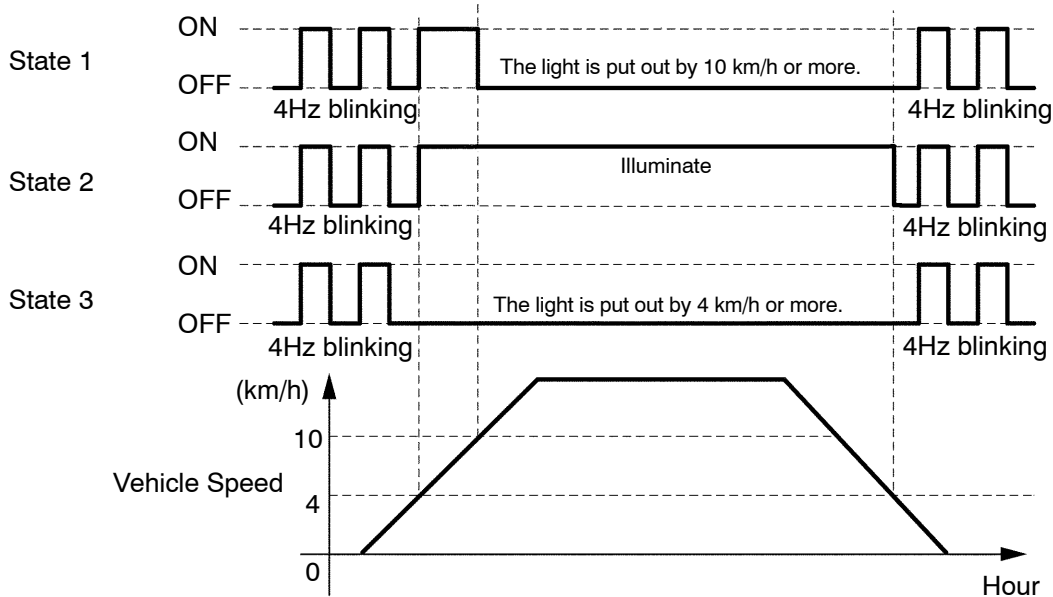
- The warning light display has no change.
- If the actuator moving amount is correctly checked, the diagnostic codes C1575/75 and C1576/76 in the test mode are cleared.

- (7) Drive the vehicle at more than 10 km/h (6 mph) for 15 to 30 seconds.

HINT:

If the vehicle speed sensor is correctly checked, the diagnostic codes C1571/71 and C1572/72 in the test mode are cleared.

HINT: The situation of VGRS warning light when driving.



State 1: If either DTC C1575/75 or C1576/76 is abnormal, the warning light remains on between 4 and 10 km/h after first starting.

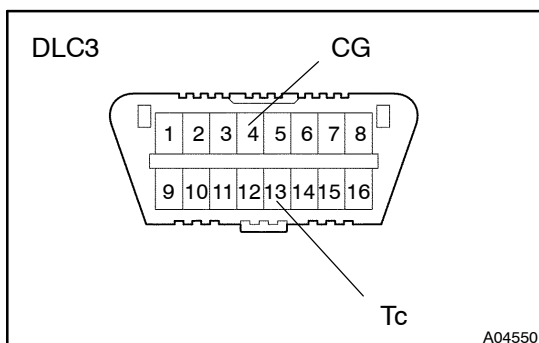
State 2: If a speed sensor DTC is detected at 10 km/h or above, the warning light will remain on until vehicle speed is less than 4 km/h.

State 3: Warning light pattern when all sensors are normal.

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- (8) Stop the vehicle. Leave the engine running.



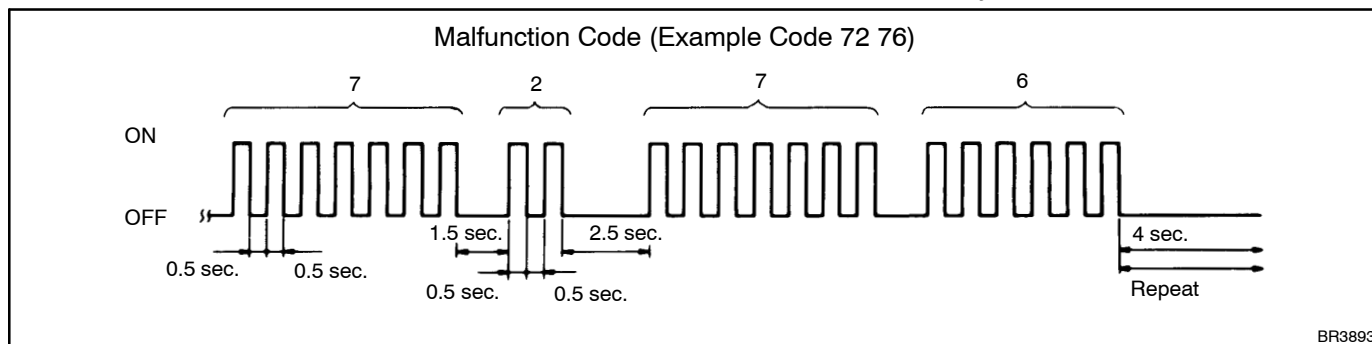
- (9) Using the SST check wire, connect the 3rd terminal of the SST check wire to terminal Tc of DLC3.

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- (10) Read the number of blinks of the VGRS warning light. (Refer to the chart below)

HINT:

- If all wheel speed sensors are normal, the normal blinking code is output. (A repeating cycle of 0.25 sec. ON and 0.25 sec. OFF)
- If 2 or more faults are detected at the same time, the lowest number will be displayed first.



- (11) After completing the check, disconnect the SST from DLC3 and turn the ignition OFF.
- (b) Procedure for Sensor Test Mode using the hand-held tester.
- (1) Connect the hand-held tester.
 - (2) Turn the ignition switch ON.
 - (3) Complete the VGRS Test Mode following the prompts on the tester screen.

HINT:

Refer to the hand-held tester operator's manual for further details.

- (4) Read the DTCs.
- (5) After completing the test, disconnect the tester and turn the ignition switch OFF.

DTC of VGRS sensor check function:

Code No.	Diagnosis	Trouble Area
C1571 / 71	Vehicle speed sensor malfunction (FLO)	• Left front speed sensor • Sensor installation • Sensor rotor
C1572 / 72	Vehicle speed sensor malfunction (FRO)	• Right front speed sensor • Sensor installation • Sensor rotor
C1575 / 75	Steering angle sensor malfunction	• Steering sensor • Sensor installation
C1576 / 76	DC motor revolution sensor malfunction	• VGRS actuator