A technology factsheet on Volvo Cars' T8 Twin Engine AWD powertrain technology

ELECTRIFICATION
CLEAN EFFICIENCY
RESPONSIVE POWER
Contents

Twin Engine (PHEV) Technology 3
- Introducing Twin Engine Technology
- T8 Twin Engine AWD
- Electric Rear Axle Drive (ERAD)
- Crank-Integrated Starter Generator (C-ISG)
- High Voltage Battery
- On board charger
- Power electronics
- Cooling and brake system
- Fuel and control system

Petrol engine technology 12
- Supercharging and turbocharging
- Direct injection
- T6 - the base engine for T8 Twin Engine AWD

Transmissions 16
- 8-speed automatic
Twin Engine Technology
Plug-in hybrids

“Volvo Cars has made a clear commitment to electrification across our entire product range. Our Twin Engine technology is a confident first step forward. This technology delivers a no compromise balance of clean, efficient performance and exceptional driving pleasure. It is all about using the latest available technology to address unmet consumer needs,” says Dr Peter Mertens, Senior Vice President Research & Development at Volvo Car Group.

Twin Engine Definition
Volvo’s Twin Engine technology is essentially a combination of an internal combustion engine and electric power. Electric energy from the grid can be stored in a High Voltage Battery. The technology is more commonly known as Plug-in Hybrid Technology (PHEV).

Volvo’s technology is designed to deliver three cars experiences in one.

- **PURE** – where the car runs on electric power alone.
- **HYBRID** – where an optimal combination of the engine and electric machine propels the cars in a balanced and sustainable way.
- **POWER** – where all available power is used to deliver maximum performance.

Volvo’s Twin Engine set-up means that the high voltage battery is positioned in the tunnel console for maximum safety and also improved weight distribution that gives an improved driving experience.

Twin Engine technology delivers a no compromise mix of performance, driving pleasure, efficiency interior, cargo space and flexibility.
T8 Twin Engine Technology
All Wheel Drive

- Internal Combustion Engine Petrol 2.0I Super Turbo
- Electric A/C compressor
- Crankshaft mounted Integrated Starter Generator (C-ISG)
- 8-Speed Automatic Transmission
- High Voltage Li-ion Battery
- Electric Rear Axle Drive (ERAD)
- Power Electronics

SPA only
65 kW motor
9.2 kWh battery
43 km range
T8 Twin Engine Technology

Electric Rear Axle Drive

- Propels vehicle in electric mode
- Provides electric boost torque and power during acceleration
- Provides electric all wheel drive functionality
- Performs brake energy recuperation

Permanent Magnet Synchronous Machine
- Peak power: 65 kW
- Peak torque 240 Nm
- Weight: 34 kg
- Cooling: Water cooled stator
T8 Twin Engine Technology
Crank-Integrated Starter Generator

- Charges the battery
- Starter for the combustion engine
- Can support the combustion engine with electric boost power

Permanent Magnet Synchronous Machine
Peak power: 34 kW
Peak torque: boost 150 Nm, cold crank = 180 Nm 240 Nm
Weight: 18kg
Cooling: Water cooled
T8 Twin Engine Technology
High Voltage Battery

The function of the high voltage battery is to store energy. It receives energy from electric grid charging and also from regenerative braking of the vehicle or from the C-ISG.

The high voltage battery delivers power for pure electric drive and also to run the electric air conditioning for pre-climatisation of the passenger compartment.

96 Li-ion cells
270-400V
9.2 kWh (nominal)
Lithium Manganese Oxide – Nickel
Manganese Cobalt/Graphite
Weight: 113 kg (excluding coolant)
Manual service disconnect
World-wide use, adapted to EU, US and China standards for AC charging
AC input voltage: 85–265V
Output power 3,5 kW@230V, 1,4 kW@120V
Charging time: 3h@16A, 8h@10A. Extended time due to climatisation may occur
T8 Twin Engine Technology
Power Electronics

**ERAD inverter**
Controls the ERAD EM
Provides/receives AC current and voltage to/from the ERAD EM
600 A/650 V rated power module
10 kHz switch frequency (variable)

**CIDD (Combined Inverter and DC/DC)**
Controls the C-ISG
Voltage converter 400V–12V
Provides/receives AC current and voltage to/from the C-ISG
650 V rated power module
10 kHz switch frequency (variable)
Cooling system
• The C-ISG is cooled by the base engine cooling circuit.
• One extra cooling circuit cools the ERAD and the power electronics.
• A second, extra cooling circuit, cools the battery in one of two ways; either passively, via the radiator, or actively, through integration with the car’s climate system.

Brake system
• The T8 Twin Engine’s intelligent blended braking system uses brake-by-wire technology to automatically recover and transmit regenerated energy to recharge the battery or for immediate use.
• The system is also equipped with a stability function that controls the amount of energy that may be regenerated while maintaining both optimal stability and traction.
T8 Twin Engine Technology
Fuel and Control Systems

**Fuel system**
- Non vented tank.
- Canister adsorbs fuel vapour in combination with refuel or high tank pressure.
- Canister is purged from adsorbed fuel when engine is running.

**Control system**
- Hybrid master control in Engine Control Module.
- Control of subsystem via CAN.
- Model based in-house developed software for hybrid control.
Petrol Engine Technology

**Advanced Boosting**
Volvo Cars has taken advanced boosting to a new level, using a modular based system that effectively offers Volvo owners a range of power levels and engine performance attributes. Advanced boosting means that our compact engines can deliver power levels equivalent to those of larger six- and eight-cylinder units. Advanced boosting also ensures high torque availability across a wider speed range.

We use state-of-the-art charging systems consisting of turbochargers and superchargers designed to our precise specifications to deliver improved fuel economy, leading performance and drivability.

**Supercharger & Turbos**
Superchargers deliver low-end torque and response. Turbos deliver horsepower. Below 3500 rpm the supercharger and turbo are active. Above 3500 rpm, only the turbo is applied.
Advanced Combustion
The combustion system designed for the petrol engines is comprised of a centrally mounted spark plug and injector with a unique spray layout that provides a homogeneous air-fuel mixture.

This central **direct injection** technique enables:
- Stratified start and an effective catalyst heating mode that outperforms Port Fuel Injection (PFI) and side mounted Direct Injection engines, resulting in low fuel consumption and enabling Euro6 and LEVIII emission compliance.
- Improved low-end torque compared with PFI by using scavenging and charge cooling by direct fuel injection.

The intake ports are designed to generate a high tumble motion, promoting the mixing of air and fuel during the intake stroke. In the succeeding compression stroke, this tumble motion is broken down into turbulence, accelerating the combustion speed. The combustion is therefore very stable, enabling a high degree of internal EGR, which minimizes pumping losses, hence reducing the fuel consumption. Special efforts were made to achieve a combustion system that is knock resistant. The cooling water jacket, intake ports, spray target and combustion chamber geometry were fine-tuned, enabling a fuel-efficient, high compression ratio of 10.8 for the gasoline T5 and 10.3 for the gasoline T6.
### Petrol Engines

#### T6 - the base engine for T8 Twin Engine AWD

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Displacement</strong></td>
<td>2.0l</td>
</tr>
<tr>
<td><strong>Charging system</strong></td>
<td>One supercharger + one turbo with waste gate</td>
</tr>
<tr>
<td><strong>Balancer shafts</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Engine structure</strong></td>
<td>Light weight high-pressure die cast aluminium crank cases and bedplates with cast-in iron liners and nodular cast iron bearing reinforcements.</td>
</tr>
<tr>
<td><strong>Crank system</strong></td>
<td>Similar pistons i.e. forged steel crank shafts to minimise bearing sizes, different machining of the piston top for different compression ratios. Friction reduced by 50%, ring tangential load reduction with Physical Vapour Deposition-coating (PVC) on the top ring and new honing specification. Piston pins are coated with Diamond-like Carbon (DLC).</td>
</tr>
<tr>
<td><strong>Cylinder head</strong></td>
<td>The T6 utilizes a double water jacket design to aid cooling and flow.</td>
</tr>
<tr>
<td><strong>Valve system</strong></td>
<td>Direct-acting high-speed variable valve system with service-free DLC-coated mechanical tappets. Roller bearings on first cam bearing position to reduce friction. Cam phasers on both intake and exhaust camshafts enables flexibility in the trade-off between emissions, fuel consumption and drivability.</td>
</tr>
<tr>
<td><strong>Oil system</strong></td>
<td>The oil pump is fully variable and the oil pressure is controlled by a solenoid actuator for friction reduction.</td>
</tr>
<tr>
<td>(with variable oil pump)</td>
<td></td>
</tr>
<tr>
<td><strong>Cooling system / Thermal management</strong></td>
<td>The petrol engines are equipped with a 400 W electrical water pump to reduce friction losses and create the possibility to control the coolant flow for fast engine warm-up and friction reduction</td>
</tr>
<tr>
<td><strong>Combustion system</strong></td>
<td>A centrally mounted spark plug and injector with a unique spray layout that provides a very homogeneous air-fuel mixture.</td>
</tr>
<tr>
<td><strong>Exhaust gas after-treatment</strong></td>
<td>Volvo’s compact modular exhaust gas after-treatment system shows very low pressure drop and high uniformity qualities and shares a similar base design for both petrol and diesel applications. The petrels fulfill all Euro 6b/ULEV and PZEV requirements.</td>
</tr>
</tbody>
</table>
Petrol Engines
Transmissions

8 speed automatic

The Volvo eight-speed planetary automatic transmission is a vital part of Drive-E powertrain technology.

The number of gears means that the engine’s torque and power band can be utilized more efficiently.

Two of the gears are ‘overdrives’, which save fuel when cruising at constant speeds.

The Lock-up (LU) system is comprised of the latest Noise, Vibration, Harshness damping technology (super long travel damper for the petrol engine). This enables frequent use of LU and allows the engine to run on low revs for best fuel economy.

T8 Twin Engine

The maximum torque level is increased to enable better use of the C-ISG for performance boosting purposes.

To secure transmission lubrication in pure electric mode and a quick transmission engagement (incl. start-stop response) at engine starts, an enlarged electric oil pump is integrated onto the transmission.

Shift by Wire technology

Added to transmission is an electric actuator that shift the transmission between P, R, N and D.

T8 Twin Engine variant has a unique engine-braking mode (B on shifter). Manual downshifting can be done by shifter and/or paddles.