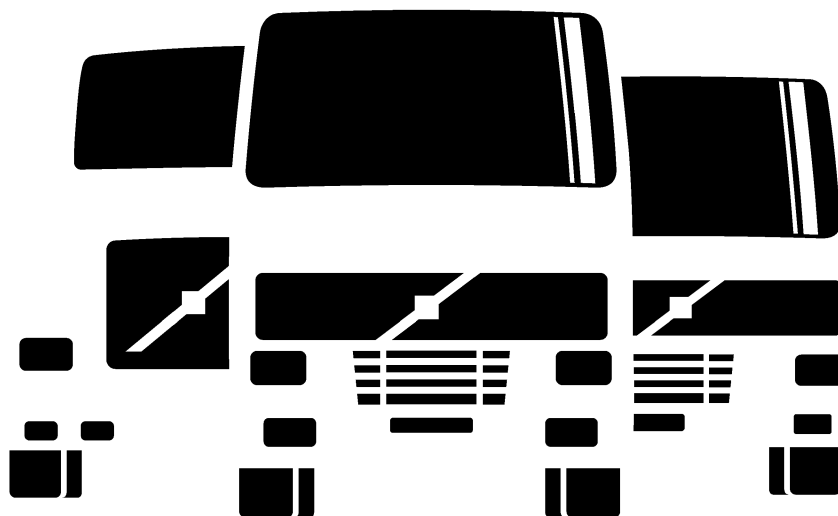


# Service Manual Trucks

Group **28, 36, 43**  
Fault Code Guide  
2007 Emissions  
VN, VHD VERSION2, VT



# Foreword

Descriptions and instructions in this handbook are based on design and method studies up to and including 1.2007.

The products are under continual development. Values and repair methods may therefore differ on vehicles and components manufactured after this date.

This service information uses the following observation and warning levels:

- |                   |   |
|-------------------|---|
| <b>Note!</b>      | Indicates a situation, use or circumstance that should be emphasized.                               |
| <b>Important!</b> | Indicates a situation, where a special service hint or technique is used.                           |
| <b>Caution!</b>   | Indicates a situation that, unless avoided, can lead to physical damage to the product.             |
| <b>Warning!</b>   | Indicates a dangerous situation that, unless avoided, can lead to personal injury.                  |
| <b>Danger!</b>    | Indicates a dangerous situation that, unless avoided, can lead to serious personal injury or death. |

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# Group 28

## Design and Function

### Engine Control System

The "Premium Tech Tool" (PTT) is the preferred tool for performing diagnostic work. Contact your local dealer for more information.

### System Overview

Five electronic control modules are used; the Engine Management System (EMS) Module, Instrument Cluster Module (ICM), Vehicle Electronic Control Unit (VECU), Transmission Electronic Control Unit (TECU) and the Gear Selector Electronic Control Unit (GSECU). Together, these modules operate and communicate through the J1939 high speed serial data line to control a variety of engine and vehicle cab functions. The Engine Management System (EMS) Module controls fuel timing and delivery, fan operation, engine protection functions, engine brake operation, the EGR valve, and the turbocharger nozzle. The Vehicle Electronic Control Unit (VECU) controls cruise control functions, accessory relay controls and idle shutdown functions. The Instrument Cluster Module (ICM) primarily displays operational parameters and communicates these to the other ECU's. All have the capability to communicate over the J1587 normal speed data lines primarily for programming, diagnostics and data reporting.

In addition to their control functions, the modules have on-board diagnostic capabilities. The on-board diagnostics are designed to detect faults or abnormal conditions that are not within normal operating parameters. When the system detects a fault or abnormal condition, the fault will be logged in one or both of the modules' memory, the vehicle operator will be advised that a fault has occurred by illumination a malfunction indicator lamp and a message in the driver information display, if equipped. The module may initiate the engine shutdown procedure if the system determines that the fault could damage the engine.

In some situations when a fault is detected, the system will enter the "limp home" mode. The limp home mode allows continued vehicle operation but the system may substitute a sensor or signal value that may result in poor performance. In some instances, the system will continue to function but engine power may be limited to protect the engine and vehicle. Fault codes logged in the system memory can later be read, to aid in diagnosing the faults, with a diagnostic computer or through the instrument cluster display, if equipped. When diagnosing

an intermittent code or condition, it may be necessary to use a diagnostic computer connected to the Serial Communication Port.

Additional data and diagnostic tests are available when a diagnostic computer is connected to the Serial Communication Port.

For diagnostic software, contact your local dealer.

The Vehicle Electronic Control Unit (VECU) is mounted on a panel below the top dash access panel in the center of the dash on conventional models. The VECU is a microprocessor based controller programmed to perform several functions, these include:

- Driver controls
- Vehicle and engine speed controls
- Starter control
- Cab power
- Idle controls
- Broadcasting data on the serial data lines
- Trip data logging
- Diagnostic fault logging and password processing

The VECU performs these functions by monitoring the signals from sensors and switches, and data received over the serial data lines from the other ECU's. The VECU directly monitors the Throttle Position (TP) Sensor and Vehicle Speed Sensor (VSS).

The VECU also monitors the position or state of a number of switches to perform its control and diagnostic functions. They are:

- A/C Pressure Switch
- Air Suspension Height Control Switch
- Differential Lock Switch
- Engine Brake Switches
- Ignition Key Switch
- PTO Switches (if equipped)
- Service and Park Brake Switches
- Speed Control Switches (Set/Decel, Resume/Accel)
- 5th Wheel Slide Switch

The EMS is a microprocessor based controller programmed to perform fuel injection quantity and timing control, diagnostic fault logging, and to broadcast data to other modules. The fuel quantity and injection timing to each cylinder is precisely controlled to obtain optimal fuel economy and reduced exhaust emissions in all driving situations.

The EMS controls the operation of the Electronic Unit Injectors (EUIs), engine brake solenoid, EGR valve, turbocharger nozzle position, and cooling fan clutch based on input information it receives over the serial data lines and from the following sensors:

- Ambient Air Temperature Sensor
- Ambient Pressure sensor
- Boost Air Pressure (BAP) Sensor
- Camshaft Position (Engine Position) Sensor
- Cooling Fan Speed (CFS) Sensor
- Crankshaft Position (Engine Speed) Sensor
- Differential Pressure DPF Sensor
- EGR Differential Pressure Sensor
- EGR Temperature Sensor

- Engine Coolant Level (ECL) Sensor
- Engine Coolant Temperature (ECT) Sensor
- Engine Oil Pressure (EOP) Sensor
- Engine Oil Level (EOL) Sensor
- Engine Oil Temperature (EOT) Sensor
- Exhaust Temperature Sensor (DPF Sensors)
- Fuel Pressure Sensor
- Intake Air Temperature And Humidity (IATH) Sensor
- Intake Manifold (Boost) Temperature Sensor
- Throttle Position (TP) Sensor
- Turbo Speed Sensor
- Variable Geometry Turbocharger (VGT) Position Sensor

The Vehicle Electronic Control Unit (VECU) and Engine Management System (EMS) Module are dependent on each other to perform their specific control functions. In addition to switch and sensor data the broadcast of data between modules also includes various calculations and conclusions each module has developed, based on the input information it has received.

## Sensors

### **Ambient Air Temperature Sensor**

The Ambient Air Temperature Sensor is used to detect the outside air temperature. The sensor modifies a voltage signal from the ECM. The modified signal returns to the ECM as the ambient air temperature. The sensor uses a thermistor that is sensitive to the change in temperature. The electrical resistance of the thermistor decreases as temperature increases.

The Ambient Air Temperature Sensor is located in the front of the vehicle.

### **Ambient (Atmospheric) Pressure Sensor**

The Ambient (Atmospheric) Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Ambient (Atmospheric) Pressure Sensor is built into the Engine Management System (EMS) Module.

### **Camshaft Position Sensor**

The Camshaft Position (Engine Position) Sensor is located in the rear face of the timing gear cover at the rear of the engine, near the bottom of the valve cover. It uses magnetic induction to generate a pulsed electrical signal. It senses the passage of seven (7) timing bumps on the edge of the camshaft dampener. Six of the holes correspond to the phasing of the electronic unit injectors, while the seventh hole indicates the top dead center position.

### **Cooling Fan Speed (CFS) Sensor**

On engines with an electronically controlled viscous fan drive, the electronic fan drive contains a Hall effect speed sensor. When the engine is running, a series of vanes in the fan drive housing rotates past a magnet in the fan drive solenoid generating a pulsed voltage signal. The Engine Management System (EMS) Module monitors the status of the air conditioning system and signals from the Engine Coolant Temperature (ECT) Sensor, the Engine Oil Temperature (EOT) Sensor, and the Engine Speed/Timing (RPM/TDC) Sensor and calculates the optimal cooling fan speed.

The Cooling Fan Speed Sensor is located in the fan drive on the front of the engine.

## **Crankshaft Position (Engine Speed) Sensor**

The Crankshaft Position (Engine Speed) Sensor uses magnetic induction to generate a pulsed electrical signal. Notches are machined into the edge of the flywheel. When one of the notches passes close to the sensor, electric pulses result.

The Crankshaft Position (Engine Speed) Sensor also indicates when the crankshaft is at the top dead center position.

## **Differential Pressure DP Sensor**

The differential pressure sensor is used for flow measurement of the Diesel Particulate Filter (DPF). This sensor has two pressure ports and senses the difference in pressure between the two ports. Measurement of the pressure before and after the DPF is used to calculate diesel filter regeneration.

The Differential Pressure DPF Sensor is located on the side of the Diesel Particulate Filter (DPF).

## **EGR Differential Pressure Sensor**

The EGR differential pressure sensor is used for flow measurement of the Exhaust Gas Recirculation (EGR) valve. This sensor has two pressure ports and senses the difference in pressure between the two ports. Measurement of the pressure before and after the EGR valve is used to calculate EGR flow.

The EGR Differential Pressure Sensor is located on the left or right side of the engine.

## **EGR Temperature Sensor**

The EGR temperature sensor detects exhaust gas temperature for EGR system. The sensor modifies a voltage signal from the control unit. The modified signal returns to the control unit as the exhaust temperature of the EGR system to confirm EGR operation. The sensor uses a thermistor that is sensitive to the change in temperature.

The EGR Temperature Sensor is located near the EGR valve.

## **Engine Coolant Level (ECL) Sensor**

The Engine Coolant Level (ECL) Sensor is a switch. If engine coolant level falls below a calibrated point the contacts open and the driver will be notified of the low coolant level.

The Engine Coolant Level (ECL) Sensor is located in the cooling system reservoir tank.

## **Engine Coolant Temperature (ECT) Sensor**

The Engine Coolant Temperature Sensor is located at the front of the engine. The sensor will indicate a high coolant temperature caused by problems like radiator blockage, thermostat failure, heavy load, or high ambient temperatures. This sensor is also used for cold start enhancement and for fan clutch engagement.

## **Engine Oil Pressure (EOP) Sensor**

The Engine Oil Pressure Sensor contains a pressure sensitive diaphragm and a electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Engine Oil Pressure Sensor is located on the oil filter assembly. The sensor monitors engine oil pressure to warn of lubrication system failure.

## **Engine Oil Level (EOL) Sensor**

The Engine Oil Level Sensor is located in the oil pan.

## **Engine Oil Temperature (EOT) Sensor**

The Engine Oil Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative temperature coefficient, which means the sensor resistance will decrease as the engine oil temperature increases.

The Engine Oil Temperature Sensor is located in the oil pan.

## **Exhaust Temperature Sensor (DPF Sensors)**

The exhaust gas temperature sensor detects exhaust gas temperature for DPF protection as well as DPF regeneration control. The sensor modifies a voltage signal from the control unit. The modified signal returns to the control unit as the exhaust temperature at that specific location of the exhaust. The sensor uses a thermistor that is sensitive to the change in temperature.

The Exhaust Temperature Sensors are located in the DPF assembly.

## **Fuel Pressure Sensor**

The fuel pressure sensor contains a diaphragm that senses fuel pressure. A pressure change causes the diaphragm to flex, inducing a stress or strain in the diaphragm. The resistor values in the sensor change in proportion to the stress applied to the diaphragm and produces an electrical output.

The Fuel Pressure Sensor is located on top of the fuel filter housing.

## **Intake Air Temperature and Humidity (IATH) Sensor**

The Intake Air Temperature and Humidity (IATH) Sensor contains a thermistor and a capacitive sensor. The resistance of the thermistor varies inversely to temperature. The output of the capacitive sensor increases as the humidity of the surrounding air increases. By monitoring the signals from both portions of the sensor, the Engine Management System (EMS) Module calculates the temperature and humidity of the air passing through the air filter housing.

The Intake Air Temperature and Humidity (IATH) Sensor is located in the air intake tube just downstream from the air filter canister.

## **Intake Manifold (Boost) Temperature Sensor**

The Intake Manifold (Boost) Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative temperature coefficient, which means the sensor resistance will decrease as the inlet air temperature increases.

The Intake Manifold (Boost) Temperature Sensor is located in the intake manifold.

## **Intake Manifold Pressure Sensor**

The Intake Manifold Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Intake Manifold Pressure Sensor is located on the air inlet pipe before the intake manifold.

## **Throttle Position (TP) Sensor**

The Throttle Position Sensor is a potentiometer that is mechanically linked to the accelerator pedal. A potentiometer is a variable resistor whose resistance will change as the pedal is pressed. As the resistance changes, the signal voltage of the sensor changes indicating the accelerator pedal position.

The Throttle Position Sensor is located above the accelerator pedal. The sensor is designed to improve the driver's control by reducing sensitivity to chassis motion. This sensor provides the driver's fuel request input to the VECU.

## **Turbo Speed Sensor**

The Turbo Speed Sensor informs the EMS of the turbo shaft speed. The sensor does not read from the vanes, but reads from the shaft. The Engine Management System (EMS) Module uses this signal in conjunction with the VGT position sensor signal to control the speed of the turbocharger and therefore optimize the intake manifold pressure.

The Turbo Speed Sensor is mounted in the center of the turbocharger.



## **Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA)**

The Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA) takes the position commands from the EMS, moves the nozzle of the turbocharger to the desired position, and performs all of the diagnostics and self checks on the actuator.

## MID 130 Transmission Control Unit

The "Premium Tech Tool" (PTT) is the preferred tool for performing diagnostic work. Contact your local dealer for more information.

### System Overview

The I-Shift transmission is a technologically advanced automated mechanical transmission, designed specifically to work in conjunction with Volvo's new family of heavy-duty diesel engines. In order to work as a total package, the I-Shift is programmed with each engine's efficiency map and is offered with different software options to fulfill each operator's needs.

All variants of the Volvo I-Shift have 12 forward speeds and up to 4 reverse speeds depending on programming. It is a single countershaft transmission built up with a splitter section, a main section with three forward and one reverse gear, and a range gear section. It is an automated mechanical transmission and uses synchronizers in its splitter and range gears but not in the main section. The main section utilizes a countershaft brake to mesh gears and equalize shaft speeds as needed. A single disc automated clutch system is utilized. The I-Shift is a "two pedal" transmission and does not require a clutch pedal.

The I-Shift uses compressed air and electrical solenoids to perform shift functions, clutch control and countershaft brake functions. All of these functions are timed and controlled by the Transmission Electronic Control Unit (TECU). A dedicated air tank is needed on the vehicle to supply air for these components. The air is plumbed to the transmission via a supply line and is distributed to the other components internally. The air control solenoids are housed in the Transmission Control Housing and in the Clutch Control Valve Assembly.

All Volvo Truck models will be available with this transmission including the VT, VN Series & VHD vocational trucks. Four I-Shift models will be offered to support the power ranges of the engines as well as offering different gear arrangements:

	<b>AT2512C</b>	<b>ATO2512C</b>	<b>AT2812C</b>	<b>ATO3112C</b>
<b>Operation</b>	Two Pedal	Two Pedal	Two Pedal	Two Pedal
<b>Forward Speeds</b>	12	12	12	12
<b>Engines Available</b>	D11/D13	D11/D13	D16	D16
<b>Overall Ratio</b>	14.94:1	15.04:1	14.94:1	15.04:1
<b>Top Ratio</b>	Direct 1.00:1	Overdrive 0.78:1	Direct 1.00:1	Overdrive 0.78:1
<b>Weight lbs (kg)</b>	597 (275)	597 (275)	610 (281)	610 (281)

### Transmission Identification

Each transmission has two identification tags. One is found on the top of the clutch housing and the other is found on the back of the range housing. The transmission version can be readily identified by the following nomenclature table.

Make	Volvo
Type	AT2512C, ATO2512C, AT2812C and ATO3112C
Description	A — Automatic T — Transmission O — Overdrive 25 — Torque Capacity 2500 Nm (1850 lb/ft) 28 — Torque Capacity 2800 Nm (2050 lb/ft) 31 — Torque Capacity 3100 Nm (2300 lb/ft) 12 — Number of forward gears C — Design Level