

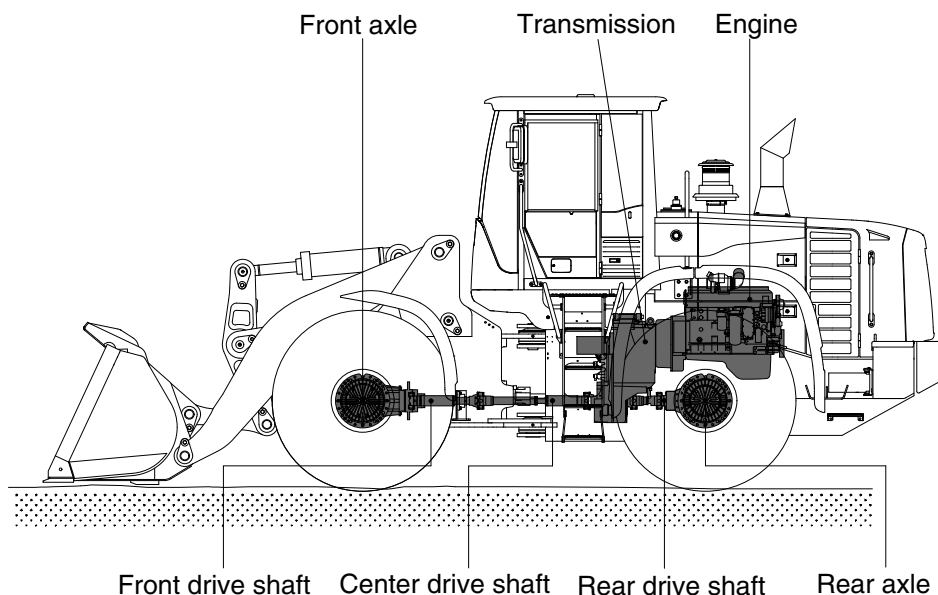
SECTION 3 POWER TRAIN SYSTEM

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SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW



97093PT01

The power train consists of the following components:

- Transmission
- Front, center and rear drive shafts
- Front and rear axles

Engine power is transmitted to the transmission through the torque converter.

The transmission is a hydraulically engaged four speed forward, three speed reverse countershaft type power shift transmission. A calliper-disc type parking brake is located on the transmission.

The transmission outputs through universal joints to three drive shaft assemblies. The front drive shaft is a telescoping shaft which drives the front axle. The front axle is mounted directly to the loader frame.

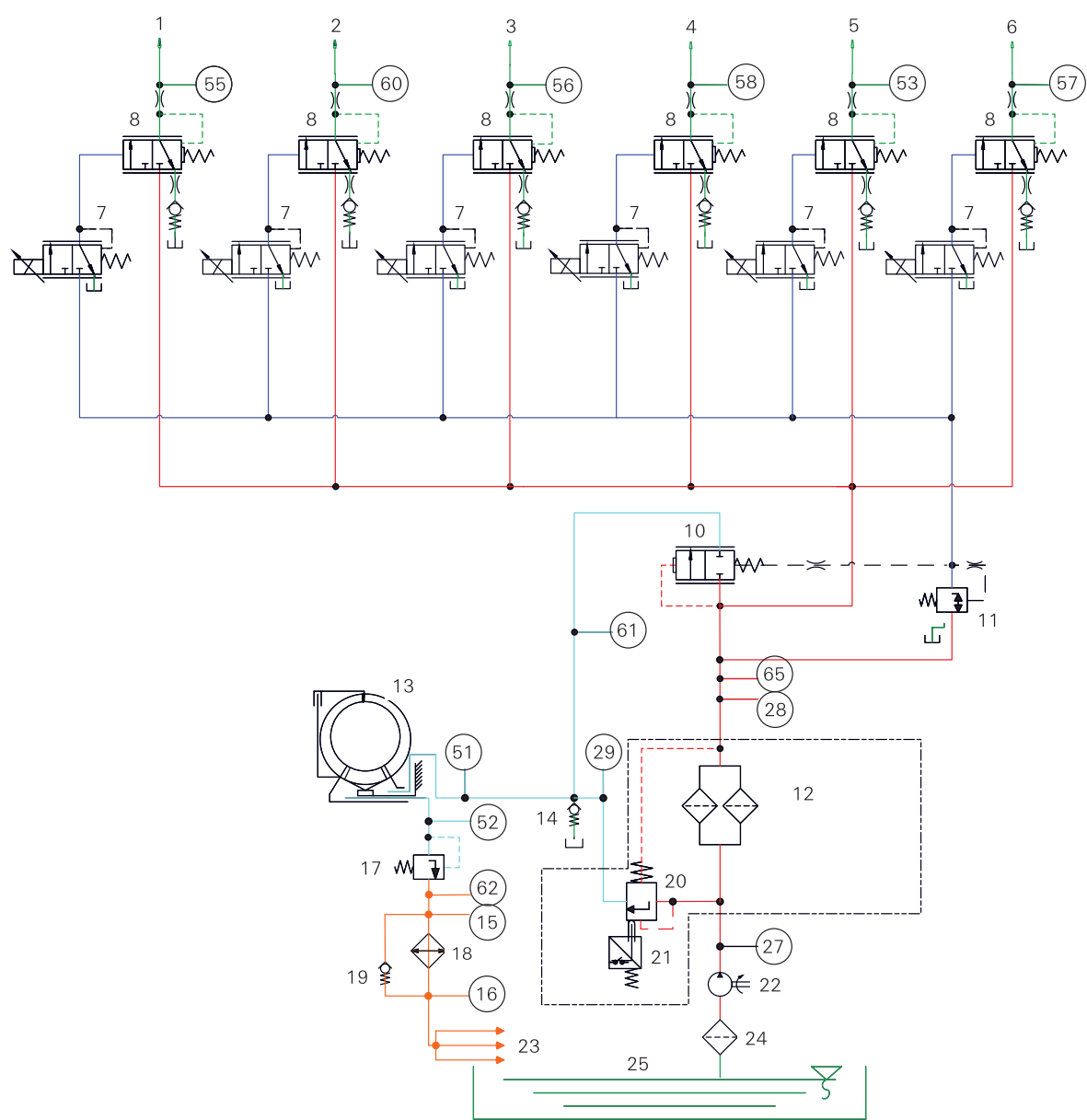
The front and rear axle are equipped with conventional differential as standard (option : Limited slip differential).

The rear axle is mounted on an oscillating pivot.

The power transmitted to front axle and rear axle is reduced by the pinion gear and ring gear of differential. It then passes from the differential to the sun gear shaft (axle shaft) of final drive.

The power of the sun gear is reduced by a planetary mechanism and is transmitted through the planetary hub to the wheel.

HYDRAULIC CIRCUIT



975T33PT18

- _____ 1 Return flow to sump
- _____ 2 Pilot pressure
- _____ 3 Main pressure
- _____ 4 Lubrication
- _____ 5 Converter pressure

Positions 15, 16, 27, 28, 29, 51, 52, 53, 55, 56, 57, 58, 60, 61, 62, 65 correspond to the numbers on the installation drawing.

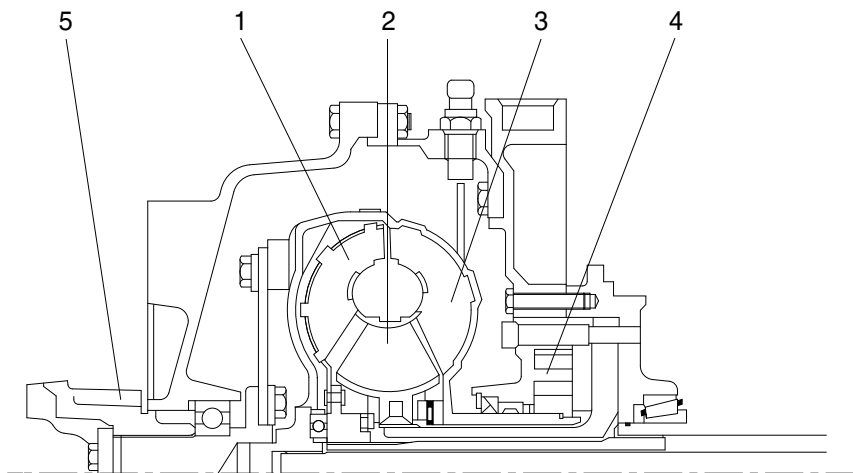
- | | |
|---|---|
| 1 Clutch K1 | 2 Clutch KV (clutch forward) |
| 3 Clutch K2 | 4 Clutch K3 |
| 5 Clutch K4 | 6 Clutch KR (clutch reverse) |
| 7 Pilot valve | 8 Downstream valve |
| 10 Main pressure valve | 11 Pressure reduction valve |
| 12 Transmission pressure filter | 13 Converter |
| 14 Converter safety valve | 15 Connection of pressure oil to oil cooler |
| 16 Connection of pressure oil from oil cooler | 17 Converter counter-pressure valve |
| 18 Oil cooler (heat exchanger) | 19 Oil cooler bypass valve |
| 20 Filter bypass valve | 21 Filter bypass switch |
| 22 Transmission pump | 23 Lubrication |
| 24 Suction filter | 25 Tank |
| 27 Connection of pressure oil to filter | 28 Connection of pressure oil from filter |
| 29 Filter bypass connection | 51 Measuring point of oil pressure before converter |
| 52 Measuring point of oil pressure after converter | 53 Measuring point of clutch pressure K4 |
| 55 Measuring point of clutch pressure K1 | 56 Measuring point of clutch pressure K2 |
| 57 Measuring point of clutch pressure KR | 58 Measuring point of clutch pressure K3 |
| 60 Measuring point of clutch pressure KV | 61 Temperature sensor for sump temperature |
| 62 Temperature sensor for oil temperature after the converter | 65 Measuring point of system pressure |

Assignment of clutch and solenoid valve

		Live solenoid							
		Forward				Reverse			Neutral
Clutch	Solenoid valve	1	2	3	4	1	2	3	
KV	Y2	X	X	X					
KR	Y6					X	X	X	
K1	Y1	X				X			
K2	Y3		X	X			X		
K3	Y4			X	X			X	
K4	Y5			X	X				

2. TORQUE CONVERTER

1) FUNCTION



73033TM00

- | | | | | | |
|---|---------|---|-------------------|---|--------------|
| 1 | Turbine | 3 | Pump | 5 | Input flange |
| 2 | Stator | 4 | Transmission pump | | |

The converter is working according to the Trilok-system, i.e. it assumes at high turbine speed the characteristics, and with it the favorable efficiency of a fluid clutch.

The converter is designed according to the engine power so that the most favorable operating conditions are obtained for each installation case.

The Torque converter is composed of 3 main components :
Pump wheel - turbine wheel - stator (reaction member)

These 3 impeller wheels are arranged in such a ring-shape system that the fluid is streaming through the circuit components in the indicated order.

Pressure oil from the transmission pump is constantly streaming through the converter. In this way, the converter can fulfill its task to multiply the torque of the engine and at the same time, the heat created in the converter is dissipated via the escaping oil.

The oil which is streaming out of the pump wheel, enters the turbine wheel and is there inversed in the direction of flow.

According to the rate of reversion, the turbine wheel and with it also the output shaft is receiving a more or less high reaction torque. The stator (reaction member), following the turbine, has the task to reverse the oil streaming out of the turbine once more and to deliver it under the suitable discharge direction to the pump wheel.

Due to the reversion, the stator receiving a reaction torque.

The relation turbine torque/pump torque is called torque multiplication.

This is the higher, the greater the speed difference of pump wheel and turbine wheel will be.

Therefore, the maximum torque multiplication is created at stationary turbine wheel.

With increasing output speed, the torque multiplication is decreasing. The adaption of the output speed to a certain required output torque will be infinitely variable and automatically achieved by the torque converter.

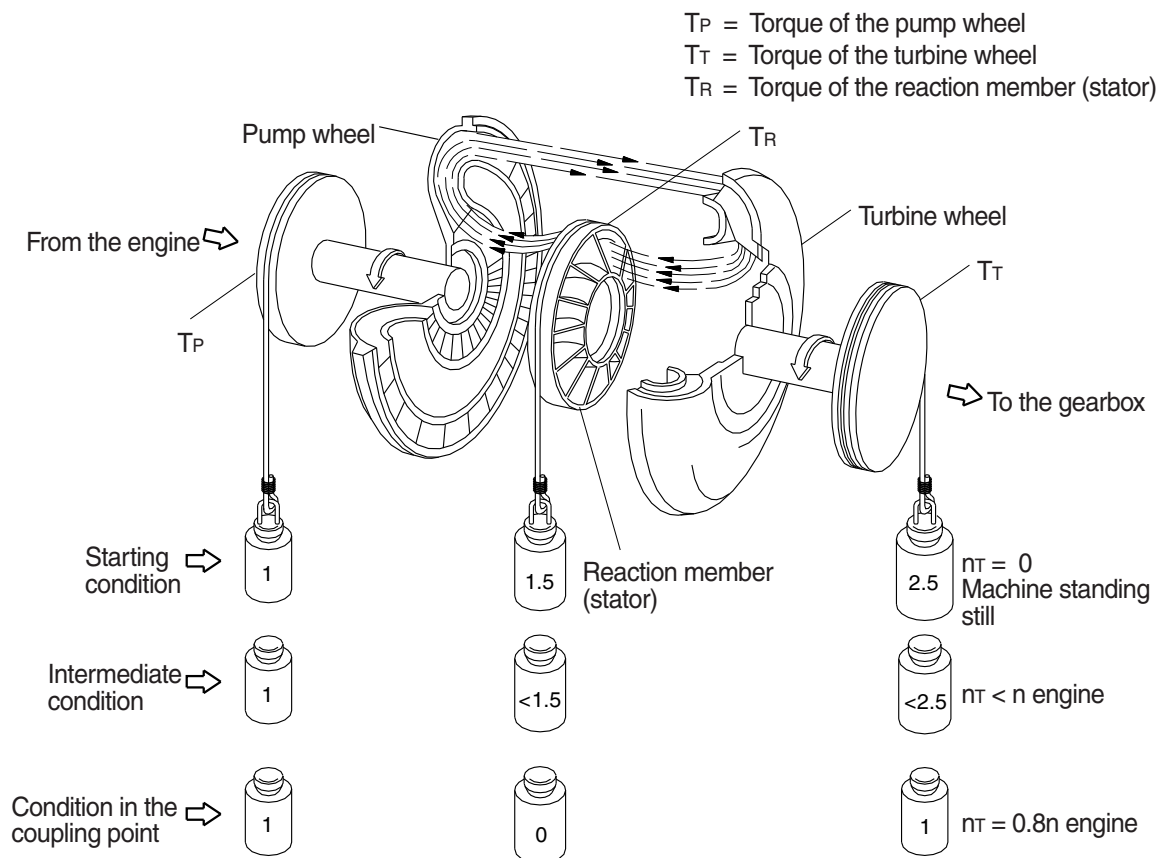
When the turbine speed is reaching about 80% of the pump speed, the torque multiplication becomes 1.0 i.e. the turbine torque becomes equal to that of the pump torque.

From this point on, the converter is working similar to a fluid clutch.

A stator freewheel serves to improve the efficiency in the upper driving range, in the torque multiplication range it is backing-up the torque upon the housing, and is released in the clutch range.

In this way, the stator can rotate freely.

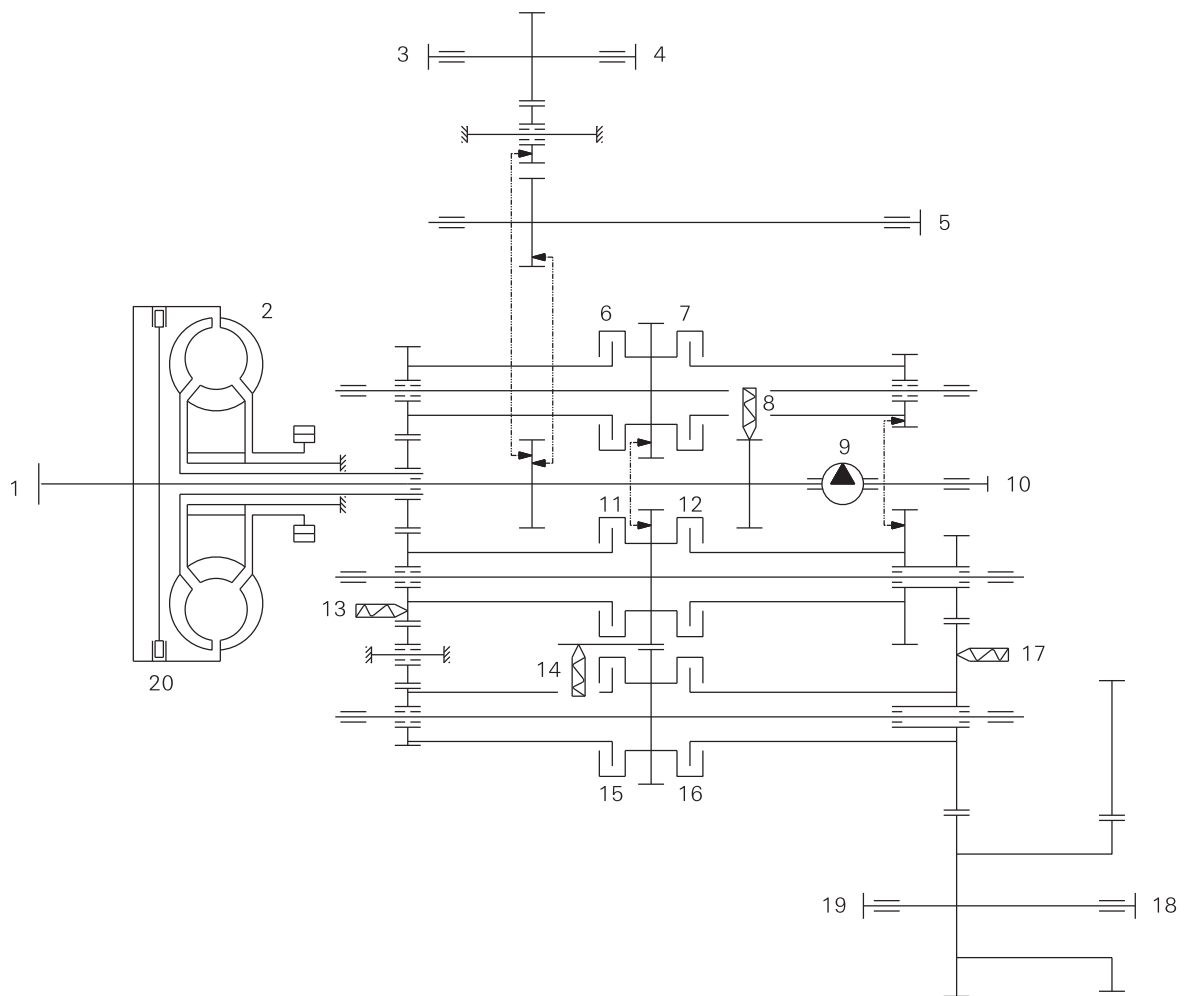
Function of a hydrodynamic torque converter (schematic view)



7577APT100

3. TRANSMISSION

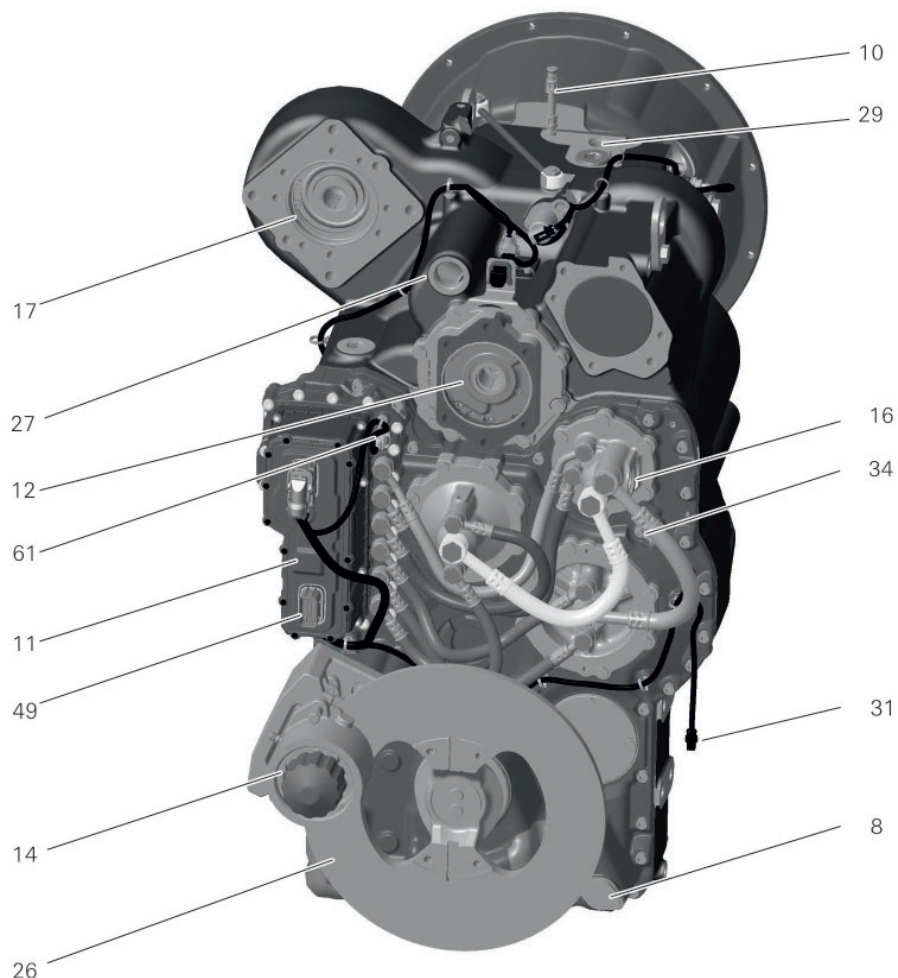
1) DIAGRAM



975T33PT10

- | | |
|--|---|
| 1 Input | 2 Converter |
| 3 PTO (if equipped) | 4 PTO (if equipped) |
| 5 PTO (if equipped) | 6 Clutch KV (clutch forward) |
| 7 Clutch K1 | 8 Inductive sensor for engine speed |
| 9 Pump | 10 Engine-dependent PTO |
| 11 Clutch KR (clutch reverse) | 12 Clutch K2 |
| 13 Inductive sensor for turbine speed | 14 Inductive sensor for speed of central gear chain |
| 14 Emergency steering pump (optional) | 16 Clutch K3 |
| 15 Clutch K4 | 18 Output |
| 17 Inductive sensor for the output speed | 20 Lock-up clutch (not used) |
| 19 Output | |

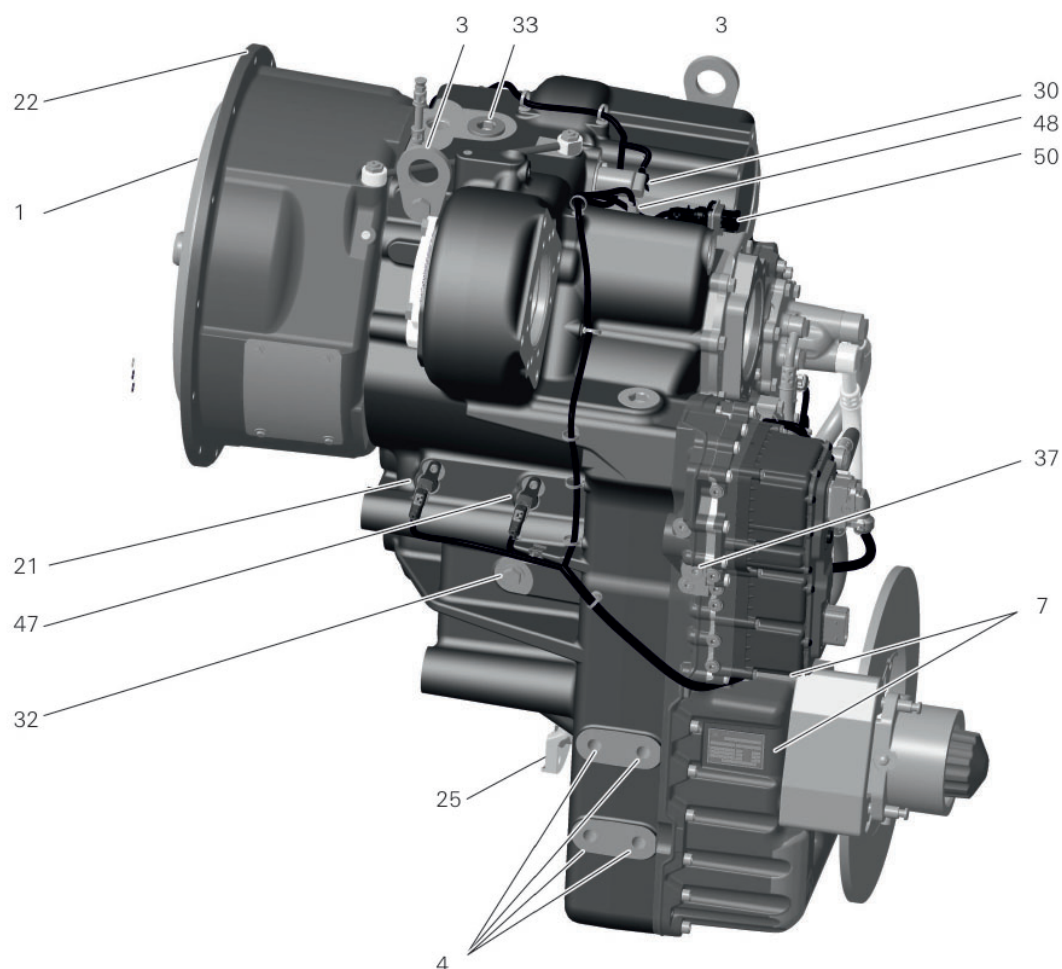
2) INSTALLATION VIEW



975T33PT11

- | | | | |
|----|---|----|--|
| 8 | Connection for oil level gauge\ | 31 | Connector for filter bypass valve |
| 10 | Breather | 34 | Inductive sensor for output speed |
| 11 | Electro hydraulic transmission control unit | 39 | Connection of return flow to sump |
| 12 | Engine-dependent PTO | 49 | Machine connector |
| 14 | Parking brake - disc brake | 61 | Temperature sensor for oil temperature in sump |
| 16 | Connection from oil cooler | | |
| 17 | PTO (if equipped) | | |
| 26 | Output flange | | |
| 27 | Connection to filter | | |
| 29 | Connection from filter bypass | | |

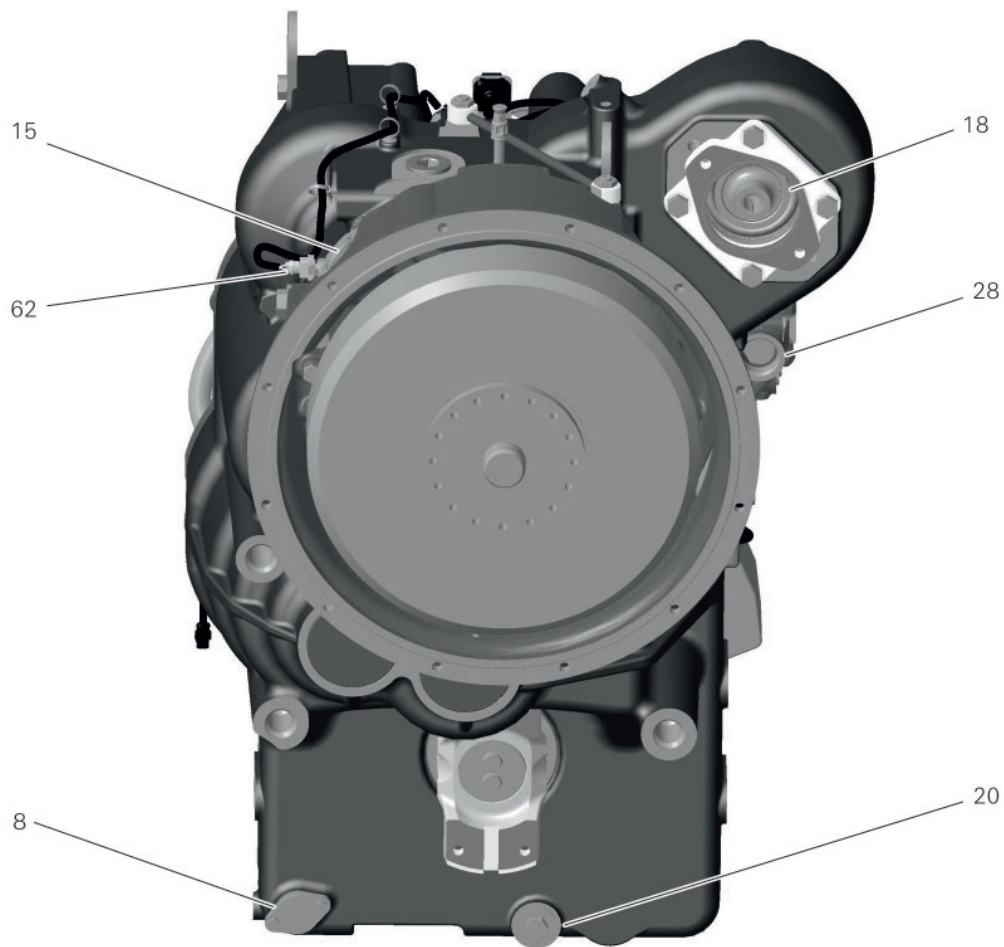
INSTALLATION VIEW



975T33PT12

- | | | | |
|----|------------------------------------|----|---|
| 1 | Converter | 30 | Solenoid valve for converter clutch (not used) |
| 3 | Lifting eye | 32 | Connection of return flow to sump M26X1.5 |
| 4 | Transmission suspension holes | 33 | Oil filler plug M42X2
(Tightening torque 145 Nm) |
| 7 | Name plate | 37 | Connection for system pressure M16X1.5 |
| 15 | Connection to heat exchanger | 47 | Inductive sensor for speed of central gear chain |
| 21 | Inductive sensor for turbine speed | 48 | Inductive sensor for engine speed |
| 22 | Connection to engine | 50 | Plug |
| 25 | Output flange | | |

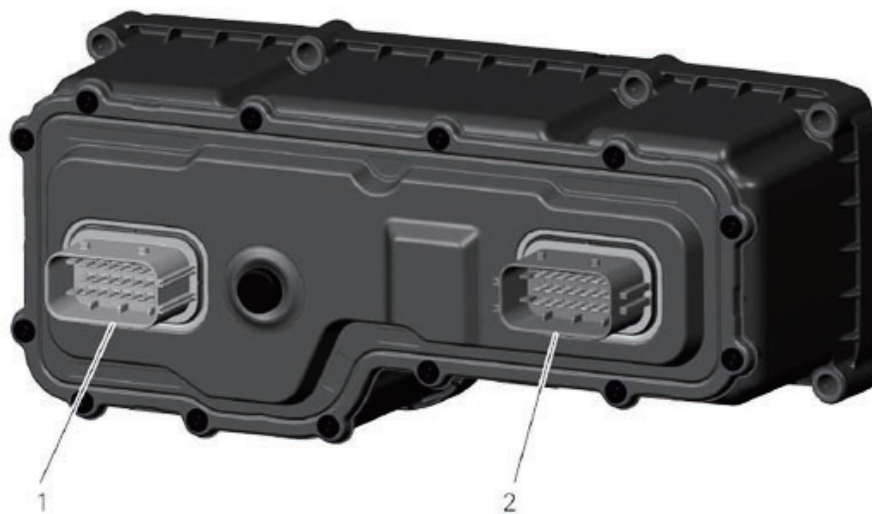
INSTALLATION VIEW



975T33PT13

- | | | | |
|----|---|----|--|
| 8 | Connection for oil level gauge | 28 | Connection from filter |
| 15 | Connection to oil cooler | 62 | Temperature sensor for oil temperature after converter |
| 18 | PTO (if equipped) | | |
| 20 | Oil drain plug M38X1.5
(Tightening torque 80 Nm) | | |

3) ELECTRONIC TRANSMISSION CONTROL UNIT



960T33PT13

- 1 Transmission connector
- 2 Machine connector

The electronic transmission control unit controls the electro-hydraulic transmission control unit.

The electronic control unit (EC4A) is designed as on-site electronics. An internal plug connection and wiring harness (plug-in connector 1) connect the electronic transmission control unit and the internal elements of the transmission. A second slot is provided for the connection of the transmission to the machine (plug-in connector 2). This plug connection is responsible for the power supply via on-board supply system and the connection to the CAN communication network. At delivery the second plug connection is closed with a cap for protection against outside influences. Carefully remove the cap with a screwdriver or similar tool. Do not damage the detents on the plug.

4. FAULT CODE

1-1) MACHINE FAULT CODE

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
101	3	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage > 3.95 V	●		
	4	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage < 0.3 V	●		
	(Results / Symptoms) 1. Monitor – Hydraulic Oil temperature display failure 2. Control Function – No warming up operation, No fuel warmer function operation, High hydraulic oil temperature warning failure (Checking list) 1. CN-58B (#23) – CD-01 (#2) Checking Open/Short 2. CN-58B (#25) – CD-01 (#1) Checking Open/Short				
202	0	10 seconds continuous, Steering main pump pressure Measurement Voltage > 5.3 V	●		
	4	10 seconds continuous, Steering main pump pressure Measurement Voltage < 0.3 V	●		
	(Results / Symptoms) 1. Monitor – Steering main pump press. Display failure 2. Control Function – No automatic Emergency steering operation, ECO gauge display failure 3. RMS – Working hours accumulation failure (Checking list) 1. CN-58B (#35) – CD-39 (B) Checking Open/Short 2. CN-58A (#11) – CD-39 (A) Checking Open/Short 3. CN-58B (#25) – CD-39 (C) Checking Open/Short				
204	0	10 seconds continuous, Boom cylinder 'head' pressure Measurement Voltage > 5.3 V	●		
	4	10 seconds continuous, Boom cylinder 'head' pressure Measurement Voltage < 0.3 V	●		
	(Results / Symptoms) 1. Monitor – Boom cylinder 'head' press. display failure 2. Control Function – No Boom pressure calibration function operation, workload measurement sys. operation failure (Checking list) 1. CN-58B (#29) – CD-80 (B) Checking Open/Short 2. CN-58A (#11) – CD-80 (A) Checking Open/Short 3. CN-58B (#25) – CD-80 (C) Checking Open/Short				

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
205	0	10 seconds continuous, Boom cylinder 'rod' pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Boom cylinder 'rod' pressure Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Boom cylinder 'rod' press. display failure 2. Control Function – No Boom pressure calibration function operation, workload measurement sys. operation failure (Checking list) 1. CN-58B(#36) – CD-81(B) Checking Open/Short 2. CN-58A(#11) – CD-81(A) Checking Open/Short 3. CN-58B(#25) – CD-81(C) Checking Open/Short			
301	3	10 seconds continuous, Fuel level Measurement Voltage > 3.8V	●		
	4	10 seconds continuous, Fuel level Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Fuel level display failure 2. Control Function – Fuel level low warning operation failure (Checking list) 1. CN-58B (#22) – CD-02 (#2) Checking Open/Short 2. CN-58B (#25) – CD-02 (#1) Checking Open/Short			
318	8	(In the startup conditions) 30 seconds continuous, Fan speed < 10 rpm in the Remote cooling fan EPPR current reference value is in X Ma(differ by model)	●		
		(Results / Symptoms) 1. Monitor – Cooling Fan revolutions display failure (Checking list) 1. CN-58A (#15) – CD-73 (#1) Checking Open/Short 2. CN-58A (#18) – CD-73 (#2) Checking Open/Short			
339	3	10 seconds continuous, Accel pedal position 1 voltage Measurement Voltage > 5.0 V			●
	4	10 seconds continuous, Accel pedal position 1 voltage Measurement Voltage < 0.2 V			●
		(Results / Symptoms) 1. Monitor – Accel pedal position 1 voltage display failure 2. Control Function – Engine rpm control failure (Checking list) 1. CN-58B(#39) – CN-162(#2) Checking Open/Short 2. CN-58A(#6) – CN-162(#3) Checking Open/Short 3. CN-58A(#8) – CN-162(#1) Checking Open/Short			

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DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
343	3	10 seconds continuous, Accel pedal position 2 voltage Measurement Voltage > 5.0 V			●
	4	10 seconds continuous, Accel pedal position 2 voltage Measurement Voltage < 0.2 V			●
	(Results / Symptoms) 1. Monitor – Accel pedal position 2 voltage display failure 2. Control Function – Engine rpm control failure (Checking list) 1. CN-58B (#40) – CN-162 (#5) Checking Open/Short 2. CN-58A (#7) – CN-162 (#6) Checking Open/Short 3. CN-58A (#9) – CN-162 (#4) Checking Open/Short				
503	0	10 seconds continuous, Brake oil pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Brake oil pressure Measurement Voltage < 0.3V	●		
	(Results / Symptoms) 1. Monitor – Brake oil press. display failure 2. Control Function – Brake oil pressure low warning display failure (Checking list) 1. CN-58B (#27) – CD-03 (B) Checking Open/Short 2. CN-58A (#11) – CD-03 (A) Checking Open/Short 3. CN-58B (#25) – CD-03 (C) Checking Open/Short				
507	0	10 seconds continuous, Parking oil pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Parking oil pressure Measurement Voltage < 0.3V	●		
	(Results / Symptoms) 1. Monitor – Parking oil Press. display failure 2. Control Function – No judgment Parking status (Checking list) 1. CN-58B (#34) – CD-26 (B) Checking Open/Short 2. CN-58A (#11) – CD-26 (A) Checking Open/Short 3. CN-58B (#25) – CD-26 (C) Checking Open/Short				
557	0	10 seconds continuous, Brake oil charging priority pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Brake oil charging priority pressure Measurement Voltage < 0.3V	●		
	(Results / Symptoms) 1. Monitor – Brake oil charging priority press. display failure 2. Control Function – Cooling fan revolutions control failure, Brake oil(Accumulator) charging failure (Checking list) 1. CN-58B (#38) – CD-31 (B) Checking Open/Short 2. CN-58A (#11) – CD-31 (A) Checking Open/Short 3. CN-58B (#25) – CD-31 (C) Checking Open/Short				

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
705	0	10 seconds continuous, Battery input Voltage > 35V	●		
	1	10 seconds continuous, Battery input Voltage < 18V	●		
		(Results / Symptoms) 1. Control Function – Disabled startup (Checking list) 1. Checking battery voltage 2. CN-58A (#1) – CN-36 (07 fuse) Checking Open/Short 3. CN-58A (#2) – CN-36 (07 fuse) Checking Open/Short			
707	1	(In the 500rpm or more) 10 seconds continuous, Alternator Node I Measurement Voltage < 18V	●		
		(Results / Symptoms) 1. Control Function – Battery charging circuit failure (Checking list) 1. CN-58B (#33) – CN-04 (#18) Checking Open/Short 2. CN-04 (#18) – CN-74 (#2) Checking Open/Short			
728	3	10 seconds continuous, Boom position sensor signal voltage Measurement Voltage > 5.0V	●		
	4	10 seconds continuous, Boom position sensor signal voltage Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Boom position sensor signal voltage display failure 2. Control Function – No calibration angle sensor, No calibration boom pressure , Boom Detent operation failure, Soft end stop(Boom) operation failure, Lock-up clutch operation failure (Checking list) 1. CN-58B (#37) – CN-100 (B) Checking Open/Short 2. CN-58A (#5) – CN-100 (C) Checking Open/Short 3. CN-58B (#25) – CN-100 (A) Checking Open/Short			
729	3	10 seconds continuous, Bucket position sensor signal voltage Measurement Voltage > 5.0V	●		
	4	10 seconds continuous, Bucket position sensor signal voltage Measurement Voltage < 0.3V	●		
		(Results /Symptoms) 1. Monitor – Bucket position sensor signal voltage display failure 2. Control Function – No calibration angle sensor, Bucket Detent operation failure, Soft end stop(Bucket) operation failure (Checking list) 1. CN-58B(#30) – CN-101(B) Checking Open/Short 2. CN-58A(#5) – CN-101(C) Checking Open/Short 3. CN-58B(#25) – CN-101(A) Checking Open/Short			

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
831	2	(When mounting the A/C Controller) 10 seconds continuous, A/C controller Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – A/C Controller malfunction				
841	2	10 seconds continuous, ECM Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – ECM operation failure				
842	2	10 seconds continuous, TCU Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – TCU operation failure				
844	2	10 seconds continuous, Monitor Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – Monitor operation failure				
850	2	(When mounting the RMCU) 90 seconds continuous, RMCU Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – RMCU operation failure				
861	2	(When mounting the EHCU) 10 seconds continuous, EHCU Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – EHCU operation failure				
869	2	(When mounting the BKCU) 10 seconds continuous, BKCU Communication Data Error	●		
	(Results / Symptoms) 1. Control Function – BKCU operation failure				

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

1-2) EHCU FAULT CODE (NOT USED)

HCESPN	FMI	Description
2333	9	Communication timeout between EHCU and TCU
2331	9	Communication timeout between EHCU and MCU
2332	9	Communication timeout between EHCU and working joystick
2317	9	Communication timeout between EHCU and steering joystick
2319	2	Steering joystick position signal error
2320	2	Steering joystick - FNR enable switch error
2321	2	Steering joystick - forward switch error
2322	2	Steering joystick - neutral switch error
2323	2	Steering joystick - reverse switch error
2324	2	Steering joystick - kick down switch error
2325	2	Steering joystick - steering on switch error
2326	5	PVE coil power current below normal or open circuit
2326	6	PVE coil power current above normal or grounded circuit
2327	0	PVE coil PWM duty cycle input value above normal operation range
2327	1	PVE coil PWM duty cycle input value below normal operation range
2327	5	PVE coil PWM duty cycle current below normal or open circuit
2327	6	PVE coil PWM duty cycle current above normal or grounded circuit
2327	14	PVE coil PWM duty cycle control block parameter invalid
2311	2	Boom joystick position signal error
2311	0	Boom joystick position input value above normal operation range
2311	1	Boom joystick position input value below normal operation range
2311	3	Boom joystick position input voltage above normal or shorted to high source
2311	4	Boom joystick position input voltage below normal or shorted to low source
2311	13	Boom joystick position control block out of calibration
2311	14	Boom joystick position control block parameter invalid
2311	31	Boom joystick position signal redundancy lost
2313	2	Bucket joystick position signal error
2313	0	Bucket joystick position input value above normal operation range
2313	1	Bucket joystick position input value below normal operation range
2313	3	Bucket joystick position input voltage above normal or shorted to high source
2313	4	Bucket joystick position input voltage below normal or shorted to low source
2313	13	Bucket joystick position control block out of calibration
2313	14	Bucket joystick position control block parameter invalid
2313	31	Bucket joystick position signal redundancy lost
2315	2	Aux joystick position signal error
2315	0	Aux joystick position input value above normal operation range
2315	1	Aux joystick position input value below normal operation range

HCESPN	FMI	Description
2315	3	Aux joystick position input voltage above normal or shorted to high source
2315	4	Aux joystick position input voltage below normal or shorted to low source
2315	13	Aux joystick position control block out of calibration
2315	14	Aux joystick position control block parameter invalid
2315	31	Aux joystick position signal redundancy lost
2304	0	Boom up EPPR valve input value above normal operation range
2304	1	Boom up EPPR valve input value below normal operation range
2304	5	Boom up EPPR valve input current below normal or open circuit
2304	6	Boom up EPPR valve input current above normal or grounded circuit
2304	14	Boom up EPPR valve block parameter invalid
2305	0	Boom down EPPR valve input value above normal operation range
2305	1	Boom down EPPR valve input value below normal operation range
2305	5	Boom down EPPR valve input current below normal or open circuit
2305	6	Boom down EPPR valve input current above normal or grounded circuit
2305	14	Boom down EPPR valve block parameter invalid
2306	0	Bucket in EPPR valve input value above normal operation range
2306	1	Bucket in EPPR valve input value below normal operation range
2306	5	Bucket in EPPR valve input current below normal or open circuit
2306	6	Bucket in EPPR valve input current above normal or grounded circuit
2306	14	Bucket in EPPR valve block parameter invalid
2307	0	Bucket dump EPPR valve input value above normal operation range
2307	1	Bucket dump EPPR valve input value below normal operation range
2307	5	Bucket dump EPPR valve input current below normal or open circuit
2307	6	Bucket dump EPPR valve input current above normal or grounded circuit
2307	14	Bucket dump EPPR valve block parameter invalid
2308	0	Aux. Up EPPR valve input value above normal operation range
2308	1	Aux. Up EPPR valve input value below normal operation range
2308	5	Aux. Up EPPR valve input current below normal or open circuit
2308	6	Aux. Up EPPR valve input current above normal or grounded circuit
2308	14	Aux. Up EPPR valve block parameter invalid
2309	0	Aux. Down EPPR valve input data above normal operation range
2309	1	Aux. Down EPPR valve input data below normal operation range
2309	5	Aux. Down EPPR valve input current below normal or open circuit
2309	6	Aux. Down EPPR valve input current above normal or grounded circuit
2309	14	Aux. Down EPPR valve block parameter invalid
2328	0	EHCUSensor power voltage high
2328	1	EHCUSensor power voltage low
2328	3	EHCUSensor power voltage above normal or shorted to high source

HCESPN	FMI	Description
2328	4	EHCUC sensor power voltage below normal or shorted to low source
2329	0	EHCUC power voltage high
2329	1	EHCUC power voltage low
2329	11	EHCUC safety cpu error
739	2	Armrest switch signal error
2334	0	Steering pilot pressure sensor data above normal range
2334	1	Steering pilot pressure sensor data below normal range
2335	2	Steering proportional valve moving position error
2335	14	Steering proportional valve start position error

1-3)AAVM FAULT CODE (NOT USED)

Fault Code	Description
A01	AAVM Communication Error -AAVM
A02	AAVM Communication Error -Front Camera
A03	AAVM Communication Error -Rear Camera
A04	AAVM Communication Error -Left Camera
A05	AAVM Communication Error -Right Camera
A06	Manual Setting Fail
A07	No MCU CID
A08	MCU CID Format Error
A09	AAVM Hardware Error -AAVM
A10	AAVM Hardware Error -Front Camera
A11	AAVM Hardware Error -Rear Camera
A12	AAVM Hardware Error -Left Camera
A13	AAVM Hardware Error -Right Camera
A14	MCU CID Model is not registered
A15	MCU CID Model can't be applied

2) ENGINE FAULT CODE

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
111 629 12	Engine control module critical internal failure - Bad intelligent device or component. Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	Possible no noticeable performance effects, engine dying, or hard starting.
115 612 2	Engine magnetic crankshaft speed/position lost both of two signals - Data erratic, intermittent, or incorrect. The ECM has detected the primary and backup speed sensor signals are connected backwards.	The engine will shut down or will not start.
122 102 3	Intake manifold 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the intake manifold pressure circuit.	Engine power derate.
123 102 4	Intake manifold 1 pressure sensor circuit - Voltage below normal, or shorted to low Source. Low signal voltage or open circuit detected at the intake manifold pressure circuit.	Engine power derate.
124 102 16	Intake manifold 1 pressure - Data valid but above normal operational range - Moderately severe level. Intake manifold pressure is above the maximum operating limit.	Engine power derate.
125 102 18	Intake Manifold 1 Pressure - Data valid but below normal operating range - Moderately severe level. Intake manifold pressure is below the minimum operating limit.	Engine power derate.
131 91 3	Accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at accelerator pedal position number 1 circuit.	The engine will operate in limp home mode.
132 91 4	Accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at accelerator pedal position number 1 signal circuit.	The engine will operate in limp home mode.
133 974 3	Remote accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
134 974 4	Remote accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
143 100 18	Engine oil rifle pressure - Data valid but below normal operational range - Moderately severe level. Engine oil pressure signal indicates engine oil pressure is below the engine protection warning limit.	Engine power derate.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
144 110 3	Engine coolant temperature 1 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
145 110 4	Engine coolant temperature 1 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
146 110 16	Engine coolant temperature - Data valid but above normal operational range - Moderately severe level. Engine coolant temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
151 110 0	Engine coolant temperature - Data valid but above normal operational range - Most severe level. Engine coolant temperature signal indicates engine coolant temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
153 105 3	Intake manifold 1 temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
154 105 4	Intake manifold 1 temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
155 105 0	Intake manifold 1 temperature - Data valid but above normal operational range - Most severe level. Intake manifold air temperature signal indicates intake manifold air temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
175 3464 3	Electronic throttle control actuator driver circuit - Voltage above normal, or shorted to high source. A short circuit to battery or open circuit has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
176 3464 4	Electronic throttle control actuator driver circuit - Voltage below normal, or shorted to low source. A short circuit to ground has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
177 3464 7	Electronic throttle control actuator - Mechanical system not responding or out of adjustment. The engine intake air throttle actuator has failed the auto zero span check.	Possible reduced engine performance.
187 3510 4	Sensor supply 2 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the sensor supply number 2 circuit.	Engine power derate.
195 111 3	Coolant level sensor 1 circuit - Voltage above normal, or shorted to high source. High signal voltage detected at engine coolant level circuit.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
196 111 4	Coolant level sensor 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant level circuit.	None on performance.
197 111 18	Coolant level - Data valid but below normal operational range - Moderately severe level. Low coolant level has been detected.	Engine power derate.
221 108 3	Barometric pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at barometric pressure circuit.	Engine power derate.
222 108 4	Barometric pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at barometric pressure circuit.	Engine power derate.
227 3510 3	Sensor supply 2 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 2 circuit.	Engine power derate.
234 190 0	Engine crankshaft speed/position - Data valid but above normal operational range - Most severe level. Engine speed signal indicates engine speed above engine protection limit.	Engine power derate.
238 3511 4	Sensor supply 3 circuit - Voltage below normal, or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
239 3511 3	Sensor supply 3 circuit - Voltage above normal or shorted to high source. High voltage detected on the 5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
241 84 2	Wheel-based vehicle speed - Data erratic, intermittent, or incorrect. The ECM lost the vehicle speed signal or is reading an erratic value.	Engine speed limited to ,maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
245 647 4	Fan control circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fan control circuit when commanded on.	The fan may stay on continuously or not run at all.
249 171 3	Ambient air temperature sensor 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
256 171 4	Ambient air temperature sensor 1 circuit - Voltage below normal or shorted to low source. Low voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
271 1347 4	Fuel pump pressurizing assembly 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fuel pump actuator circuit.	Engine power derate.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
272 1347 3	Fuel pump pressurizing assembly 1 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at the fuel pump actuator circuit.	Engine may run rough, may stop running, may not start, or may be difficult to start.
285 639 9	SAE J1939 multiplexing PGN timeout error - Abnormal update rate. The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286 639 13	SAE J1939 multiplexing configuration error - Out of calibration. The ECM expected information from a multiplexed device but only received a portion of the necessary information.	At least one multiplexed device will not operate properly.
288 974 19	Sae J1939 multiplexing remote accelerator pedal or lever position sensor circuit - Received network data in error. The oem vehicle electronic control unit (VECM) detected a fault with the remote accelerator.	Remote accelerator will not operate.
295 108 2	Barometric pressure - Data erratic, intermittent, or incorrect. An error in the barometric pressure sensor signal was detected by the ECM.	Engine power derate.
322 651 5	Injector solenoid driver cylinder 1 circuit - Current below normal, or open circuit. Current detected at injector 1 when voltage is turned OFF.	Engine power derate.
323 655 5	Injector solenoid driver cylinder 5 circuit - Current below normal, or open circuit. Current detected at injector 5 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
324 653 5	Injector solenoid driver cylinder 3 circuit - Current below normal, or open circuit. Current detected at injector 3 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
325 656 5	Injector solenoid driver cylinder 6 circuit - Current below normal, or open circuit. Current detected at injector 6 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
331 652 5	Injector solenoid driver cylinder 2 circuit - Current below normal, or open circuit. Current detected at injector 2 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
332 654 5	Injector solenoid driver cylinder 4 circuit - Current below normal, or open circuit. Current detected at injector 4 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
334 110 2	Engine coolant temperature - Data erratic, intermittent, or incorrect. The engine coolant temperature sensor is reading an erratic value at initial key ON.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
338 1267 3	Idle shutdown vehicle accessories relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or short to voltage source detected at the idle shutdown vehicle accessory/ignition bus relay circuit.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
339 1267 4	Idle shutdown vehicle accessories relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at the idle shutdown vehicle accessory or ignition bus relay circuit when commanded ON.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
343 629 12	Engine control module warning internal hardware failure - Bad intelligent device or component. ECM power supply errors have been detected.	Engine power derate.
346 630 12	Engine control module calibration memory software - Bad intelligent device or component. Invalid switch configuration adjustable parameter setting have been detected by the engine control module (ECM).	Various optional switch inputs to the ECM may not operate correctly.
351 627 12	Injector power supply - Bad intelligent device or component. The ECM measured injector boost voltage is low.	Engine power derate.
352 3509 4	Sensor supply 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at sensor supply number 1 circuit.	Engine power derate.
383 729 5	Engine intake air heater 1 circuit - Current below normal or open circuit. A malfunctioning engine intake air heater circuit has been detected.	Engine may not start or may be difficult to start.
386 3509 3	Sensor supply 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 1 circuit.	Engine power derate.
415 100 1	Engine oil rifle pressure - Data valid but below normal operational range - Most severe level. Oil pressure signal indicates oil pressure below the engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red stop lamp starts flashing.
418 97 15	Water in fuel indicator - Data valid but above normal operational range - Least severe level. water has been detected in the fuel filter.	None on performance.
427 639 9	J1939 data link - Abnormal update rate. Communication between the engine control module (ECM) and another device on the SAE J1939 data link has been lost.	Engine will only idle.
428 97 3	Water in fuel indicator sensor circuit - Voltage above normal, or shorted to high source. High voltage detected at the water in fuel circuit.	None on performance. No water in fuel warning available.
435 100 2	Engine oil rifle pressure - Data erratic, intermittent, or incorrect. The engine oil pressure sensor is reading an erratic value.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
436 105 2	Intake manifold 1 temperature - Data erratic, intermittent, or incorrect. The intake manifold temperature sensor is reading an erratic value at initial key on or while the engine is running.	Possible reduced engine performance.
441 168 18	Battery 1 voltage - Data valid but below normal operational range - Moderately severe level. ECM supply voltage is below the minimum system voltage level.	Engine may run rough, may stop running, may not start, or may be difficult to start.
442 168 16	Battery 1 Voltage - Data valid but above normal operational range - Moderately severe level. ECM supply voltage is above the maximum system voltage level.	None on performance.
451 157 3	Injector metering rail 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
452 157 4	Injector metering rail 1 pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
483 1349 3	Injector metering rail 2 pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
484 1349 4	Injector metering rail 2 pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
515 3514 3	Sensor supply 6 circuit - Voltage above normal or shorted to high source. High voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
516 3514 4	Sensor supply 6 circuit - Voltage below normal or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
553 157 16	Injector metering rail 1 pressure - Data valid but above normal operational range - Moderately severe level. The ECM has detected that fuel pressure is higher than commanded pressure.	Possible reduced engine performance.
555 101 16	Crankcase pressure - Data valid but above normal operational range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.
556 101 0	Crankcase pressure - Data valid but above normal operational range - Most severe level. The crankcase breather filter requires maintenance.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
559 157 18	Injector metering rail 1 pressure - Data valid but below normal operational range - Moderately severe level. The ecm has detected that fuel pressure is lower than commanded pressure.	Possibly hard to start or low power. Engine could possibly not start.
584 677 3	Starter relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
585 677 4	Starter relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
595 103 16	Turbocharger 1 speed - Data valid but above normal operating range - Moderately severe level. High turbocharger speed has been detected by the ecm.	Engine power derate.
596 167 16	Electrical charging system voltage - Data valid but above normal operational range - Moderately severe level. High battery voltage detected by the battery voltage monitor feature.	None on performance.
597 167 18	Electrical charging system voltage - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the battery voltage monitor feature.	None on performance.
649 1378 31	Engine oil change interval - Condition exists. Change engine oil and filter.	None on performance.
687 103 18	Turbocharger 1 speed - Data valid but below normal operational range - Moderately severe level. Low turbocharger speed detected by the ECM.	Engine power derate. The ECM uses an estimated turbocharger speed.
689 190 2	Engine crankshaft speed/position - Data erratic, intermittent, or incorrect. The ECM has detected an error in the engine speed signal.	Possible reduced engine performance.
691 1172 3	Turbocharger 1 compressor inlet temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
692 1172 4	Turbocharger 1 compressor inlet temperature circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
693 1172 2	Turbocharger 1 compressor intake temperature - Data erratic, intermittent, or incorrect. A temperature too high or low for the operating conditions has been detected by the turbocharger compressor intake temperature sensor.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
731 723 7	Engine speed / position camshaft and crankshaft misalignment - Mechanical system not responding properly or out of adjustment. Engine position signal from the crankshaft position sensor and camshaft position sensor do not match.	Engine power derate.
755 157 7	Injector metering rail 1 pressure - Mechanical system not responding or out of adjustment. The ecm has detected a difference in the 2 fuel rail pressure signals.	Possible reduced engine performance.
778 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. The ECM has detected an error in the camshaft position sensor signal.	Possible reduced engine performance.
784 1590 2	Adaptive cruise control mode - Data erratic, intermittent, or incorrect. Loss of communication with adaptive cruise control.	Adaptive cruise control will not operate. Standard cruise control may not operate.
1117 627 2	Power supply lost with ignition on - Data erratic, intermittent, or incorrect. Supply voltage to the ECM fell below 6.2 volts momentarily, or the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key OFF).	Possible no noticeable performance.
1139 651 7	Injector solenoid driver cylinder 1 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1141 652 7	Injector solenoid driver cylinder 2 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1142 653 7	Injector solenoid driver cylinder 3 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1143 654 7	Injector solenoid driver cylinder 4 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1144 655 7	Injector solenoid driver cylinder 5 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1145 656 7	Injector solenoid driver cylinder 6 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1228 27 2	Egr valve position - Data erratic, intermittent, or Incorrect. The EGR valve is unable to meet commanded position.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1239 2623 3	Accelerator pedal or lever position sensor 2 circuit - Voltage above normal or shorted to high source. High voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1241 2623 4	Accelerator pedal or lever position sensor 2 circuit - Voltage below normal or shorted to low source. Low voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1242 91 2	Accelerator pedal or lever position sensor 1 and 2 - Data erratic, intermittent, or incorrect. Accelerator position sensor number 1 and number 2 are reading different values.	The engine will only idle.
1515 91 19	Sae J1939 multiplexed accelerator pedal or lever sensor system - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the multiplexed accelerator pedal.	The engine will only idle.
1654 1323 31	Engine misfire cylinder 1- Condition exists. Engine misfire has been detected in cylinder number 1.	Possible reduced engine performance.
1655 1324 31	Engine misfire cylinder 2 - Condition exists. Engine misfire has been detected in cylinder number 2.	Possible reduced engine performance.
1656 1325 31	Engine misfire cylinder 3 - Condition exists. Engine misfire has been detected in cylinder number 3.	Possible reduced engine performance.
1657 1326 31	Engine misfire cylinder 4 - Condition exists. Engine misfire has been detected in cylinder number 4.	Possible reduced engine performance.
1658 1327 31	Engine misfire cylinder 5 - Condition exists. Engine misfire has been detected in cylinder number 5.	Possible reduced engine performance.
1659 1328 31	Engine misfire cylinder 6 - Condition exists. Engine misfire has been detected in cylinder number 6.	Possible reduced engine performance.
1668 1761 4	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank level sensor circuit.	Possible reduced engine performance.
1669 1761 3	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst tank level sensor circuit.	Possible reduced engine performance.
1673 1761 1	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Most severe level. The aftertreatment diesel exhaust fluid tank level has fallen below the critical warning level.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1677 3031 4	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1678 3031 3	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1679 3031 2	Aftertreatment diesel exhaust fluid tank temperature - Data erratic, intermittent, or incorrect. The diesel exhaust fluid tank temperature sensor has indicated a tank temperature too high or too low for the ambient conditions.	Possible reduced engine performance.
1682 3362 31	Aftertreatment diesel exhaust fluid dosing unit input lines - Condition exists. The aftertreatment diesel exhaust fluid dosing unit is unable to prime.	Possible reduced engine performance.
1683 3363 3	Aftertreatment diesel exhaust fluid tank heater - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1684 3363 4	Aftertreatment diesel exhaust fluid tank heater - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1691 100 18	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. The temperature increase across the aftertreatment catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
1695 3513 3	Sensor supply 5 - Voltage above normal or shorted to high source. High voltage detected at sensor supply 5 circuit in the oem harness.	the engine will operate in limp home mode.
1696 3513 4	Sensor supply 5 - Voltage below normal or shorted to low source. Low voltage detected at sensor supply number 5 circuit in the oem harness.	the engine will operate in limp home mode.
1712 3363 18	Aftertreatment diesel exhaust fluid tank heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank heater is unable to thaw the frozen diesel exhaust fluid.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1713 3363 16	Aftertreatment diesel exhaust fluid tank heater - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid tank heater is continuously in the on position.	None on performance.
1718 1322 31	Engine misfire for multiple cylinders - Condition exists. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1776 2634 3	Power relay driver circuit - Voltage above normal or shorted to high source. High voltage detected at power relay driver circuit.	Possible reduced engine performance.
1777 2634 4	Power relay driver circuit - Voltage below normal or shorted to low source. An open circuit or low voltage has been detected at the power relay circuit.	Possible reduced engine performance.
1843 101 3	Crankcase pressure circuit - Voltage above normal or shorted to high source. High signal voltage detected at the crankcase pressure circuit.	None on performance.
1844 101 4	Crankcase pressure circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the crankcase pressure circuit.	None on performance.
1866 411 2	Exhaust gas recirculation valve delta pressure - Data erratic, intermittent, or incorrect. An error in the egr delta pressure signal was detected at initial key on or the sensor failed the autozero test.	possible reduced engine performance.
1867 412 2	Engine gas recirculation temperature - Data erratic, intermittent, or incorrect. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1879 3251 3	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1881 3251 4	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage or open circuit detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1883 3251 2	Aftertreatment diesel particulate filter differential pressure sensor - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter differential pressure sensor is reading an erratic value at initial key on or during engine operation.	possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1885 3216 4	Aftertreatment intake NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
1887 3226 4	Aftertreatment outlet NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
1896 2791 13	EGR valve controller - Out of calibration. The EGR valve has failed the automatic calibration procedure at initial key ON.	Possible reduced engine performance.
1921 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Moderately severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
1922 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Most severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits. Engine protection derate is enabled.	Possible reduced engine performance.
1938 3597 1	Ecu power output supply voltage 1 - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the VGT actuator.	Possible reduced engine performance.
1942 101 2	Crankcase pressure - Data erratic, intermittent, or incorrect. The ECM has detected that the crankcase pressure signal is reading an erratic value at initial key ON or during engine operation.	None on performance.
1961 2791 0	EGR valve control circuit calculated over temperature - Data valid but above normal operational range - Least severe level. High EGR valve driver temperature has been detected.	Possible reduced engine performance.
1962 641 0	VGT Actuator driver over temperature (calculated) - Data valid but above normal operating range - Least severe level. High internal VGT actuator temperature has been detected.	None on performance.
1974 101 16	Crankcase pressure - Data valid but above normal operating range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1993 4795 31	Aftertreatment diesel particulate filter missing - Condition exists. The aftertreatment diesel particulate filter in the exhaust system is not present.	Active aftertreatment diesel particulate filter regeneration will be disabled.
2185 3512 3	Sensor supply 4 circuit - Voltage above normal, or shorted to high source. High voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2186 3512 4	Sensor supply 4 circuit - Voltage below normal, or shorted to low source. Low voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2198 641 11	VGT Actuator driver circuit - Root cause not known. Intermittent communication between the smart VGT controller and the ECM has been detected. The VGT controller is not interpreting the J1939 message from the ECM correctly.	Possible reduced engine performance.
2272 27 4	EGR Valve position circuit - Voltage below normal or shorted to low source. Low signal voltage has been detected at the EGR valve position sensor circuit	Possible reduced engine performance.
2273 411 3	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2274 411 4	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2288 103 15	Turbocharger 1 speed - Data valid but above normal operating range - Least severe level. High turbocharger speed has been detected by the ECM.	Possible reduced engine performance.
2311 633 31	Electronic fuel injection control valve circuit - Condition exists. Fuel pump actuator circuit resistance too high or too low, or an intermittent connection has been detected.	Possible reduced engine performance.
2322 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. Camshaft engine speed sensor intermittent synchronization.	None on performance.
2349 2791 5	EGR Valve control circuit - Current below normal or open circuit. Motor terminal or motor coil open circuit has been detected by the ECM.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2353 2791 6	EGR Valve control circuit - Current above normal or grounded circuit. A short circuit to ground has been detected in the EGR valve motor circuit.	Possible reduced engine performance.
2372 95 16	Fuel filter differential pressure - Data valid but above normal operational range - Moderately severe level. Excessive fuel flow restriction to the high pressure fuel pump has been detected.	Possible reduced engine performance.
2373 1209 3	Exhaust gas pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2374 1209 4	Exhaust gas pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2375 412 3	Exhaust gas recirculation temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2376 412 4	Exhaust gas recirculation temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2377 647 3	Fan control circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at the fan control circuit.	The fan can stay on continuously or not run at all.
2387 641 7	VGT Actuator driver circuit (motor) - Mechanical system not responding or out of adjustment. The smart VGT controller has detected incorrect stop limits, or the VGT is unable to move to the closed position.	Possible reduced engine performance.
2398 171 2	Ambient air temperature - Data erratic, intermittent, or incorrect. The ambient air temperature sensor is reading an erratic value.	Possible reduced engine performance.
2448 111 17	Coolant level - Data valid but below normal operational range - Least severe level. Low engine coolant level detected.	none on performance.
2449 641 13	Vgt actuator controller - Out of calibration. The VGT actuator has been installed incorrectly.	Possible reduced engine performance.
2468 102 3	Engine crankshaft speed/position - Data valid but above normal operating range - Moderately severe level. The engine speed has exceeded a critical limit.	Engine will be shut down.
2554 1209 2	Exhaust gas pressure - Data erratic, intermittent or incorrect. The exhaust gas pressure sensor is reading an erratic value.	possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2555 729 3	Intake air heater 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2556 729 4	Intake air heater 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2634 641 12	VGT Actuator controller - Bad intelligent device or component. An internal error has been detected by the smart VGT controller.	Possible reduced engine performance.
2636 641 9	VGT Actuator driver circuit - abnormal update rate. No communications on the J1939 data link between the engine ECM and the smart VGT controller.	Possible reduced engine performance.
2638 5298 17	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Least severe level. The temperature increase across the aftertreatment diesel oxidation catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
2639 3251 15	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Least severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
2646 110 32	Engine coolant temperature - Condition exists. The EGR valve was closed to reduce engine coolant temperature.	Possible reduced engine performance.
2718 520325 31	Brake switch and accelerator pedal position incompatible - Condition exists. The ECM has detected the brake pedal and accelerator pedal were depressed simultaneously.	The engine will operate in limp home mode.
2771 3226 9	Aftertreatment outlet NOx sensor - Abnormal update rate. No communications or an invalid data transfer rate detected on the J1939 data link between the ECM and the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
2777 3703 31	Particulate trap active regeneration inhibited due to inhibit switch - Condition exists. Regeneration of the diesel particulate filter has been prevented due to the permit switch being disabled.	Possible frequent need for aftertreatment regeneration.
2961 412 15	Exhaust gas recirculation temperature - Data valid but above normal operational range - Least severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.
2962 412 16	Exhaust gas recirculation temperature - Data valid but above normal operational range - Moderately severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2963 110 15	Engine coolant temperature - Data valid but above normal operational range - Least severe level. Engine coolant temperature is above the engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2964 105 15	Intake manifold 1 temperature - Data valid but above normal operational range - Least severe level. Intake manifold air temperature signal indicates intake manifold air temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2973 102 2	Intake manifold 1 pressure - Data erratic, intermittent, or incorrect. The intake manifold pressure sensor is reading an erratic value.	Possible reduced engine performance.
2976 3361 2	Aftertreatment diesel exhaust fluid dosing unit temperature - Data erratic, intermittent, or incorrect. An internal error has been detected in the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3133 3610 3	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3134 3610 4	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3135 3610 2	Aftertreatment diesel particulate filter outlet pressure - Data erratic, intermittent or incorrect. The aftertreatment diesel particulate filter outlet pressure sensor is reading an erratic value at initial key ON or during engine operation.	Possible reduced engine performance.
3146 4363 3	Aftertreatment SCR outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3147 4363 4	Aftertreatment SCR outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3148 4363 2	Aftertreatment SCR outlet temperature sensor - Data erratic, intermittent, or incorrect. The SCR outlet temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3151 4794 31	Aftertreatment SCR catalyst system missing - Condition exists. The aftertreatment SCR catalyst in the exhaust system is not present.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3165 4363 0	Aftertreatment SCR outlet temperature - Data valid but above normal operational range - Most severe level. The SCR outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3168 3936 16	Aftertreatment diesel particulate filter system - Data valid but above normal operating range - Moderately severe level. The system has detected a malfunction in the filtering capability of the aftertreatment diesel particulate filter.	None on performance.
3186 1623 9	Tachograph output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the tachograph output shaft speed sensor.	None on performance.
3213 1623 19	Tachograph output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the tachograph output shaft speed sensor.	None on performance.
3228 3216 2	Aftertreatment Intake NOx sensor - Data erratic, intermittent, or incorrect. An incorrect NOx sensor reading has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3232 3216 9	Aftertreatment Intake NOx sensor - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3235 4363 16	Aftertreatment SCR outlet temperature - Data valid but above normal operating range - Moderately severe level. The SCR outlet temperature sensor reading has exceeded the maximum temperature limit.	Possible reduced engine performance.
3237 4340 3	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3238 4340 4	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3239 4342 3	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.
3241 4342 4	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3242 3363 7	Aftertreatment diesel exhaust fluid tank heater - Mechanical system not responding or out of adjustment. The aftertreatment diesel exhaust fluid temperature did not increase when the aftertreatment diesel exhaust fluid tank heater was commanded ON.	Possible reduced engine performance.
3243 3060 18	Engine cooling system monitor - Data valid but below normal operating range - Moderately severe level. The engine is not warming up as expected.	None on performance.
3251 4765 16	Aftertreatment diesel oxidation catalyst intake temperature - Data valid but above normal operating range - Moderately severe level. The diesel oxidation catalyst intake temperature sensor reading has exceeded the maximum temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3253 3242 16	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3254 3242 15	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3255 3246 16	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3256 3246 15	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3258 4340 5	Aftertreatment diesel exhaust fluid line heater 1 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 1.	Possible reduced engine performance.
3261 4342 5	Aftertreatment diesel exhaust fluid line heater 2 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 2.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3311 3242 0	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3312 3246 0	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3313 4765 4	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the catalyst intake sensor circuit.	Possible reduced engine performance.
3314 4765 3	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst intake temperature sensor circuit.	Possible reduced engine performance.
3315 4765 2	Aftertreatment diesel oxidation catalyst intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel oxidation catalyst intake temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3316 3242 4	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3317 3242 3	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3318 3242 2	Aftertreatment diesel particulate filter intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter intake temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3319 3246 3	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3321 3246 4	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.
3322 3246 2	Aftertreatment diesel particulate filter outlet temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter outlet temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3326 91 9	SAE J1939 Multiplexed accelerator pedal or lever sensor system - Abnormal update rate. The ECM expected information from a multiplexed accelerator pedal or lever sensor but did not receive it soon enough or did not receive it at all.	Engine will only idle.
3328 191 9	Transmission output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the transmission output shaft speed sensor.	None on performance.
3342 4752 18	Engine exhaust gas recirculation cooler efficiency - Data valid but below normal operating range - Moderately severe level. The EGR cooler is not cooling the recirculated exhaust gas sufficiently.	None on performance.
3343 5285 18	Engine charge-air cooler efficiency - Data valid but below normal operating range - Moderately severe level. The engine charge air cooler is not cooling the intake air flow sufficiently.	None on performance.
3361 102 10	Intake manifold 1 pressure - Abnormal rate of change. The VGT position reading is stuck.	Possible reduced engine performance.
3366 111 18	Coolant level - Data valid but below normal operating range - Moderately severe level. Very low engine coolant level detected.	None on performance.
3374 1818 31	Roll over protection brake control active - Condition exists. The ECM received a message from the anti-lock braking (ABS) controller, inhibiting cruise control operation.	Cruise control could possibly not operate.
3375 5397 31	Aftertreatment diesel particulate filter regeneration too frequent - Condition exists. The system has detected the need for an active regeneration has occurred too soon following the last active regeneration.	None on performance.
3376 5319 31	Aftertreatment diesel particulate filter incomplete regeneration - Condition exists. The system has detected that the aftertreatment diesel particulate filter differential pressure is too high following an active regeneration.	Possible frequent need for aftertreatment regeneration.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3382 3058 18	Engine exhaust gas recirculation (EGR) system - Data valid but below normal operating range - Moderately severe level. Measured egr flow is lower than commanded.	Possible reduced engine performance.
3383 3058 16	Engine exhaust gas recirculation (EGR) system - Data valid but above normal operating range - Moderately severe Level. Measured EGR flow is higher than commanded.	Possible reduced engine performance.
3394 4766 18	Aftertreatment 1 diesel oxidation catalyst outlet gas temperature - Data valid but below normal operating range - Moderately severe level. The diesel oxidation catalyst outlet Temperature is below the operating limit	Possible frequent need for aftertreatment regeneration.
3396 3750 31	Diesel particulate filter 1 conditions not met for active regeneration - Condition exists. The aftertreatment temperatures are not warm enough for aftertreatment injection.	Possible frequent need for aftertreatment regeneration.
3418 191 19	Transmission output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the transmission output shaft speed sensor.	None on performance.
3422 4344 3	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3423 4344 4	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3425 4344 5	Aftertreatment diesel exhaust fluid line heater 3 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 3.	Possible reduced engine performance.
3488 563 9	Anti-lock braking (ABS) controller - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the anti-lock braking (ABS) controller.	None on performance.
3492 251 10	Real time clock - Abnormal rate of change. The real time clock indicates a stuck engine off timer.	None on performance.
3494 1081 7	Engine wait to start lamp - Mechanical system not responding or out of adjustment. Wait to Start lamp has malfunction.	None on performance.
3497 1761 17	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Least severe level. The aftertreatment diesel exhaust fluid tank level is low.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3498 1761 18	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank level is very low.	None on performance.
3525 84 19	Wheel-based vehicle speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3526 84 9	Wheel-Based vehicle speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3527 558 19	Accelerator pedal or lever idle validation switch - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the accelerator pedal or lever idle validation switch.	The engine will only idle.
3528 558 9	Accelerator pedal or lever idle validation switch - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the accelerator pedal or lever idle validation switch.	Engine will only idle.
3531 171 9	Ambient air temperature - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the ambient air temperature sensor.	Possible reduced engine performance.
3532 171 19	Ambient air temperature - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the ambient air temperature sensor.	Possible reduced engine performance.
3539 51 3	Engine intake throttle actuator position sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3541 51 4	Engine intake throttle actuator position sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3542 51 2	Engine intake throttle actuator position sensor - Data erratic, intermittent or incorrect. The engine intake air throttle position feedback is erratic or incorrect.	Possible reduced engine performance.
3545 3226 10	Aftertreatment outlet NOx sensor circuit - Abnormal rate of change. The aftertreatment outlet NOx sensor reading is not valid.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3547 4096 31	Aftertreatment diesel exhaust fluid tank empty - Condition exists. The diesel exhaust fluid tank is empty.	Possible reduced engine performance.
3555 1081 9	Engine wait to start lamp - Abnormal update rate. A loss of communication has been detected.	None on performance.
3556 1081 19	Engine wait to start lamp - Received network data in error. The ECM received an invalid signal on the SAE J1939 datalink.	None on performance.
3558 3361 3	Aftertreatment diesel exhaust fluid dosing unit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3559 3361 4	Aftertreatment diesel exhaust fluid dosing unit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3562 5491 3	Aftertreatment diesel exhaust fluid line heater relay - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3563 5491 4	Aftertreatment diesel exhaust fluid line heater relay - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3567 5394 5	Aftertreatment diesel exhaust fluid dosing valve - Current below normal or open circuit. A circuit error has been detected in the aftertreatment diesel exhaust fluid dosing valve circuit.	Possible reduced engine performance.
3568 5394 7	Aftertreatment diesel exhaust fluid (DEF) Dosing valve - Mechanical system not responding or out of adjustment. A mechanical malfunction has been detected in the DEF dosing valve.	Possible reduced engine performance.
3571 4334 3	Aftertreatment diesel exhaust fluid pressure sensor - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3572 4334 4	Aftertreatment diesel exhaust fluid pressure sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3574 4334 18	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but below normal operating range - Moderately severe level. Low diesel exhaust fluid pressure has been detected in the dosing unit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3575 4334 16	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid dosing unit has detected a blockage in the diesel exhaust fluid return flow.	Possible reduced engine performance.
3577 4376 3	Aftertreatment diesel exhaust fluid return valve - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid return valve.	Possible reduced engine performance.
3578 4376 4	Aftertreatment diesel exhaust fluid return valve - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid return valve.	Possible reduced engine performance.
3582 4364 18	Aftertreatment SCR catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. NOx conversion across the SCR catalyst is too low.	Possible reduced engine performance.
3583 5031 10	Aftertreatment outlet NOx sensor heater - Abnormal rate of change. The aftertreatment outlet NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3596 4334 2	Aftertreatment diesel exhaust fluid pressure sensor - Data erratic, intermittent, or incorrect. The diesel exhaust fluid pressure sensor has reported a reading too high or low for the operating conditions.	Possible reduced engine performance.
3649 5024 10	Aftertreatment Intake NOx sensor heater - Abnormal rate of change. The aftertreatment intake NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3681 3228 2	Aftertreatment outlet NOx sensor power supply - Data erratic, intermittent, or incorrect. The aftertreatment outlet NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3682 3218 2	Aftertreatment Intake NOx sensor power supply - Data erratic, intermittent or incorrect. The aftertreatment intake NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3697 630 12	Engine control module calibration memory - Bad intelligent device or component. Error internal to the ECM related to engine software failures.	Engine may not start or may be difficult to start.
3712 5246 0	Aftertreatment SCR operator inducement - Data valid but above normal operational range - Most severe level. Critical SCR related fault codes have been active for an extended period of time and require immediate attention.	Vehicle speed will be limited to 8 km [5 miles] per hour.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3714 1569 31	Engine protection torque derate - Condition exists. Critical fault codes related to engine operation are active.	Possible reduced engine performance.
3715 188 16	Engine speed at idle - Data valid but below normal operating range - Moderately severe level. The engine speed at idle has exceeded the governed idle speed.	Possible reduced engine performance.
3716 188 18	Engine speed at idle - Data valid but below normal operational range - Moderately severe level. Engine is not maintaining the governed idle speed.	None on performance.
3717 3226 13	Aftertreatment outlet NOx sensor - Out of calibration. A calibration mismatch between the aftertreatment outlet NOx sensor and the ECM has been detected.	None on performance.
3718 3216 13	Aftertreatment intake NOx - Out of calibration. A calibration mismatch between the aftertreatment intake NOx sensor and the ECM has been detected.	None on performance.
3724 168 17	Battery 1 voltage - Data valid but below normal operating range - Least severe level. Low voltage to the EGR valve device driver has been detected.	Possible reduced engine performance.
3725 3216 10	Aftertreatment Intake NOx sensor - Abnormal rate of change. The aftertreatment intake NOx sensor reading is not valid.	None on performance.
3727 5571 7	High pressure common rail fuel pressure relief valve - Mechanical system not responding or out of adjustment. The fuel rail high-pressure relief valve has opened at a lower than expected pressure.	Possible reduced engine performance.
3737 1675 31	Engine starter mode overcrank protection - Condition exists. The starter motor has been temporarily disabled in order to prevent starter damage.	Starter operation is prohibited until the starter motor has adequately cooled.
3741 5571 0	High pressure common rail fuel pressure relief valve - Data valid but above normal operational range - Most severe level. The fuel rail pressure relief valve has opened due to high fuel rail pressure.	Engine may run rough, may stop running, may not start, or may be difficult to start.
3749 3226 20	Aftertreatment outlet NOx sensor - Data not rational - Drifted high. An offset in the outlet NOx sensor reading has been detected.	None on performance.
3838 2978 9	Estimated engine parasitic losses - Percent torque - Abnormal update rate. A loss of communication has been detected.	None on performance.
3843 5603 9	Cruise control disable command - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the cruise control.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3844 5605 31	Cruise control pause command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3845 5603 31	Cruise control disable command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3899 5848 4	Aftertreatment 1 SCR Intermediate NH3 sensor - Voltage below normal, or shorted to low source. A circuit error has been detected in the NH3 sensor.	None on performance.
3911 5848 9	Aftertreatment SCR Intermediate NH3 sensor - Abnormal update rate. Loss of communication with the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3912 5853 10	Aftertreatment SCR Intermediate NH3 sensor heater - Abnormal rate of change. A malfunction of the aftertreatment SCR intermediate NH3 sensor heater has been detected.	Possible reduced engine performance.
3932 5851 16	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but above normal operating range - Moderately severe level. High battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3933 5851 18	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but below normal operating range - Moderately severe level. Low battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3934 5851 2	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data erratic, intermittent or incorrect. Intermittent battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3935 5848 13	Aftertreatment SCR Intermediate NH3 sensor - Out of calibration. Incorrect trim resistance has been detected in the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3936 5848 12	Aftertreatment SCR Intermediate NH3 sensor - Bad intelligent device or component. An internal error of the aftertreatment SCR intermediate NH3 sensor has been detected.	Possible reduced engine performance.
3937 5848 10	Aftertreatment 1 SCR Intermediate NH3 sensor - Abnormal rate of change. The aftertreatment SCR intermediate NH3 sensor reading is NOT valid.	Possible reduced engine performance.

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Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4149 2623 8	Accelerator pedal or lever position sensor 2 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in Limp Home mode.
4151 5742 9	Aftertreatment diesel particulate filter temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4152 5743 9	Aftertreatment selective catalytic reduction temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4155 5746 3	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4156 5746 4	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4157 4376 7	Aftertreatment diesel exhaust fluid return valve - Mechanical system not responding or out of adjustment. A stuck aftertreatment diesel exhaust fluid return valve has been detected.	None on performance.
4158 5742 12	Aftertreatment diesel particulate filter temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4159 5743 12	Aftertreatment selective catalytic reduction temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4161 5742 3	Aftertreatment diesel particulate filter temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4162 5742 4	Aftertreatment diesel particulate filter temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4163 5742 16	Aftertreatment diesel particulate filter temperature sensor module- Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4164 5743 3	Aftertreatment selective catalytic reduction temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4165 5743 4	Aftertreatment selective catalytic reduction temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4166 5743 16	Aftertreatment selective catalytic reduction temperature sensor module - Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4168 5745 3	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage above normal, or shorted to high source. The aftertreatment diesel exhaust fluid dosing unit heater is detected to be stuck on.	None on performance.
4169 5745 5	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage below normal, or shorted to low source. The aftertreatment diesel exhaust fluid dosing unit heater is detected to be stuck off.	Possible reduced engine performance.
4171 5745 18	Aftertreatment diesel exhaust fluid dosing unit heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid dosing unit failed to thaw.	Possible reduced engine performance.
4213 3695 2	Aftertreatment diesel particulate filter regeneration inhibit switch - Data erratic, intermittent or incorrect. The diesel particulate filter regeneration permit switch is stuck in the OFF or INHIBIT position.	Possible frequent need for aftertreatment regeneration.
4215 563 31	Anti-lock braking (ABS) Active - Condition exists. Cruise control was paused due to an anti-wheel slip message from the ABS controller.	Adaptive cruise control will not operate. Standard cruise control may not operate.
4244 4337 2	Aftertreatment diesel exhaust fluid dosing temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing temperature is irrational.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4245 5798 2	Aftertreatment diesel exhaust fluid dosing unit heater temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing unit heater temperature is irrational.	None on performance.
4249 4337 10	Aftertreatment diesel exhaust fluid dosing temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit temperature is stuck.	None on performance.
4251 5798 10	Aftertreatment 1 diesel exhaust fluid dosing unit heater temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit heater temperature sensor reading is stuck.	None on performance.
4252 1081 31	Engine wait to start lamp - Condition exists. The received signal does not match the commanded signal.	None on performance.
4259 5742 11	Aftertreatment diesel particulate filter temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4261 5743 11	Aftertreatment selective catalytic reduction temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4279 5848 21	Aftertreatment 1 SCR Intermediate NH3 - Data not rational - Drifted low. An in range low failure has been detected.	Possible reduced engine performance.
4281 5848 2	Aftertreatment SCR Intermediate NH3 - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate NH3 sensor reading is stuck.	None on performance.
4284 5793 9	Desired engine fueling state - Abnormal update rate. A valid message from the transmission ECU has NOT been received.	Engine may not start or may be difficult to start.
4289 91 8	Accelerator pedal or lever position sensor 1 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in limp home mode.
4452 520668 31	Aftertreatment outlet NOx sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	Possible reduced engine performance.
4453 520669 31	Aftertreatment intermediate NH3 sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	None on performance.
4517 237 13	Vehicle Identification number - Out of calibration. The vehicle identification number has not been programmed into the ECM.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4518 5862 3	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4519 5862 4	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4521 5862 2	Aftertreatment SCR Intermediate gas temperature sensor - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate temperature sensor reading is irrational.	Possible reduced engine performance.
4524 5862 0	Aftertreatment SCR intermediate gas temperature - Data valid but above normal operational range - Most severe level. The aftertreatment SCR intermediate temperature sensor reading is above the engine protection limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4525 5862 16	Aftertreatment 1 SCR intermediate gas temperature - Data valid but above normal operating range - Moderately severe level. High SCR Intermediate temperature detected.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4526 521 2	Brake pedal position - Data erratic, intermittent or incorrect. The values of the 2 brake switch signals do not match.	None on performance.
4572 3031 9	Aftertreatment diesel exhaust fluid tank temperature - Abnormal update rate. The ECM lost communication with the aftertreatment diesel exhaust fluid tank temperature sensor.	Possible reduced engine performance.
4584 3936 14	Aftertreatment diesel particulate filter system - Special instructions. The incorrect aftertreatment diesel particulate filter system has been installed with the engine.	Engine will be shut down.
4585 4792 14	Aftertreatment 1 SCR catalyst system - Special instructions. The incorrect SCR system has been Installed.	Engine will be shut down.
4612 520701 31	Engine intake manifold pressure system monitor - Condition exists. The engine is unable to meet the air handling system commands.	Possible reduced engine performance.
4658 4331 18	Aftertreatment SCR actual dosing reagent quantity - Data valid but below normal operating range - Moderately severe level. Low aftertreatment diesel exhaust fluid flow detected.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4691 5585 18	Engine injector metering rail 1 cranking pressure - Data valid but below normal operating range - Moderately severe level. The fuel rail pressure during cranking is too low for the engine to start.	Engine may not start or may be difficult to start.
4713 5357 31	Engine fuel injection quantity error for multiple cylinders - Condition exists. A malfunction of all fuel injectors has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4726 1239 16	Engine fuel leakage - Data valid but above normal operating range - Moderately severe level. Fuel rail pressure decay has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4727 157 15	Injector metering rail 1 pressure - Data valid but above normal operating range - Least severe level. A self pumping condition has been detected in the fuel system.	Possible reduced engine performance.
4731 3031 13	Aftertreatment diesel exhaust fluid tank temperature sensor - Out of calibration. The received datalink message was not valid.	Possible reduced engine performance.
4732 1761 13	Aftertreatment diesel exhaust fluid tank level sensor - Out of calibration. The received datalink message was not valid.	None on performance.
4739 1761 11	Aftertreatment 1 diesel exhaust fluid tank level sensor - Root cause not known. An unknown error has been detected with the aftertreatment diesel exhaust fluid tank level sensor.	Possible reduced engine performance.
4769 1761 10	Aftertreatment 1 diesel exhaust fluid tank level sensor - Abnormal rate of change. A valid diesel exhaust fluid tank level reading has NOT been received.	Possible reduced engine performance.
4865 6303 3	Engine coolant level 2 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4866 6303 4	Engine coolant level 2 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4956 520750 13	Engine variable geometry turbo (VGT) software - Out of calibration. VGT software does not match application.	Possible reduced engine performance.
4957 520750 31	Engine variable geometry turbo (VGT) software - Condition exists. The VGT actuator and ECM software is not compatible.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

3) DEFINITION OF OPERATING MODES

(1) Normal

There's no failure detected in the transmission system or the failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations.

(2) Substitute clutch control

TCU can't change the gears or the direction under the control of the normal clutch modulation. TCU uses the substitute strategy for clutch control. All modulations are only time controlled.

(3) Limp home

This mode is intended to allow the driver to leave area of work or area of danger. If an error is detected whichs error reaction is limp home, the transmission shifts to neutral. The driver can reengage the gear if he selects neutral with the shift lever. The first possible gear in the desired direction will be engaged on a driving request. The transmission is not able to shift into other gears in Limp Home mode. To perform reversals the driver has to shift to neutral and then to the opposite direction.

(4) Transmission shutdown (Trm shutdown)

This mode is intended to put the transmission into safe state if an error occurs whichs error reaction is transmission shutdown. The transmission shifts to neutral and no driving is possible as long as the failure is active. The driver has to shift to neutral to get into normal operation after the failure went inactive.

(5) TCU shutdown

This mode is intended put the transmission into safe state if an erro occurs whichs erro reaction is tcu shutdown. In this operation mode no driving is possible. The driver has to shift to neutral and run a power off-on cycle to get into normal operation mode after the failure went inactive.

※ Abbreviations

OC	: Open circuit
SC	: Short circuit
OP mode	: Operating mode
TCU	: Transmission control unit
EEC	: Electronic engine controller
PTO	: Power take off

4) TRANSMISSION FAULT CODES

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
523000	1	Battery low undervoltage	Trm Shutdown	<p>The control unit detects a voltage of < 7.00 volt (12 V device) or < 9.00 volt (24 volt device) on the supply input of terminal 30.</p> <ol style="list-style-type: none"> 1. The alternator control unit has an internal defect. 2. Vehicle battery not sufficiently charged. 3. Wiring or plug connection defective (supply or ground cable). 4. Control unit parameters incorrectly set. 	<p>The cause of the missing or insufficient voltage on terminal 30 must be located.</p> <ol style="list-style-type: none"> 1. Check the fuse of the terminal 30 control units. 2. If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3. Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4. Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523000	3	Battery overvoltage	Trm Shutdown	<p>The control unit detects a voltage of > 18.00 volt (12 volt device) or > 32.50 volt (24 volt device) on the supply input terminal 30.</p> <ol style="list-style-type: none"> 1. The alternator control unit has an internal defect. 2. Wiring or plug connection defective (supply or ground cable). 3. Control unit parameters incorrectly set. 	<p>The cause of the excessive voltage on terminal 30 must be located.</p> <ol style="list-style-type: none"> 1. Make sure that the control unit has a stable voltage supply. Check the voltage on the terminal tester with a voltmeter. <ul style="list-style-type: none"> · Target voltage ignition ON: Vehicle power supply. · Target voltage ignition OFF: Vehicle power supply. 2. With the ignition off, use a voltmeter to check the voltage on the connection of terminal 30 (steady plus) to terminal 31 (ground). The measured voltage must correspond to the vehicle power supply. 3. With the engine running, check the voltage in the same manner as described in the point above. The measured voltage must correspond to the vehicle power supply. 4. Check the wiring between the alternator and the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
					control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523000	4	Battery undervoltage	Trm Shutdown	<p>The control unit detects a voltage of < 9.00 volt (12 V device) or < 16.00 volt (24 volt device) on the supply input terminal 30.</p> <ol style="list-style-type: none"> 1. The alternator control unit has an internal defect. 2. Vehicle battery not sufficiently charged. 3. Wiring or plug connection defective (supply or ground cable). 4. Control unit parameters incorrectly set. 	<p>The cause of the missing or insufficient voltage on terminal 30 must be located.</p> <ol style="list-style-type: none"> 1. Check the fuse of the terminal 30 control units. 2. If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3. Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4. Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523020	3	EC3: Supply for speed sensors (AU3) overvoltage	Trm Shutdown	<p>The measured voltage is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523020	4	EC3: Supply for speed	Trm Shutdown	The measured voltage is too low.	The cause of the incorrect voltage must be located.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
		sensors (AU3) undervoltage		1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523020	6	EC3: Supply for speed sensors (AU3) short to ground	Trm Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. Note: If this error occurs, calculations are partially being made with replacement values. The transmission functions are limited and the shifting quality is reduced.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523021	3	EC3: Supply for temperature sensors and oil filter restriction switch (AU2) overvoltage EC4: Supply for speed sensors (AU2) overvoltage	Trm Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523021	4	EC3: Supply for temperature sensors	Trm Shutdown	The measured voltage is too low. 1. Wiring or plug connection is defective.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
		and oil filter restriction switch (AU2) undervoltage EC4: Supply for speed sensors (AU2) undervoltage		2. Sensor has an internal defect. 3. Control unit has an internal defect.	defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523021	6	EC3: Supply for temperature sensors and oil filter restriction switch (AU2) short to ground EC4: Supply for speed sensors (AU2) short to ground	Trm Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. Note: If this error occurs, calculations are partially being made with replacement values. The transmission functions are limited and the shifting quality is reduced.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523022	3	EC4: Supply for oil filter restriction switch (AU1) overvoltage	Limp Home	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523022	4	EC4: Supply for oil filter restriction switch (AU1) undervoltage	Limp Home	The measured voltage is too low. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				3. Control unit has an internal defect.	damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523022	6	EC4: Supply for oil filter restriction switch (AU1) short to ground	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523030	3	Propvalve power supply 1 (VPS1) overvoltage	TCU Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the connected component or replace the component. 4. Replace the control unit if the error continues to occur.
523031	3	Propvalve power supply 2 (VPS2) overvoltage	TCU Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
					3. Check the function of the connected component or replace the component. 4. Replace the control unit if the error continues to occur.
523040	0	TCU overtemperature	TCU Shutdown	The measured temperature on the control unit of the transmission is too high. 1. Overheating due to outside influences. 2. Temperature sensor has an internal defect.	The cause of the increased temperature input in the control unit must be located. 1. Check if outside influences have caused the excessive temperature. 2. If the error continues to occur then the control unit needs to be replaced.
523040	2	TCU temperature invalid value	TCU Shutdown	The measured temperature on the control unit of the transmission is invalid. 1. Control unit has an internal defect.	1. Replace the control unit.
523044	12	Internal TCU Error 5	TCU Shutdown	There are 3 startup self-tests concerning power lines 1. Watch dog cut-off test – WD chip allow VPS to be enabled only if it is activated (armed) and disable all VPSs before it resets MCU. The self-test check it. 2. VPS cut off test – SW is able to control VPS via power supply manager component – self test check it 3.. OCG off test – it check if when VPS is on and OCG/AIM channels are disable (requested current = 0), there really is no current on the lines.	The cause of the incorrect behaviour must be located. 1.Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2.Check the correct wiring of the pins. 3.Check the function of the connected component or replace the component. 4.Replace the control unit if the error continues to occur.
523045	12	Internal TCU Error 1	TCU Shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523046	12	Internal TCU Error 2	TCU Shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523049	12	Unknown transmission	TCU Shutdown	Wrong TCU mounted. The TCU doesn't fit to the	Contact your ZF representative.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
		controller hardware detected		application.	
523100	3	Speed sensor input 1 (EF1) overvoltage: Turbine speed	Limp Home	<p>The measured voltage at the input is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523100	6	Speed sensor input 1 (EF1) open or short to ground: Turbine speed	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523100	8	Speed sensor input 1 (EF1) direction of rotation unknown: Turbine speed	Limp Home	<p>The control unit does not recognize the rotational direction at the input.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect. 	<p>The cause of the unknown rotational direction must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
523100	9	Speed sensor input 1 (EF1) speed unknown: Turbine speed	Limp Home	<p>The control unit does not recognize the speed at the input.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect. 	<p>The cause of the unknown speed must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	3	Speed sensor input 2 (EF2) overvoltage: Internal speed	Limp Home	<p>The measured voltage at the input is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523105	6	Speed sensor input 2 (EF2) open or short to ground: Internal speed	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523105	8	Speed sensor input 2 (EF2) direction of	Limp Home	<p>The control unit does not recognize the rotational direction at the input.</p>	<p>The cause of the unknown rotational direction must be located.</p>

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
		rotation unknown: Internal speed		1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	9	Speed sensor input 2 (EF2) speed unknown: Internal speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523110	3	Speed sensor input 3 (EF3) overvoltage: Output speed	Limp Home	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523110	6	Speed sensor input 3 (EF3) open or short to ground: Output speed	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					replace it if needed. 4. Replace the control unit if the error continues to occur.
523110	8	Speed sensor input 3 (EF3) direction of rotation unknown: Output speed	Limp Home	The control unit does not recognize the rotational direction at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	The cause of the unknown rotational direction must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523110	9	Speed sensor input 3 (EF3) speed unknown: Output speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	3	Speed sensor input 4 (EF4) overvoltage: Engine speed	Limp Home	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523115	6	Speed sensor input 4 (EF4) open or short to ground: Engine speed	Limp Home	The measured line resistance between the connected component and the control unit is too high.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523115	8	Speed sensor input 4 (EF4) direction of rotation unknown: Engine speed	Limp Home	The control unit does not recognize the rotational direction at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	The cause of the unknown rotational direction must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	9	Speed sensor input 4 (EF4) speed unknown: Engine speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523140	3	Resistance sensor input 1 (ER1) open circuit or short to high source: Sump temperature	Normal	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					4. Replace the control unit if the error continues to occur.
523140	6	Resistance sensor input 1 (ER1) short to ground: Sump temperature	Normal	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523155	3	Current sensor input 2 (EI2) overvoltage: Oil Filter Restriction Switch	Normal	<p>The measured voltage at the input is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the connected component or replace the component. 4. Replace the control unit if the error continues to occur.
523155	6	Current sensor input 2 (EI2) open circuit or short to ground: Oil Filter Restriction Switch	Normal	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
					4. Replace the control unit if the error continues to occur.
523160	3	Voltage sensor input 3 (EU3) overvoltage	TCU Shutdown	The measured voltage at the sensor input 3 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage.	check the cable from TCU to the sensor check the connectors 3 check the sensor
523160	6	Voltage sensor input 3 (EU3) open or short to ground	TCU Shutdown	The measured voltage at the sensor input 3 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523160	12	Voltage sensor input 3 (EU3) defect	TCU Shutdown	The measured sensor voltage is out of the allowed thresholds.	check the cable from TCU to the sensor check the connectors check the sensor 4 Change the sensor
523165	3	Voltage sensor input 4 (EU4) overvoltage	Normal	The measured voltage at the sensor input 3 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523165	6	Voltage sensor input 4 (EU4) open or short to ground	Normal	The measured voltage at the sensor input 3 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523165	12	Voltage sensor input 4	Normal	The measured sensor voltage is out of the	check the cable from TCU to the sensor check the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
		(EU4) defect		allowed thresholds.	connectors check the sensor 4 Change the sensor
523200	2	Current output driver 1 (AIM01) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	<ol style="list-style-type: none"> 1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523200	3	Current output driver 1 (AIM01) short to battery	Limp Home	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts battery voltage. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523200	5	Current output driver 1 (AIM01) open circuit	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					<p>or damaged plug contacts.</p> <p>4. Check the function of the connected component and replace it if needed.</p> <p>5. Replace the control unit if the error continues to occur.</p>
523200	6	Current output driver 1 (AIM01) short to ground	TCU Shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1. Wiring or plug connection contacts vehicle ground.</p> <p>2. Component has an internal defect.</p> <p>3. Control unit has an internal defect.</p>	<p>1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4. Check the function of the connected component and replace it if needed.</p> <p>5. Replace the control unit if the error continues to occur.</p>
523200	8	Current output driver 1 (AIM01) short to another valve	Trm Shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1. Wiring or plug connection contacts another proportional valve.</p> <p>2. Proportional valve has an internal defect.</p> <p>3. Control unit has an internal defect.</p>	<p>1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5. Check the function of the proportional valve and</p>

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					replace it if needed. 6. Replace the control unit if the error continues to occur.
523205	2	Current output driver 2 (AIM02) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523205	3	Current output driver 2 (AIM02) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523205	5	Current output driver 2 (AIM02) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					<p>component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4. Check the function of the connected component and replace it if needed.</p> <p>5. Replace the control unit if the error continues to occur.</p>
523205	6	Current output driver 2 (AIM02) short to ground	TCU Shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1. Wiring or plug connection contacts vehicle ground.</p> <p>2. Component has an internal defect.</p> <p>3. Control unit has an internal defect.</p>	<p>1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4. Check the function of the connected component and replace it if needed.</p> <p>5. Replace the control unit if the error continues to occur.</p>
523205	8	Current output driver 2 (AIM02) short circuit to another valve	Trm Shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1. Wiring or plug connection contacts another proportional valve.</p> <p>2. Proportional valve has an internal defect.</p> <p>3. Control unit has an internal defect.</p>	<p>1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using</p>

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523210	2	Current output driver 3 (AIM03) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523210	3	Current output driver 3 (AIM03) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523210	5	Current output driver 3 (AIM03) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				2. Component has an internal defect. 3. Control unit has an internal defect.	using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523210	6	Current output driver 3 (AIM03) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523210	8	Current output driver 3 (AIM03) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					<p>4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5. Check the function of the proportional valve and replace it if needed.</p> <p>6. Replace the control unit if the error continues to occur.</p>
523215	2	Current output driver 4 (AIM04) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	<p>1. Using the circuit diagram, check if a component is assigned to the output.</p> <p>2. Check the wiring, in particular that it is wired correctly.</p> <p>3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts</p> <p>4. Replace the control unit if the error continues to occur.</p>
523215	3	Current output driver 4 (AIM04) short to battery	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <p>1. Wiring or plug connection contacts battery voltage.</p> <p>2. Component has an internal defect.</p> <p>3. Control unit has an internal defect.</p>	<p>1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4. Check the function of the connected component and replace it if needed.</p> <p>5. Replace the control unit if the error continues to occur.</p>
523215	5	Current output driver 4 (AIM04) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				<p>high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523215	6	Current output driver 4 (AIM04) short to ground	TCU Shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523215	8	Current output driver 4 (AIM04) short circuit to another valve	Trm Shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				3. Control unit has an internal defect.	defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523220	2	Current output driver 5 (AIM05) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523220	3	Current output driver 5 (AIM05) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
523220	5	Current output driver 5 (AIM05) open circuit	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523220	6	Current output driver 5 (AIM05) short to ground	TCU Shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523220	8	Current output driver 5 (AIM05) short circuit to another valve	Trm Shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts another 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523225	2	Current output driver 6 (AIM06) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523225	3	Current output driver 6 (AIM06) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					5. Replace the control unit if the error continues to occur.
523225	5	Current output driver 6 (AIM06) open circuit	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523225	6	Current output driver 6 (AIM06) short to ground	TCU Shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523225	8	Current output driver 6 (AIM06) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				<p>too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect. 	<p>proportional valve or with which valve the error is bypassed.</p> <ol style="list-style-type: none"> 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523230	2	Current output driver 7 (AIM07) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	<ol style="list-style-type: none"> 1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts
523230	3	Current output driver 7 (AIM07) short to battery	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					5. Replace the control unit if the error continues to occur.
523230	5	Current output driver 7 (AIM07) open circuit	Limp Home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523230	6	Current output driver 7 (AIM07) short to ground	TCU Shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. 	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523230	8	Current output driver 7 (AIM07) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is	<ol style="list-style-type: none"> 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
				<p>too low.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect. 	<p>proportional valve or with which valve the error is bypassed.</p> <ol style="list-style-type: none"> 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523280	3	Digital current output driver 1 (ADM1) short to battery	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage cable is defective and is contacted to battery voltage device has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	5	Digital current output driver 1 (ADM1) open circuit	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin cable is defective and has no connection to TCU device has an internal defect connector has no connection to TCU	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	6	Digital current output driver 1 (ADM1) short to ground	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground cable is defective and is contacted to vehicle ground device has an internal defect connector pin is contacted to vehicle ground	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	12	Digital current output driver 1 (ADM1) defect	Trm Shutdown	TCU detected overtemperature or an internal error at the digital output	Change TCU
523281	3	Digital current output	Trm Shutdown	TCU detected a wrong voltage at the output pin,	check the cable from TCU to the device at ADM2 check

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
		driver 2 (ADM2) short to battery		that looks like a s.c. to battery voltage cable is defective and is contacted to battery voltage device has an internal defect connector pin is contacted to battery voltage	the connectors check the resistance of the device at ADM2
523281	5	Digital current output driver 2 (ADM2) open circuit	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin cable is defective and has no connection to TCU device has an internal defect connector has no connection to TCU	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	6	Digital current output driver 2 (ADM2) short to ground	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground cable is defective and is contacted to vehicle ground device has an internal defect connector pin is contacted to vehicle ground	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	12	Digital current output driver 2 (ADM2) defect	Trm Shutdown	TCU detected overtemperature or an internal error at the digital output	Change TCU
523145	3	Resistance sensor input 2 (ER2) open circuit or short to high source: Torque converter temperature	Normal	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523145	6	Resistance sensor input 2 (ER2) short to ground: Torque converter temperature	Normal	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect 3. Control unit has an internal defect.	component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523125	3	Voltage sensor input 1 (EU1) overvoltage	Limp Home	The measured voltage at the sensor input 1 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the sensor check the connectors check the sensor
523125	6	Voltage sensor input 1 (EU1) open or short to ground	Limp Home	The measured voltage at the sensor input 1 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken	check the cable from TCU to the sensor check the connectors check the sensor
523125	12	Voltage sensor input 1 (EU1) defect	Limp Home	The measured voltage from sensor output signal 1 and output signal 2 don't match or are out of range. 1. Cable is defective 2. Sensor has an internal defect	check the cable from TCU to the sensor check the connectors check the sensor
523023	3	Supply for temperature sensors (AU_ER) overvoltage	Limp Home	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				3, Control unit has an internal defect.	damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523023	4	Supply for temperature sensors (AU_ER) undervoltage	Limp Home	The measured voltage is too low. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523130	3	Voltage sensor input 2 (EU2) overvoltage	Limp Home	The measured voltage at the sensor input 2 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the sensor check the connectors check the sensor
523130	6	Voltage sensor input 2 (EU2) open or short to ground	Limp Home	The measured voltage at the sensor input 2 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken	1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the sensor

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
523130	12	Voltage sensor input 2 (EU2) defect	Limp Home	The measured voltage from sensor output signal 1 and output signal 2 don't match or are out of range. 1. Cable is defective 2. Sensor has an internal defect	1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the sensor
523050	0	Internal TCU Error 6	TCU Shutdown		
523047	12	Internal TCU Error 3	TCU Shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523300	0	Transmission sump oil most severe overtemperature	Normal	The measured temperature in the oil sump of the transmission is too high. 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high.	The cause of the increased temperature input in the transmission must be located. 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523300	16	Transmission sump oil moderately severe overtemperature	Normal	The measured temperature in the oil sump of the transmission is too high. 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high.	The cause of the increased temperature input in the transmission must be located. 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523305	0	Oil Filter contaminated	Normal	1. Filter clogged. 2. Sensor has an internal defect.	If this error occurs while driving, then remain at a standstill, switch the ignition off, then on again and wait another 40 seconds. 1. Replace the filter. 2. Check the wiring of the switch, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523310	0	Transmission input torque too high	Normal	The control unit receives a transmission input torque via the CAN bus that exceeds the permissible maximum. 1. Engine torque too high. 2. CAN bus signal is faulty.	1. Reduce the applied engine torque. 2. If this error continues to occur, please contact your vehicle manufacturer.
523311	0	Transmission input power too high	Normal	TCU calculates an transmission input power above the defined thresholds	engine controller may ignore Torque or speedlimit command from TCU via TSC1 message
523320	15	Transmission output speed too high	Normal	The speed at the transmission output exceeds the permissible maximum.	The speed at the transmission output exceeds the permissible maximum.
523330	15	Transmission input speed too high	Trm Shutdown	The speed at the transmission input exceeds the permissible maximum.	Reduce the engine speed. In order to prevent long-term damage, stay within the permissible speed range.
523340	0	Transmission output torque too high	Trm Shutdown	The control unit calculates a torque at the transmission output that exceeds the permissible maximum. 1. Engine torque too high.	Reduce the applied engine torque.
523360	9	Clutch adjustment data invalid	Normal	The clutch calibration was not performed.	Perform the clutch calibration.
523361	13	Clutch calibration process failed	TCU Shutdown	The clutch calibration did fail	Check oil level and run calibration again.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
523400	9	Vehicle CAN failure	Trm Shutdown	<p>An electrical error exists on the vehicle CAN bus.</p> <ol style="list-style-type: none"> 1. Malfunction on the CAN bus. 2. ZF control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error.</p> <p>Check the following points only when the error is active.</p> <ol style="list-style-type: none"> 1. Check the CAN connection for interruptions, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Replace the ZF control unit. 3. Check the terminating resistor of the CAN connection (CAN 1). Using an ohmmeter, also determine the resistance on the control unit and on the adapter when the ignition is off. The resistance value must be 120 Ohm \pm 10 Ohm for each. 4. If this error continues to occur, please contact the vehicle manufacturer.
523402	9	ECU connection loss	Limp Home	<p>The control unit no longer transfers any information.</p> <ol style="list-style-type: none"> 1. Engine control unit has an internal defect. 	<p>The cause of the missing connection must be located.</p> <ol style="list-style-type: none"> 1. If error vehicle can failure occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523403	9	VCU connection loss	Trm Shutdown	No communication to the Vehicle Controller	Check CAN Connection, check source Adress of the VCU
523405	9	I/O-Extension connection loss	Trm Shutdown	<p>The extension no longer transfers any information.</p> <ol style="list-style-type: none"> 1. I/O extension has an internal defect. 	<p>The cause of the missing connection must be located.</p> <ol style="list-style-type: none"> 1. If error vehicle can failure occurs, then repair this first. 2. If this error continues to be active, please contact your appropriate ZF service partner.
523411	9	Message ZFTC1 invalid or timeout	Trm Shutdown	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1. Sporadic electrical error. 2. CAN bus overloaded. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1. If error VCU Connection loss occurs, then repair this

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
				3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523413	9	Message EEC1 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523414	9	Message EEC2 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523415	9	Message EEC3 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523416	9	Message EC1 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
523417	9	Message B invalid or timeout	Normal	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1. If error VCU connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523418	9	Message EBC1 invalid or timeout	Normal	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect. 	<ol style="list-style-type: none"> 1. If error VCU connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523419	9	Signal actual engine torque or signal engine speed (EEC1) are defective	Limp Home	<p>One or more signals of the messages from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1. Incorrect software on the transmission control unit. 2. Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occurs, please contact your vehicle manufacturer.
523420	9	Message CCVS invalid or timeout	Normal	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523426	9	Message JBERC1 invalid or timeout	Limp Home	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
					HCE.
523427	9	Message JBRC invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact HCE.
523470	19	Operation Mode command invalid	Trm Shutdown	The operating mode assigned by the vehicle control unit is invalid for the transmission. 1. Incorrect software on the transmission control unit. 2. Incorrect software on the vehicle computer.	1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occurs, please contact HCE.
523471	19	Transmission command invalid	Trm Shutdown	The transmission mode assigned by the vehicle control unit is invalid for the transmission. 1. Incorrect software on the transmission control unit. 2. Incorrect software on the vehicle computer.	1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occurs, please contact HCE.
523480	9	Machine configuration invalid	TCU Shutdown	The startup handshake has not been successful.	Check version of vehicle controller (it has to support handshaking).
523481	0	Testmode requested but conditions not complied	Trm Shutdown	The conditions for Testmode are not fulfilled	Take back the test mode request, set the conditions to the allowed thresholds and request the Test Mode again
523500	0	Overspeed engine	Normal	The control unit receives an engine speed via the CAN bus that exceeds the permissible maximum. 1. Engine speed too high. 2. CAN bus signal is faulty.	1. Reduce the engine speed. 2. If this error continues to occur, please contact your vehicle manufacturer. Note: In order to prevent permanent damage, stay within the permissible speed range.
523501	0	Engine speed limit request does not take effect	Normal	The transmission control unit requires a limited engine speed; the engine does not maintain the limit;	If this error continues to be active, please contact HCE.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
523502	0	Engine speed control request does not take effect	Normal	The transmission control unit requires a certain engine speed; the engine controller does not set this speed;	If this error continues to be active, please contact HCE.
523503	0	Engine torque limit request does not take effect	Normal	The transmission control unit requires a limited engine torque; the engine does not maintain the limit;	If this error continues to be active, please contact HCE.
523504	0	Engine torque control request does not take effect	Normal	The transmission control unit requires a certain engine torque;the engine controller does not set this torque;	If this error continues to be active, please contact HCE.
523600	0	Protection related error detected	Trm Shutdown	The control unit detects a safety-relevant error.	Read out the operating data with Testman and send them to your ZF contact.
523600	1	Protection Function 1 (SF01) Unwanted driveaway	TCU Shutdown	Unexpected vehicle movement detected	Read out the operating data with Testman and send them to your ZF contact.
523600	2	Protection Function 2 (SF02) Unwanted driving direction	Trm Shutdown	Driving in the wrong direction detected	Read out the operating data with Testman and send them to your ZF contact.
523600	3	Protection Function 3 (SF03) Safely limited acceleration (blocked Transmission)	Trm Shutdown	Transmission blocking detected	Read out the operating data with Testman and send them to your ZF contact.
523600	4	Protection Function 4 (SF04) Safely limited acceleration (Downshift)	Trm Shutdown	Unalowed speeds at transmission input detected	Read out the operating data with Testman and send them to your ZF contact.
523600	5	Protection Function 5 (SF05) Safe Output at reverse driving	Trm Shutdown	Wrong Reverse signal broadcasted	Read out the operating data with Testman and send them to your ZF contact.
523600	6	Protection Function 6 (SF06) Safely limited	Trm Shutdown	Unalowed speed or gear in Reverse detected	Read out the operating data with Testman and send them to your ZF contact.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
		speed in Reverse			
523600	7	Protection Function 7 (SF07) Unwanted direction change	Trm Shutdown	Unwanted change of driving direction detected	Read out the operating data with Testman and send them to your ZF contact.
523600	8	Protection Function 8 (SF08)	Trm Shutdown	Safely limited torque	Read out the operating data with Testman and send them to your ZF contact.
523600	9	Protection Function 9 (SF09) Safely limited torque	Trm Shutdown	Unalowed engine control request detected	Read out the operating data with Testman and send them to your ZF contact.
523600	10	Protection Function 10 (SF10) Delayed gear engagement	Trm Shutdown	Unalowed delayed get into gear detected	Read out the operating data with Testman and send them to your ZF contact.
523600	11	Protection Function 11 (SF11) Safe Difflock	Trm Shutdown	Unalowed Difflock acutation at too high speeds detected	Read out the operating data with Testman and send them to your ZF contact.
523600	12	Protection Function 12 (SF12) Safe Transmission Output Signals	TCU Shutdown	Safe Transmission Output	Read out the operating data with Testman and send them to your ZF contact.
523600	16	Protection Function 16 (SF16) Safe Inching Exit	TCU Shutdown	Safe Inchen Exit	Read out the operating data with Testman and send them to your ZF contact.
523600	18	Protection Function 18 (SF18) Safe Speedlimit	Trm Shutdown	Unallowed speed limit overrun	Read out the operating data with Testman and send them to your ZF contact.
523601	0	Protection related error in transmission detected	TCU Shutdown	The control unit detects a clutch shift although no gear change is requested. 1. Energization proportional valve faulty. 2. Proportional valve faulty. 3. Control unit has an internal defect.	1. Check the proportional valves. 2. If this error continues to occur, contact your ZF representative and give us the error code and the conditions under which the error occurs. Read out the operating data with Testman and send them to us.
523602	0	Protection related error in vehicle communication	TCU Shutdown	The control unit detects a faulty check sum, a faulty message counter, or a faulty requirement from the vehicle control unit.	1. Check if the TC1 CAN bus message is present. In addition, create a CAN bus measurement on the vehicle CAN.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
		detected		1. CAN bus message is faulty.	2. If this error continues to occur, please contact HCE.
523603	0	Protection error reaction failed	TCU Shutdown	The control unit requires that the internal supply voltage is switched off but this does not happen. 1. Control unit has an internal defect.	1. Replace the control unit.
523421	9	No response to request of Time and Date message	Normal	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your dealer.
523423	9	Message VehcCFG invalid or timeout	Trm Shutdown	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your dealer.
523424	9	Message CCSS or ZFCCSS invalid or timeout	Trm Shutdown	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your dealer.
523482	9	Application program verification failed	TCU Shutdown	The control unit does not receive the ZFVI or VI message or the message contains faulty data.	Read out the operating data with Testman and send them to your ZF contact.
523100	7	EF1 speed does not match with other speeds	Trm Shutdown	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
				2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523100	11	EF1 direction of rotation does not match with other directions of rotation	Limp Home	The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different rotational directions must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	7	EF2 speed does not match with other speeds	Trm Shutdown	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	11	EF2 direction of rotation does not match with other directions of rotation	Limp Home	The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different rotational directions must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523110	7	EF3 speed does not match with other speeds	Trm Shutdown	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary,

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteps to Repair
					replace it.
523110	11	EF3 direction of rotation does not match with other directions of rotation	Trm Shutdown	<p>The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect. 	<p>The cause of the different rotational directions must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	7	EF4 speed does not match with other speeds	Limp Home	<p>The control unit measures a speed at the input which does not agree with the other speeds.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect. 	<p>The cause of the different speeds must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	11	EF4 direction of rotation does not match with other directions of rotation	Normal	<p>The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions.</p> <ol style="list-style-type: none"> 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect. 	<p>The cause of the different rotational directions must be located.</p> <ol style="list-style-type: none"> 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523302	0	Torque converter oil temperature critical	Normal	<p>The measured oil temperature at the converter is too high.</p> <ol style="list-style-type: none"> 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high. 	<p>The cause of the increased temperature at the converter must be located.</p> <ol style="list-style-type: none"> 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
					diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523302	16	Torque converter oil overtemperature	Normal	<p>The measured oil temperature at the converter is too high.</p> <ol style="list-style-type: none"> 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high. 	<p>The cause of the increased temperature at the converter must be located.</p> <ol style="list-style-type: none"> 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523450	19	Engine reference torque signal invalid	Limp Home	<p>Signal 'Engine Reference Torque from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1. Incorrect software on the transmission control unit. 2. Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occur, please contact HCE.
523451	19	Actual engine torque signal invalid	Limp Home	<p>Signal 'Actual Engine Torque' from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1. Incorrect software on the transmission control unit. 2. Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occur, please contact HCE.
523452	19	Engine nominal friction torque signal invalid	Normal	<p>Signal 'Engine Nominal Friction Torque' from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1. Incorrect software on the transmission control unit. 	<ol style="list-style-type: none"> 1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occur, please contact your

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				2. Incorrect software on the engine controller.	HCE.
523454	19	Launch gear request invalid	Normal	Signal 'Requested Launch Gear' from vehicle controller contains faulty data. 1. Incorrect software on the transmission control unit. 2. Incorrect software on the vehicle controller.	1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occur, please contact HCE.
523455	19	Message ZFSL1 invalid or timed out	Trm Shutdown	Shift Lever message is missing or provides wrong signals	Check CAN Bus, Check Shift Lever
523456	19	Invalid FNR extension switches signal	Trm Shutdown	Invalid output signals from FNR switch	Check Shift Lever, FNR switch
523650	0	Neutral selected while vehicle moves with overspeed	Normal	Shift Lever message is missing or provides wrong signals	Check CAN Bus, Check Shift Lever
523700	0	Clutch K1 slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523705	0	Clutch K2 slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523710	0	Clutch K3 slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523715	0	Clutch KV slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523720	0	Clutch K4 slipping	Limp Home	The TCU calculates a speed difference although	The cause of the occurring speed difference must be

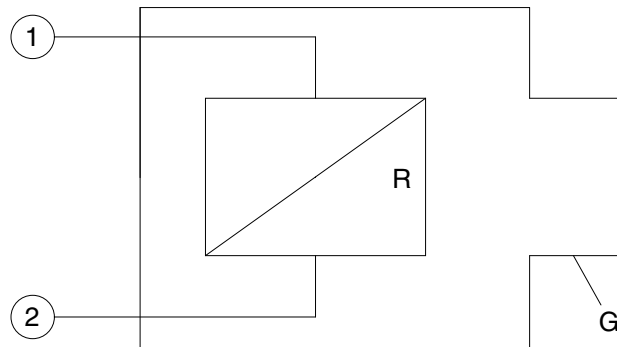
SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
		unintendedly		<p>the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed. 	<p>located.</p> <ol style="list-style-type: none"> 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523725	0	Clutch KR slipping unintendedly	Limp Home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523730	0	LUC slipping unintendedly	Normal	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepsToRepair
				6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523385	0	Upshift by engine overspeed not supported in limphome	Trm Shutdown	Normally an upshift would have been necessary to protect the motor due to the increased motor speed. Since no shift can be performed in mode Limp Home, transmission shifts to neutral instead.	Do not overspeed engine in Limp Home. Use service brakes.
523355	0	Clutch KV temperature critical	Trm Shutdown	Failure related to overheated clutch KV	1. Wait for 20s to cool down clutches 2. Train operator to avoid unnecessary direction changes
523356	0	Clutch KR temperature critical	Trm Shutdown	Failure related to overheated clutch KR	1. Wait for 20s to cool down clutches 2. Train operator to avoid unnecessary direction changes
523171	12	CCO or inch pedal signals mismatch	Normal	The measured voltage of CCO and CCO2 signals don't match or are out of range. Or received signals via CAN do not correlate. 1. Cable is defective 2. Sensor has an internal defect	1. Check the cable from TCU to the sensor 2. Check connectors 3. Check sensor
523171	13	Inchpedal calibration failed	Normal	TCU was not able to read correct inchpedal adjustment parameters 1. Interference during saving data on non volatile memory 2. TCU is brand new, the inchpedal calibration was not performed	Perform the inchpedal calibration process.
523118	11	More than one internal speed sensors are defective	Trm Shutdown	More than one internal speed sensor is not working properly. In this case limp home mode is not possible anymore.	1. Check transmission harness, cables between TCU and speed sensors 2. Check connectors 3. Check sensor

SPN	FMI	FaultDescription	OpMode	Cause	PossibleStepstoRepair
523431	19	Message ZFTC2 invalid or timed out	Trm Shutdown	ZFTC2 message is missing or provides wrong signals.	<ol style="list-style-type: none"> 1. Check CAN bus 2. Check the software version of the transmission control unit and program the current software version if required. 3. If this error continues to occurs, please contact your vehicle manufacturer.
523432	19	Message ZFSL1_FNR invalid or timed out	Trm Shutdown	Shift Lever message is missing or provides wrong signals.	<ol style="list-style-type: none"> 1. Check CAN bus 2. Check shift lever 3. Check the software version of the transmission control unit and program the current software version if required. 4. If this error continues to occurs, please contact your vehicle manufacturer.
523171	11	CCO or inch pedal signal fault during CCO or inching	Limp Home	A problem with the signals required for CCO or inching occurred while the vehicle was in CCO or inching operation.	<ol style="list-style-type: none"> 1. Check cable from TCU or the sensor 2. Check connectors 3. Check sensor

5) MEASURING OF RESISTANCE AT ACTUATOR/SENSOR AND CABLE

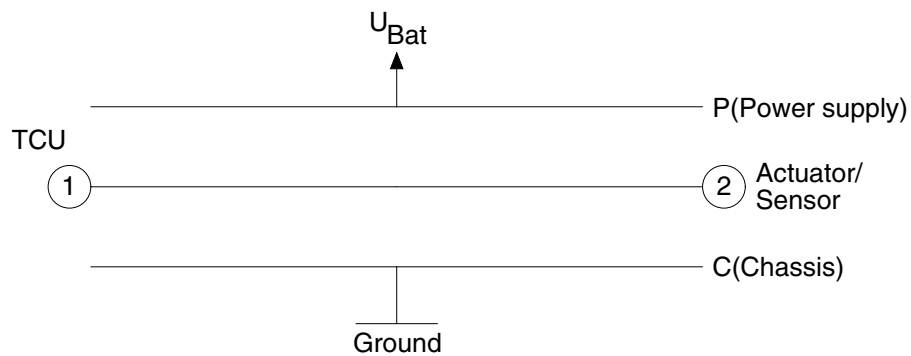
(1) Actuator



76043PT19

- Open circuit $R_{12} = R_{1G} = R_{2G} = \infty$
- Short cut to ground $R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$
(For S.C. to ground, G is connected to vehicle ground)
- Short cut to battery $R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$
(For S.C. to battery, G is connected to battery voltage)

(2) Cable



76043PT20

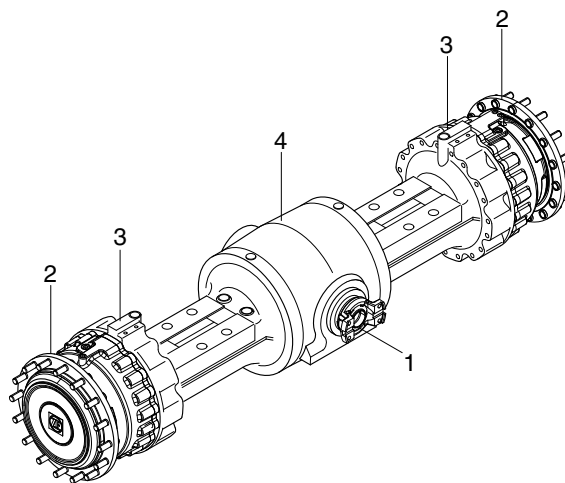
- Open circuit $R_{12} = R_{1P} = R_{1C} = R_{2P} = R_{2C} = \infty$
- Short cut to ground $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = \infty$
- Short cut to battery $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

5. AXLE

1) OPERATION

- The power from the engine passes through torque converter, transmission and drive shafts, and is then sent to the front and rear axles.
- Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles. At the same time, the speed is reduced and passes through the both differentials to the axle shafts. The power of the axle shafts is further reduced by planetary-gear-type final drives and is sent to the wheels.

(1) Front axle



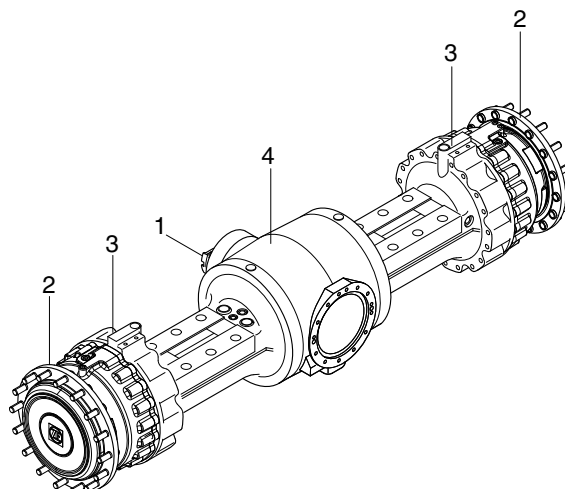
- 1 Input
4 Axle housing

2 Output

3 Brake

7709A3PT10

(2) Rear axle



- 1 Input
4 Axle housing

2 Output

3 Brake

7709A3PT11

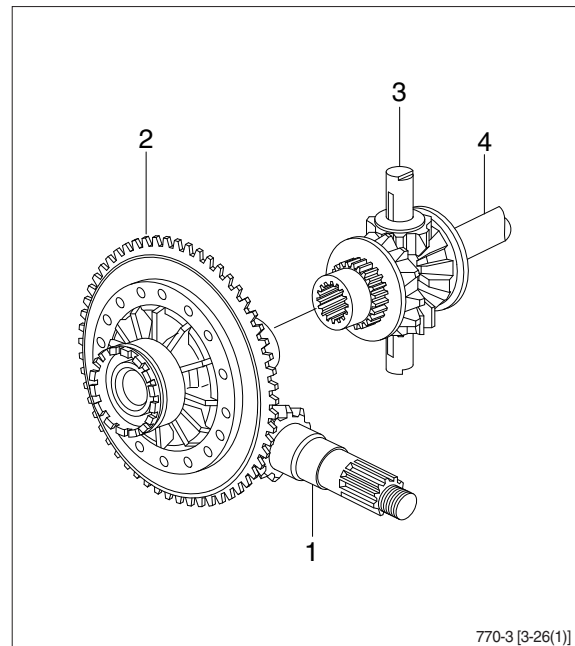
2) DIFFERENTIAL

(1) Description

When the machine makes a turn, the outside wheel must rotate faster than the inside wheel. A differential is a device which continuously transmits power to the right and left wheels while allowing them to turn at different speeds, during a turn.

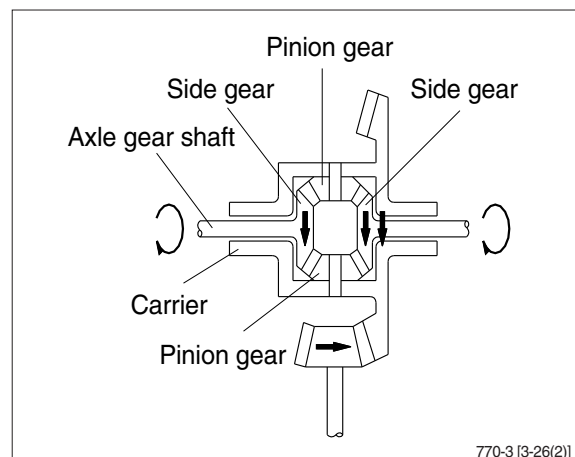
The power from the drive shaft passes through bevel pinion (1) and is transmitted to the bevel gear (2). The bevel gear changes the direction of the motive force by 90 degree, and at the same time reduces the speed.

It then transmits the motive force through the differential (3) to the axle gear shaft (4).



(2) When driving straight forward

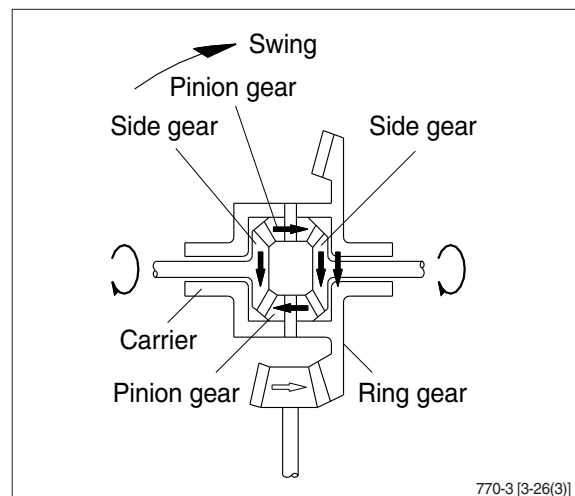
When the machine is being driven straight forward and the right and left wheels are rotating at the same speed, so the pinion gear inside the differential assembly do not rotate. The motive force of the carrier is sent through the pinion gear and the side gear, therefore the power is equally transmitted to the left and right axle gear shaft.



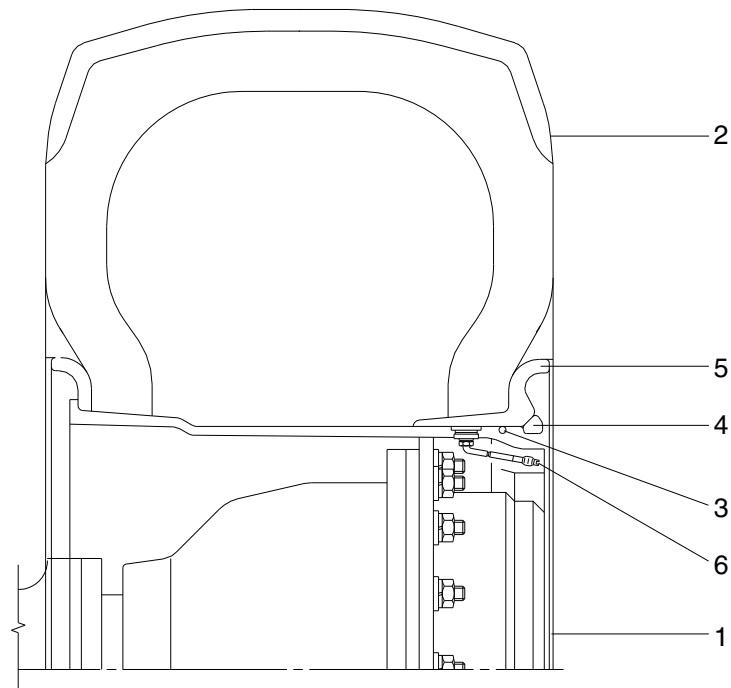
(3) When turning

When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

The power of the carrier is then transmitted to the axle gear shafts.



6. TIRE AND WHEEL



7407APT10

1 Wheel rim

3 O-ring

5 Side ring

2 Tire

4 Lock ring

6 Valve assembly

- 1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.
- 2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work and bucket capacity.