Self Study Program 820173

The EA888 2.0L TSI Engine Gen III B

Design and Function - Tablet Format

Volkswagen

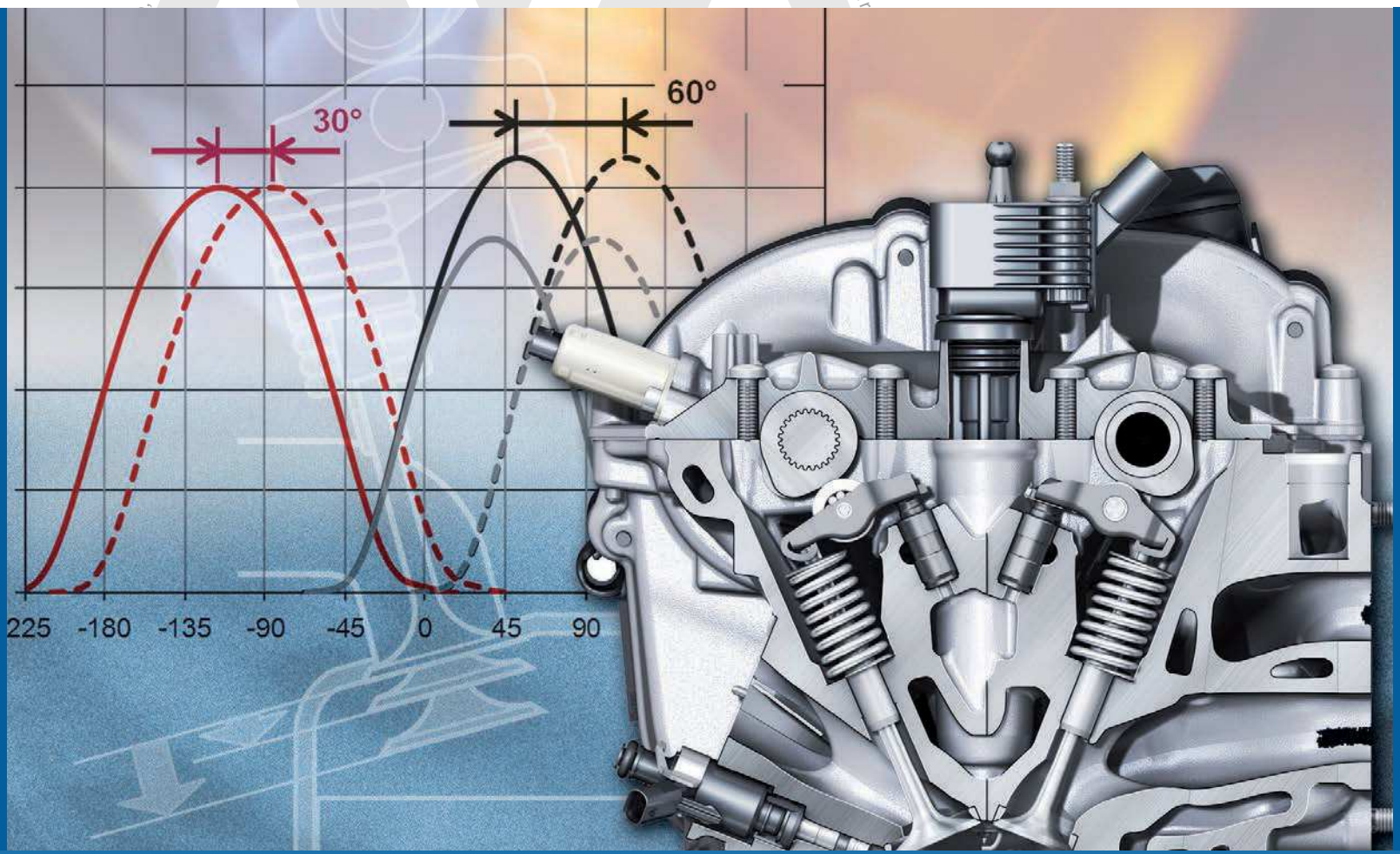

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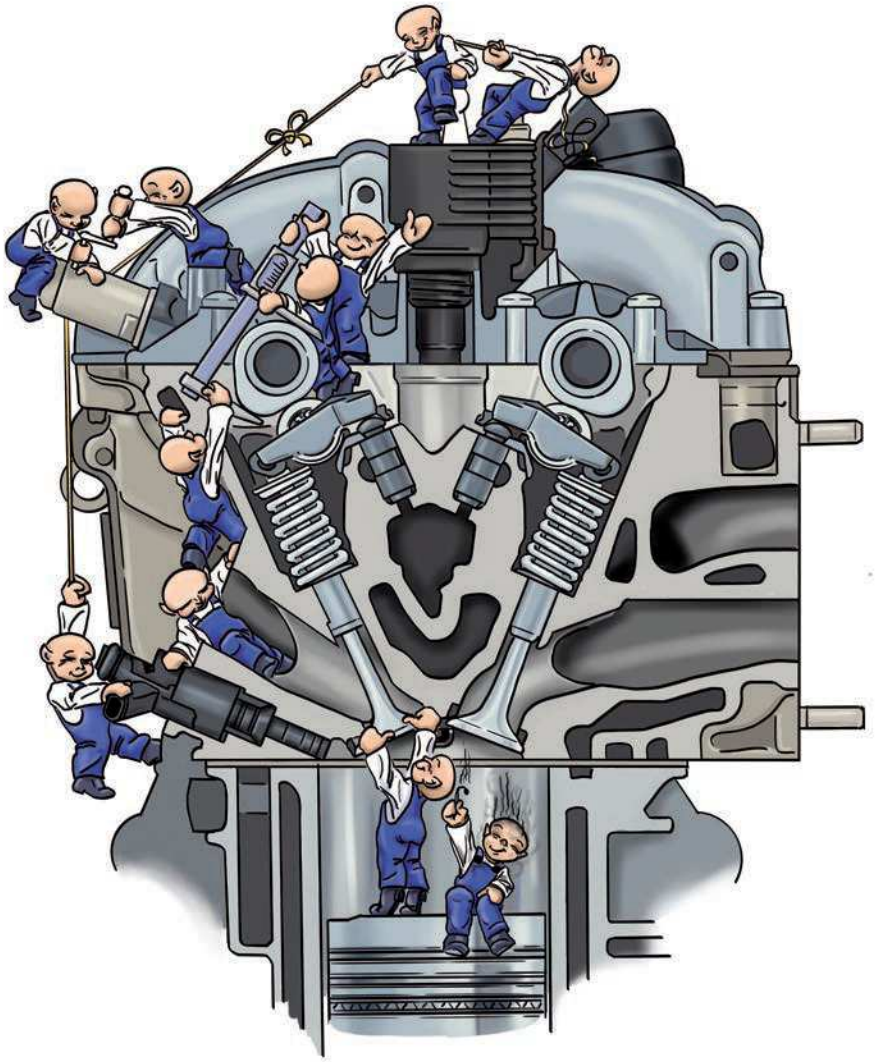
Table of Contents

Introduction

The 2.0L TSI Generation III B engine is from the EA888 series of engines. The primary goals of this engine are to reduce CO_2 and particulate emissions.



For more information about engines of the EA888 series, see Self-Study Program 820533 The 1.8L and 2.0L TSI 3rd Generation EA888 Gasoline Engines.

Introduction

Development of the 2.0L TSI Engine

The recent trend of engine development is to reduce displacement. The next step is to optimize these smaller engines. During development, special attention is placed on balancing displacement, performance, torque and fuel consumption with operating conditions.

Customers spend most driving time in the part load range. As a result, this engine focuses on improving economy in that load range.

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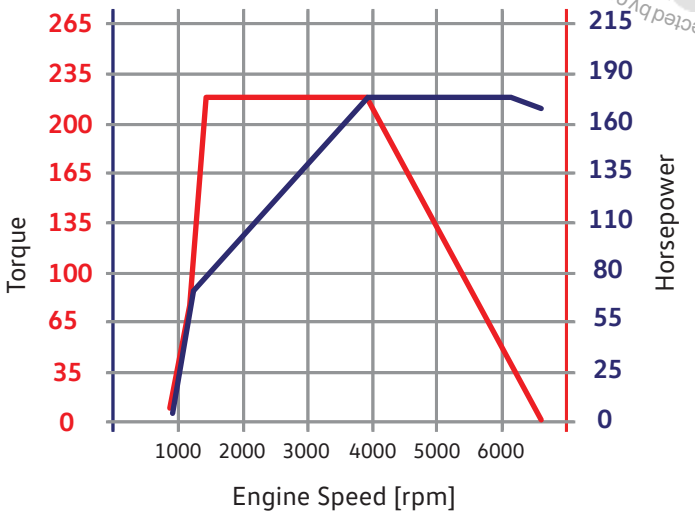
Introduction

Technical Features

Engine Mechanics

The mechanical parts of this engine are mostly identical to those in the EA888 2.0L TSI engine. The following components and assemblies have been modified due to the optimized combustion process:

- The intake port
- The combustion chamber with inlet and exhaust valves
- The injectors
- The piston



Engine Management System

The engine management system has the following characteristics:

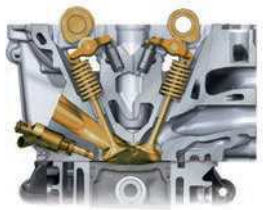
- Valvelift system on the intake side
- Injection pressure increased to 250 bar
- Mass Airflow Sensor G70 between the turbocharger and air filter housing
- Engine Control Module with quad core processor
- Intake camshaft and exhaust camshaft adjustment
- Innovative thermal management with rotary valve regulation (actuator for Engine Temperature Control Actuator N493)
- On-demand piston cooling jets
- Intake manifold flaps

Technical Data

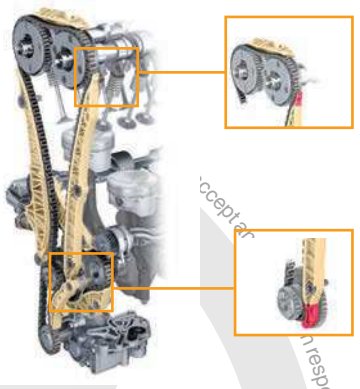
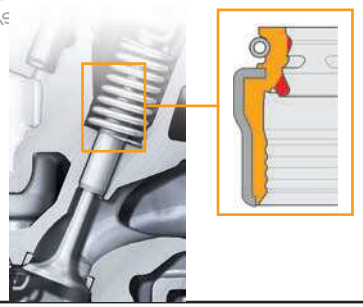
Type	4-cylinder in-line engine
Displacement	1984cm^3
Bore	82.5mm
Stroke	92.8mm
Valves per Cylinder	4
Compression Ratio	11.6 : 1
Maximum Output	183 hp (137kW) from 3940 to 6000 rpm
Maximum Torque	221 lb/ft (300Nm) from 1500 to 3940 rpm
Engine Management System	Bosch MG1
Fuel	Regular unleaded
Exhaust Gas Treatment	Three-way catalytic converter, a broadband lambda probe upstream of the turbocharger and a step-type lambda probe downstream of the catalytic converter

The Technical Changes

The following is an overview of the main changes to the 2.0L TSI engine.

Component	Change
Cylinder block  s554_032	• Blow-by gases passed via balance shaft on inlet side through slotted plastic sleeve • More precision required for installation of piston cooling nozzles on account of changes to crankcase breather system (see workshop manual)
Cylinder head  s554_024	• Valvelift system on intake side • Intake ports have been straightened • Changes to combustion chambers • Valves and injectors have been moved further back into combustion chamber
Piston  s554_022	• Three-part oil scraper ring • Piston crowns modified for deeper valve pockets Note: New special tool for piston installation.
Oil pump  s554_085	• Oil pump drive gear with 22 teeth instead of 24 teeth for higher ratio • Faster build-up of oil pressure

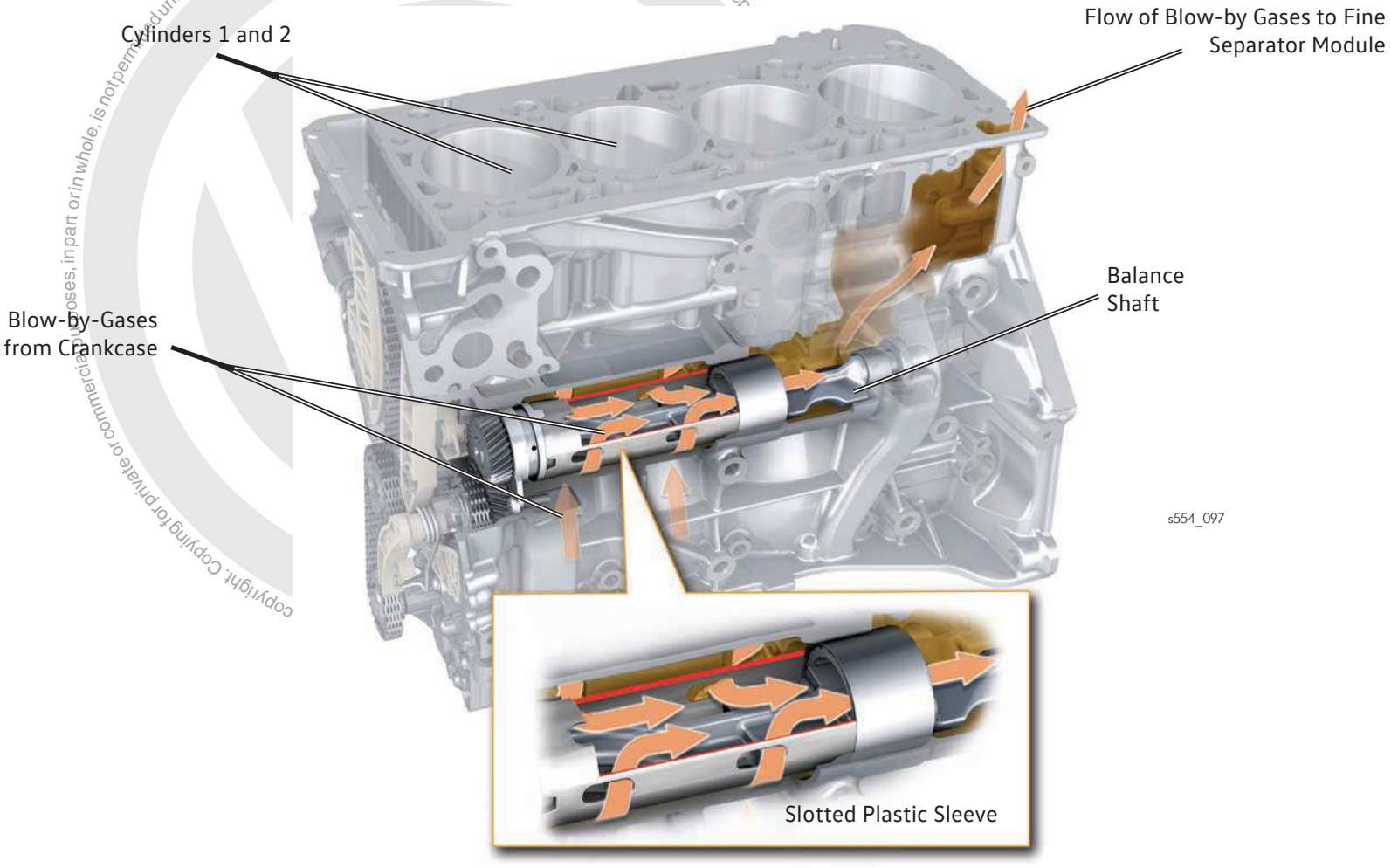
Engine Mechanics

Component	Change
Chain drive  s554_029	• Longer guide rail to prevent timing chain slipping • Crankshaft chain has three sprockets: – Oil pump drive – Balancer shaft drive – Camshaft drive • Camshaft chain sprocket is designed to be off center to reduce chain forces on timing chain.
Fuel system  s554_021	• Increase of injection pressure to 250bar, resulting in finer atomization of fuel in combustion chamber
Engine management system  s554_020	• Bosch MG1 with four core processors
Valve stem oil seal  s554_086	• Valve stem oil seals of exhaust valves have a double lip for better sealing

Crankcase Ventilation

The addition of the valvelift system on the intake side of the engine required changes to the crankcase breather system. The blow-by gases exit the crankcase near cylinders 1 and 2, move through the balance shaft area and exit to the fine separator module in the cylinder head. The balance shaft has a slotted plastic sleeve to allow the blow-by gases to flow through.

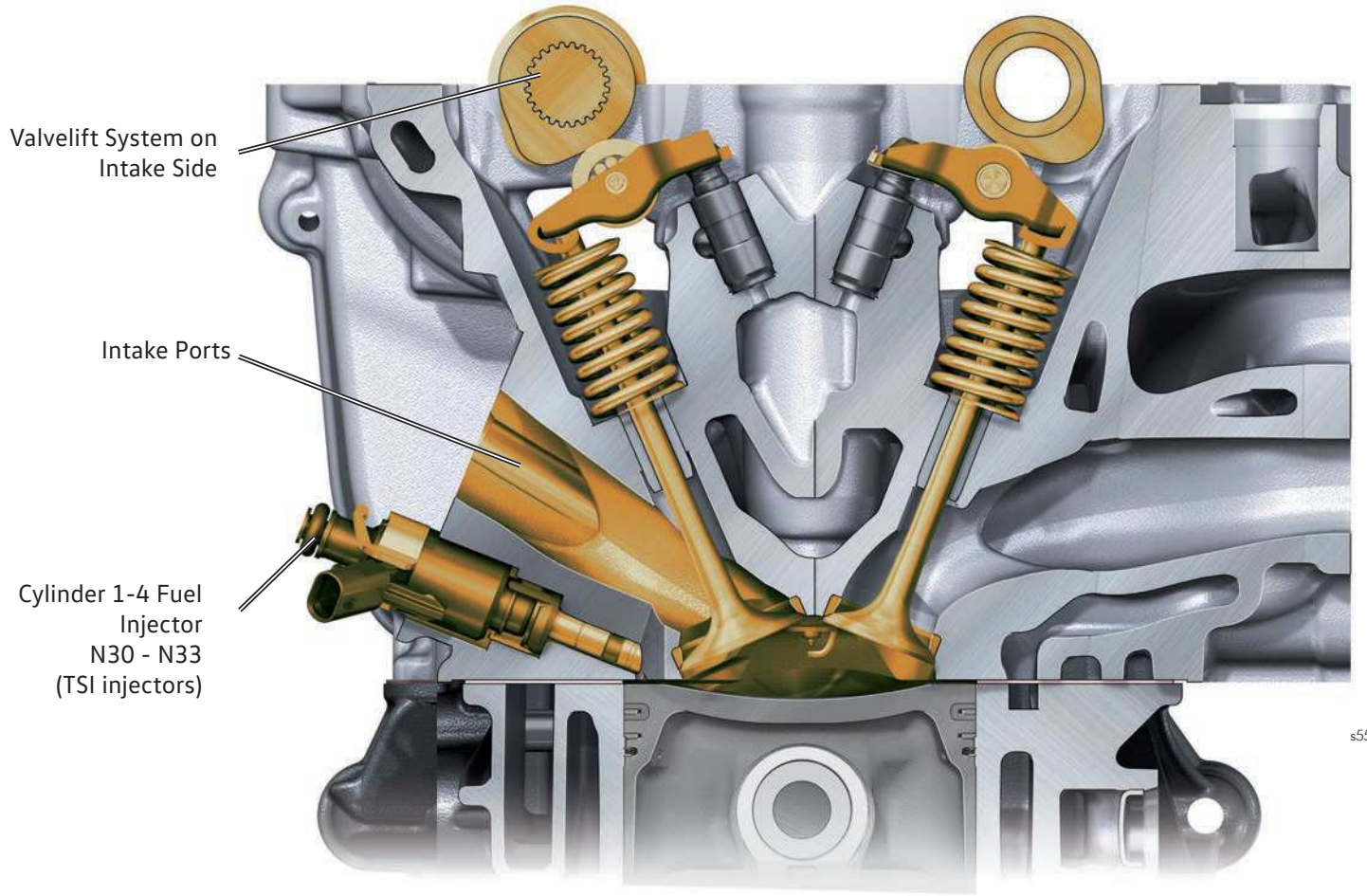
A large amount of the oil from the blow-by gases is separated (centrifugal effect) by rotation of the balance shaft, flowing back into the oil sump. This allows the balance shaft to function as a coarse oil separator.



Cylinder Head

Changes to the cylinder head were needed for an optimized combustion process. Smooth running and knock reduction were also improved. The cylinder head of the engine was changed as follows:

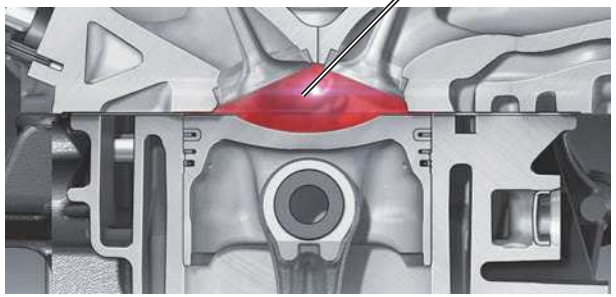
- Valvelift system on intake side
- Increase in compression ratio from 9.6 to 11.6 by:
  - lowering combustion chamber roof by 9mm
  - modified piston crown
- Injectors located closer to combustion chambers
- Intake ports designed to be straighter in order to optimize the inlet air flow
- Valve stem oil seal of exhaust valves with double lip



The Combustion Chamber Design

The combustion chamber is the area between the cylinder head and the piston crown. The combustion chamber depression has a larger compression zone, which requires the use of smaller intake valves.

The larger compressing zone provides better mixing of the fuel and air in the cylinder. To help with this, the piston crown valve pockets and the gas flow recess have been optimized.



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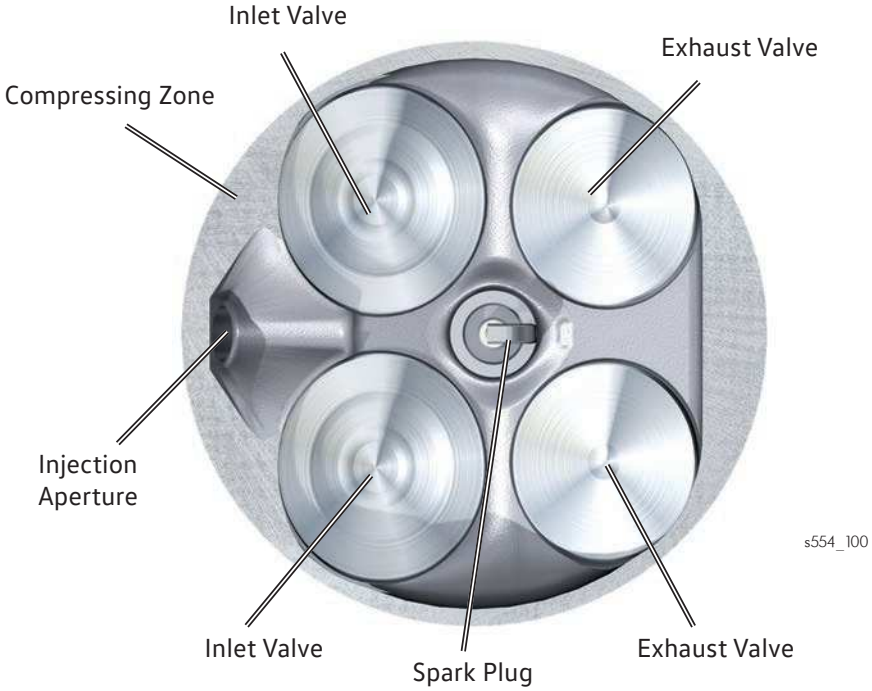
Combustion Chamber Depression in Cylinder Head



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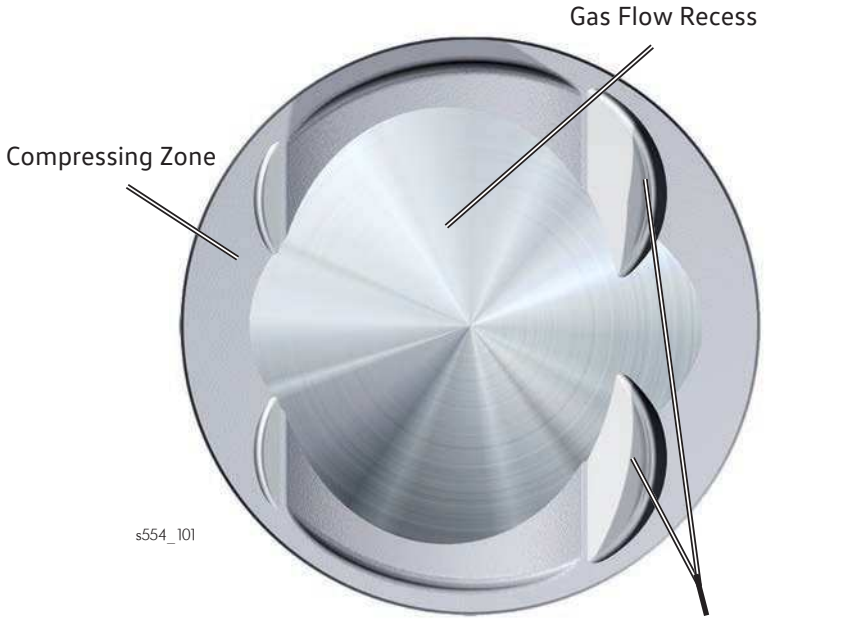
Combustion Chamber Design in Piston Crown



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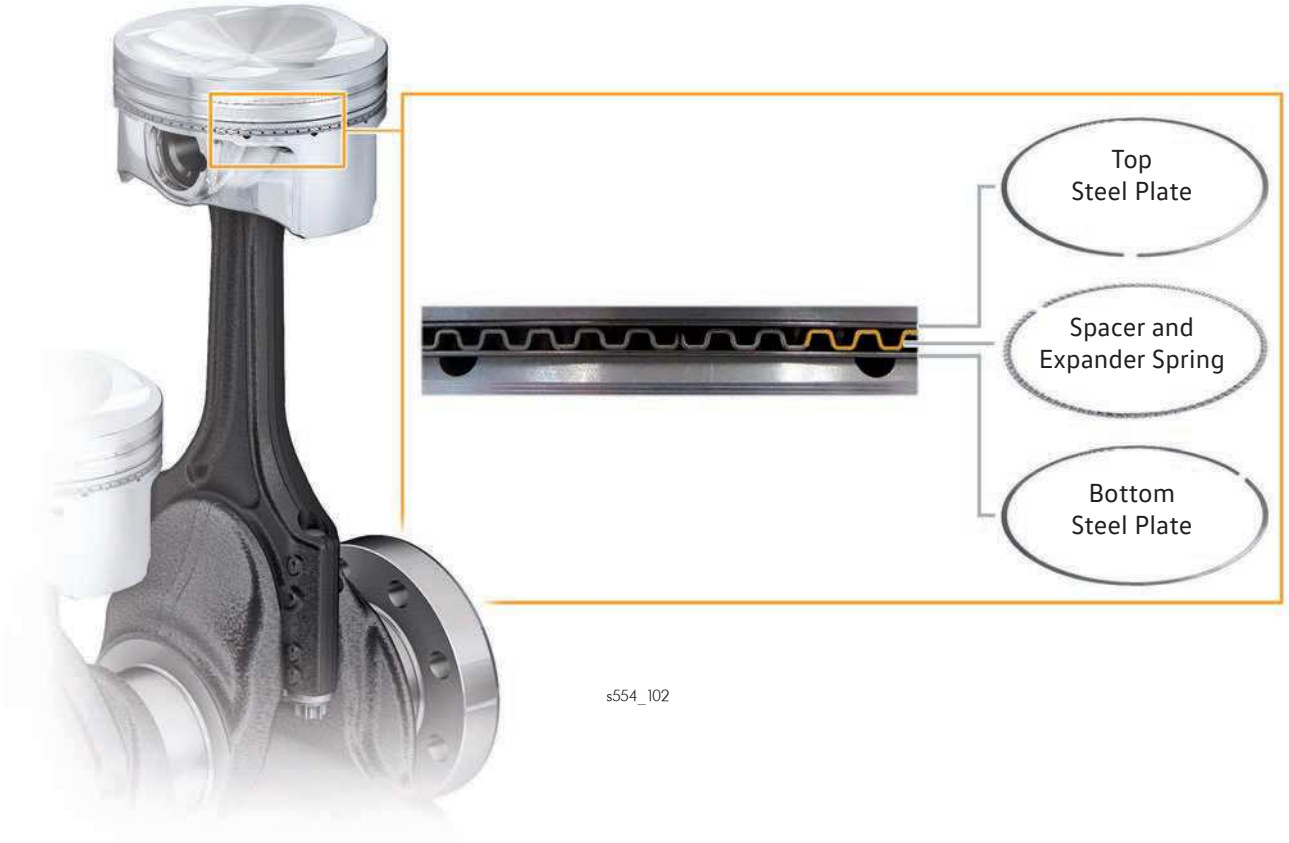
The Three-Part Oil Scraper Ring

The pistons use a three-part oil scraper ring. It has two steel plates, a spacer and expander spring.

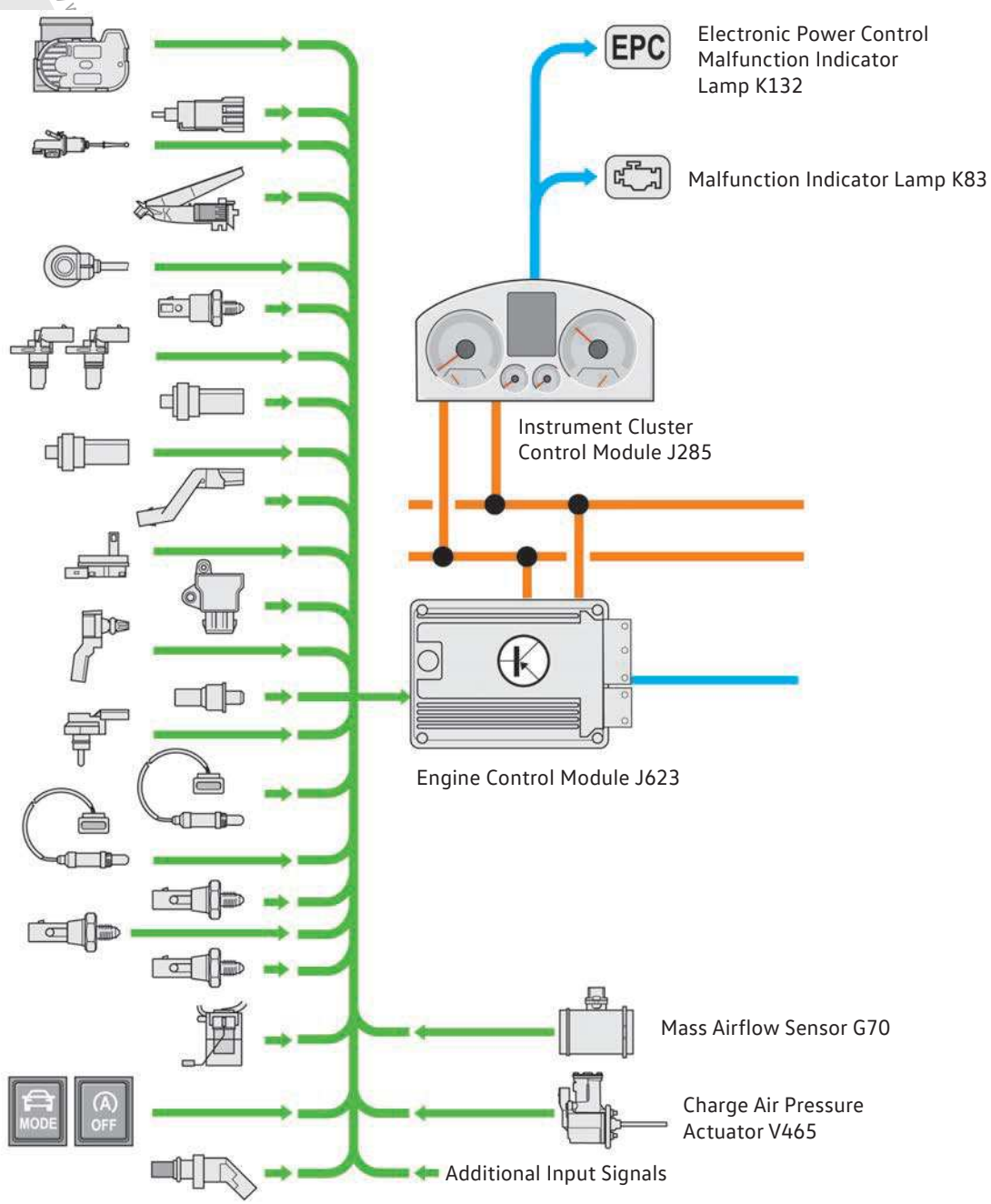


When installing the oil scraper rings, make sure that the expander spring is positioned correctly. This is especially important on pistons with the rings pre-installed. There is a risk that the ends of the springs could have shifted above each other. Both ends of the expander spring have a colored marking so that the exact position can be determined. The expander spring must not overlap or the oil scraper ring will not work. The ends of the three-part oil scraper ring must be rotated by 120° during installation.

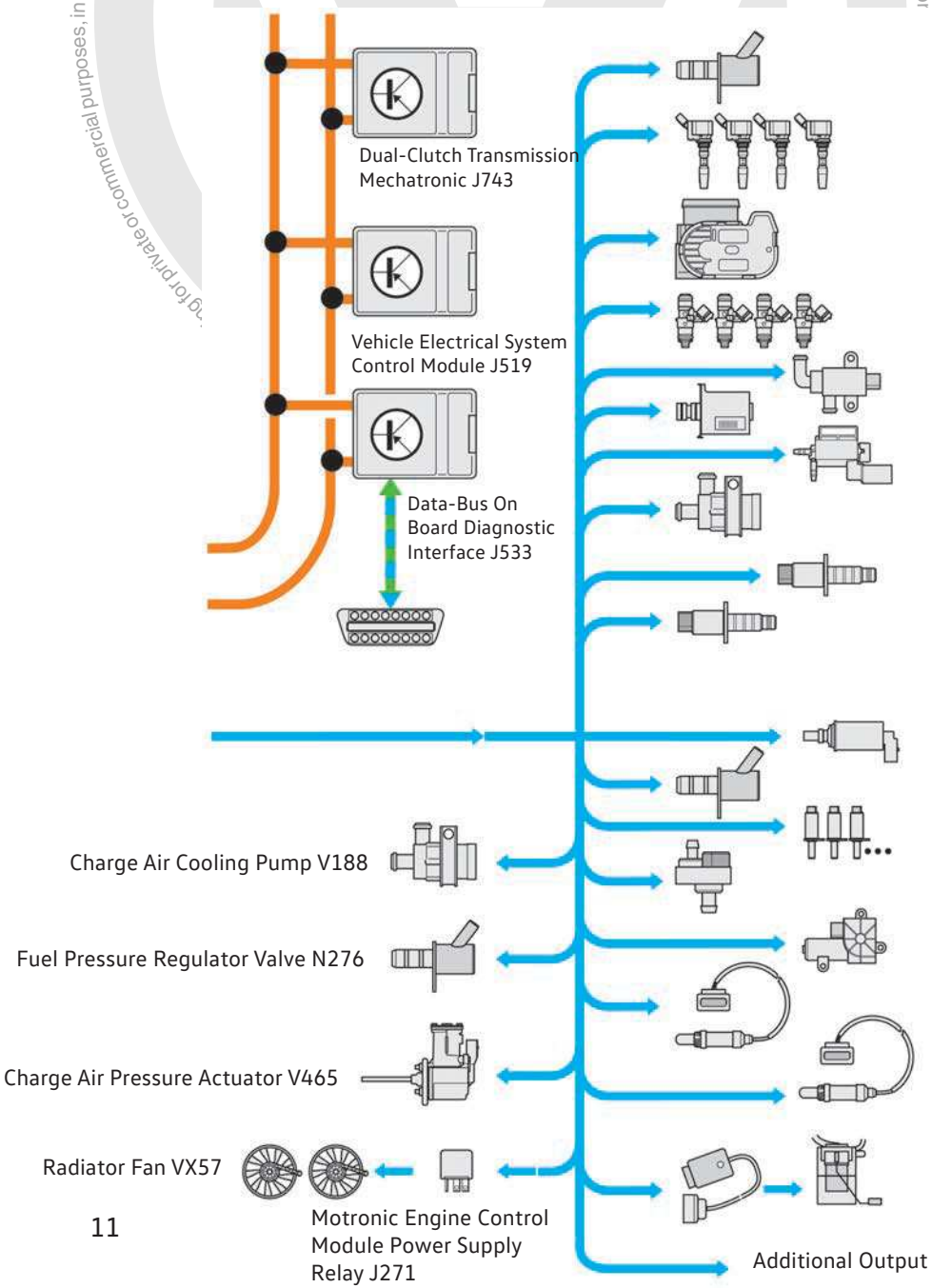
Engine Management System

System Overview

Sensors



Engine Management System



Actuators

Piston Cooling Nozzle Control Valve N522

Ignition Coil 1-4 with Power Output Stage
N70, N127, N291, N292

Throttle Valve Control Module GX3:
Throttle Valve Control Module J338
EPC Throttle Drive G186

Cylinder 1-4 Fuel Injector N30-33

Coolant Shut-off Valve N82

Turbocharger Recirculation Valve N249

Intake Manifold Runner Control Valve N316

Heater Support Pump V488

Camshaft Adjustment Valve 1 N205

Exhaust Camshaft Adjustment Valve 1 N318

Fuel Metering Valve N290

Oil Pressure Regulation Valve N428

Cylinder 1-8 Intake Cam Actuator A or B N577, N576, N584, N585, N592, N593, N600, N60

EVAP Canister Purge Regulator Valve 1 N80

Engine Temperature Control Actuator N493

Oxygen Sensor 1 before Catalytic Converter GX10:
Oxygen Sensor Heater Z19

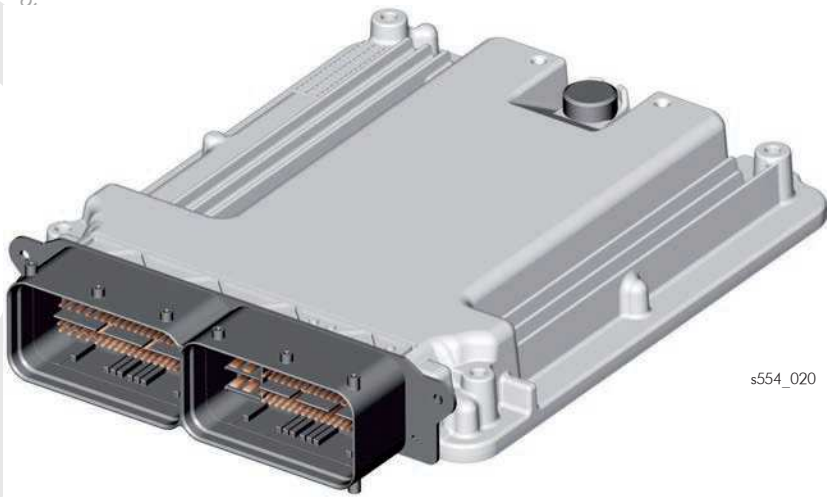
Oxygen Sensor 1 after Catalytic Converter GX7:
Heater for Oxygen Sensor 1 After Catalytic Converter Z29

Fuel Pump Control Module J538
Fuel Delivery Unit GX1:
Transfer Fuel Pump G6

Engine Control Module J623

The engine management system is a Bosch MG1. Bosch is the manufacturer of control module:

- M = Motor (engine)
- G = Gasoline
- 1 = 1st processor generation



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It uses a 32bit, 300MHz quad core processor. Two main processors are responsible for the actual computing work. Two additional processor cores monitor the computing steps of the main processors. These attributes make it possible to perform various operating modes without reaching the engine control module's performance limits.

Mass Airflow Sensor G70

This mass airflow sensor with backflow detection measures the air mass in the intake port. It is needed because, with the optimized Miller combustion process, the intake valve closes prematurely.

When this happens, the intake air flows back into the intake port from the closed intake valve. As this air mass flows back, it is measured by the backflow detection feature.

s554_034

The Principle of 4-stroke Combustion

The Otto 4-stroke Combustion Cycle

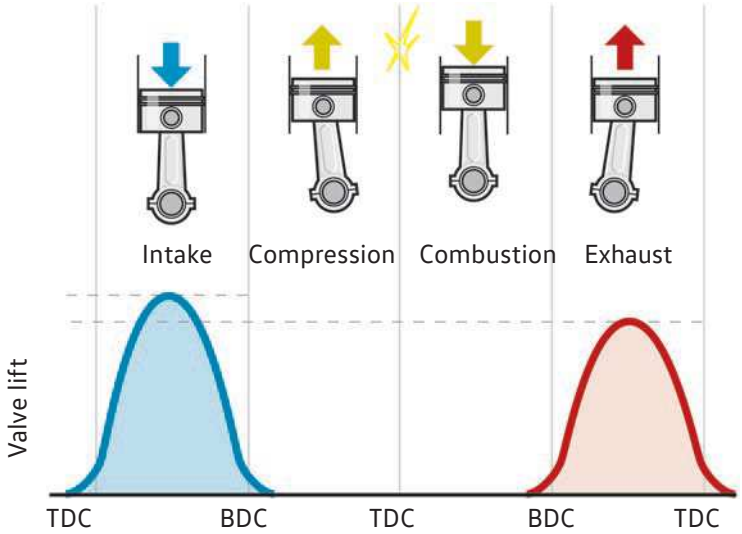
Many different approaches have been implemented to improve the performance of the Otto cycle engine over the years. The goal was always to get more power from the fuel-air mixture.

The Miller Combustion Process

Ralph Miller optimized the Otto combustion process and patented his design in 1947. It involves closing the intake valve before bottom dead center.

This results in an increased combustion chamber size. As the piston makes its downward stroke towards bottom dead center, the air is decompressed and cooled. As bottom dead center is passed, the air is compressed. This increases the efficiency of the fuel-air mixture.

Background



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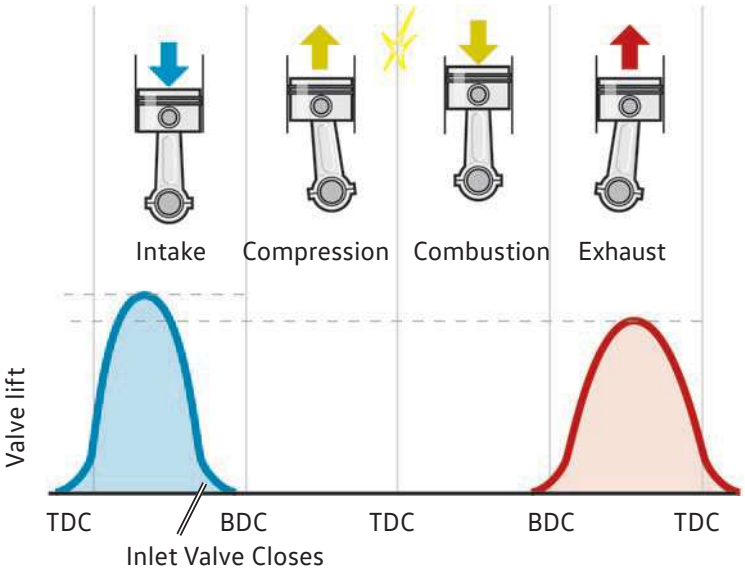

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Engine Management System

The Optimized Miller Combustion Process from Volkswagen

Thanks to the valvelift on the intake side of the engine, the 2.0L TSI engine has the capability to mimic an Otto Cycle or a Miller Cycle engine. Generally, it operates similar to an Otto Cycle during acceleration and high loads, and operates similar to a Miller Cycle for part throttle low-load conditions for economy and emissions.

The valvelift system on the intake camshaft makes it possible to switch between short and long valve lift durations, depending on the engine load. At idling speed and in the part load range, the valve lift and duration is shorter. When the engine is placed under greater load, the valve lift and duration is larger. Also, the intake and exhaust camshaft timing can be changed using variable valve timing.

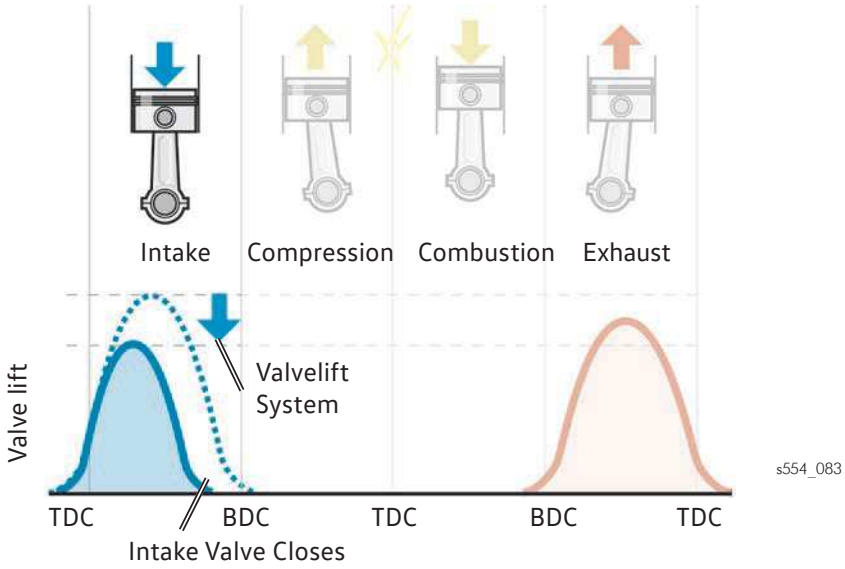
Short valve lift in the optimized combustion process

With the short valve lift, the intake valve closes (in conjunction with premature setting of the variable valve timing) before bottom dead center (BDC) is reached. The fresh mixture is decompressed as it approaches BDC and cooled in the process.

The shorter valve lift with its smaller cross section increases the speed of the air flow into the cylinder. This improves mixing of the fuel and air, and is supported by the geometrical shape of the combustion chamber.

This results in:

- a greater degree of efficiency in the fuel-air mixture
- lower fuel consumption
- fewer harmful emissions

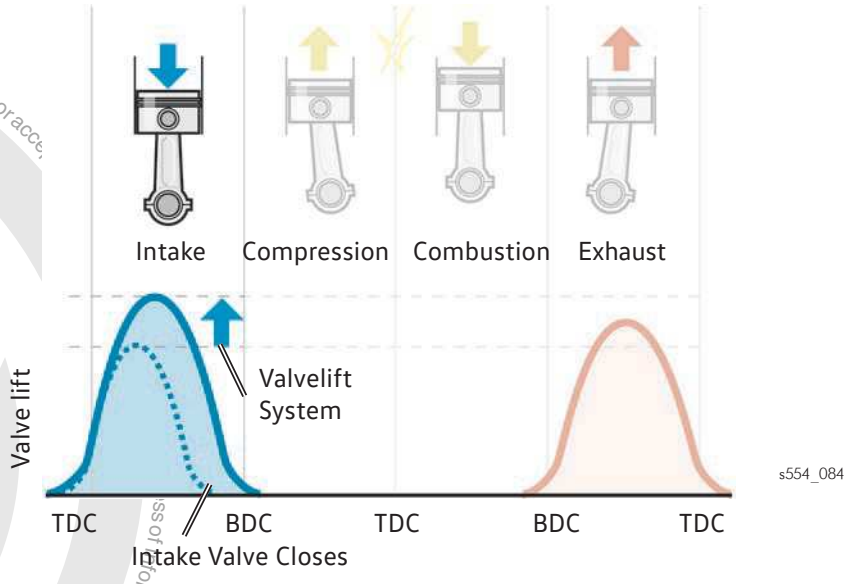


Engine Management System

Long Valve Lift in the Combustion Process

The engine switches to the long valve lift and duration process when a greater demand is required. In combination with a retarded setting of the variable valve timing, the intake valve closes after BDC.

This fills the combustion chamber more and provides maximum engine power.



Modes of Operation

Cold start

- The engine speed is increased, the valve timing adapted, ignition is set to "retarded" and up to three injection sequences are performed. This brings the catalytic converter up to operating temperature quickly.

Warm-up phase

- Up to a coolant temperature of 70°C, TSI injection occurs between one and three times.

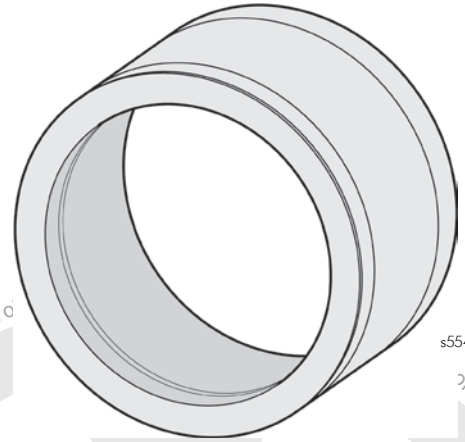
Warm start

- The intake camshaft is on the small cam profile and valve lift is small respectively.
- During the start phase, single or multiple injection takes place during the intake stroke and/or compression stroke depending on the engine temperature.

Engine running at operating temperature

- With the optimized Miller combustion process or full load depending on the load requirement.

T40347
Piston assembly tool



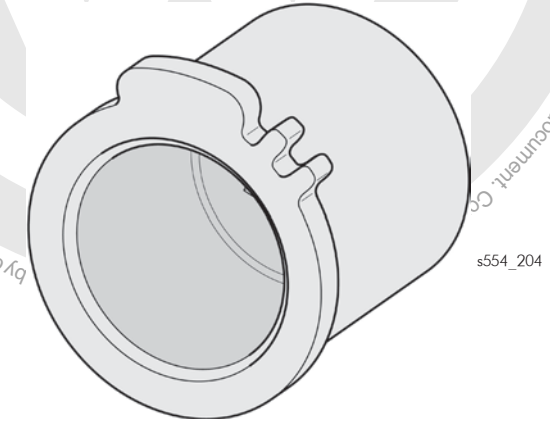
For installing the piston

Under no circumstances should a piston ring compressor be used. The oil scraper ring could be damaged beyond repair.

VAG1763/13
Screw-in adapter

For testing compression pressure

T10567



For turning the camshafts

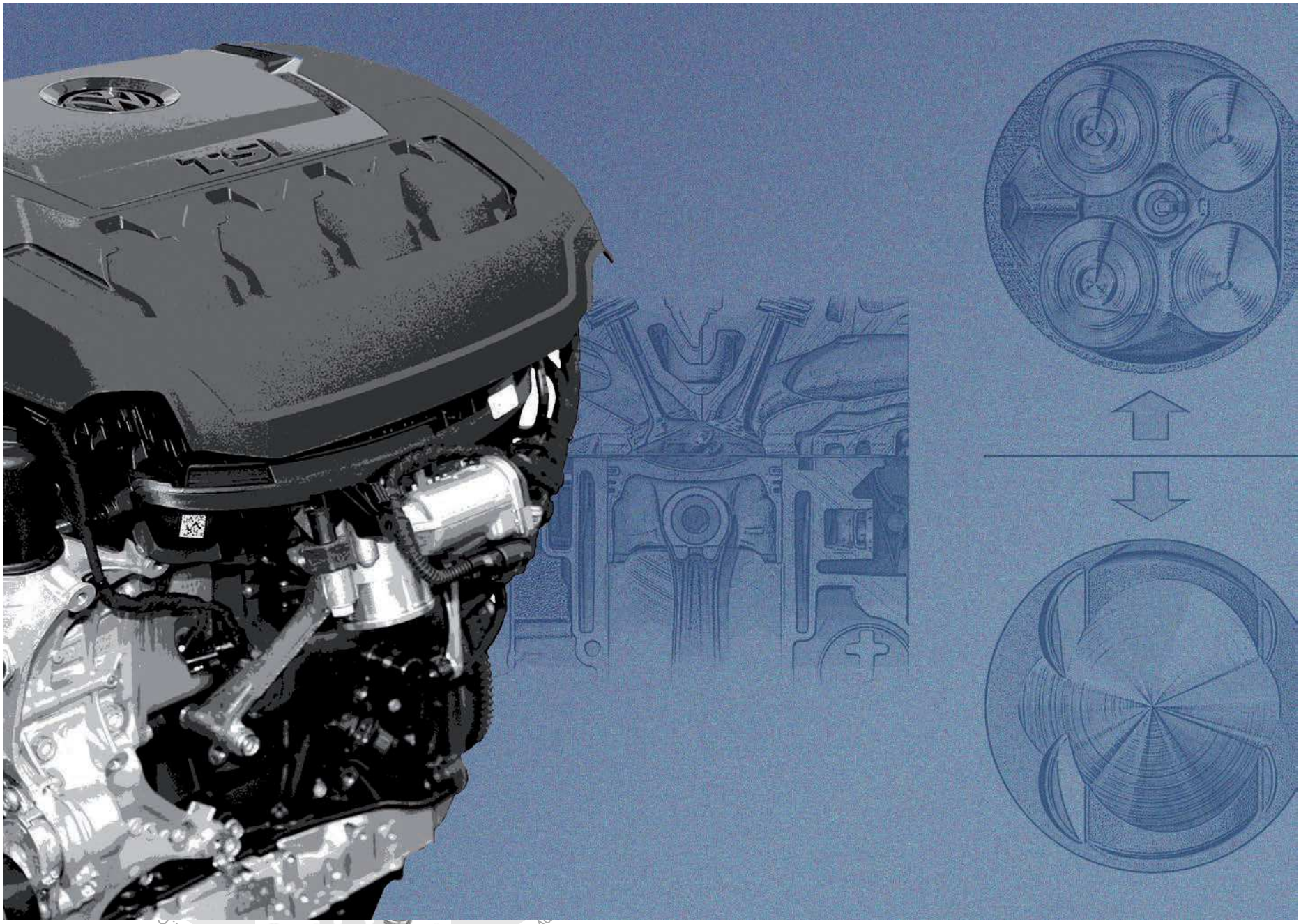
Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this Self-Study Program. The Knowledge Assessment may or may not be required for Certification.

You can find this Knowledge Assessment at: **www.vwwebsource.com**

For Assistance, please call: **Volkswagen Academy, Certification Program Headquarters 1-877-791-4838 (8:00 a.m. to 8:00 p.m. EST)**

Or, E-mail: **concierge@volkswagenacademy.com**



Volkswagen Group of America
2200 Ferdinand Porsche Drive
Herndon, VA 20171
June 2017

Cautions & Warnings

Please read these WARNINGS and CAUTIONS before proceeding with maintenance and repair work. You must answer that you have read and you understand these WARNINGS and CAUTIONS before you will be allowed to view this information.

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized Volkswagen retailer or other qualified shop. We especially urge you to consult an authorized Volkswagen retailer before beginning repairs on any vehicle that may still be covered wholly or in part by any of the extensive warranties issued by Volkswagen.

- Disconnect the battery negative terminal (ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Volkswagen is constantly improving its vehicles and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized Volkswagen retailer parts department for the latest information.

- Any time the battery has been disconnected on an automatic transmission vehicle, it will be necessary to reestablish Transmission Control Module (TCM) basic settings using the Volkswagen Factory Approved Scan Tool (ST).

- Never work under a lifted vehicle unless it is solidly supported on stands designed for the purpose. Do not support a vehicle on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a vehicle that is supported solely by a jack. Never work under the vehicle while the engine is running.

- For vehicles equipped with an anti-theft radio, be sure of the correct radio activation code before disconnecting the battery or removing the radio. If the wrong code is entered when the power is restored, the radio may lock up and become inoperable, even if the correct code is used in a later attempt.

- If you are going to work under a vehicle on the ground, make sure that the ground is level. Block the wheels to keep the vehicle from rolling. Disconnect the battery negative terminal (ground strap) to prevent others from starting the vehicle while you are under it

- Do not attempt to work on your vehicle if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medicine or any other substances that may impair you or keep you from being fully alert.

- Never run the engine unless the work area is well ventilated. Carbon monoxide (CO) kills.

- Always observe good workshop practices. Wear goggles when you operate machine tools or work with acid. Wear goggles, gloves and other protective clothing whenever the job requires working with harmful substances.

- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.

- Do not re-use any fasteners that are worn or deformed in normal use. Some fasteners are designed to be used only once and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual - replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.

next

Version 2.0

Cautions & Warnings

- Illuminate the work area adequately but safely. Use a portable safety light for working inside or under the vehicle. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

- Friction materials such as brake pads and clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing asbestos fibers and asbestos dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

- Finger rings should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.

- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly; do not attempt shortcuts. Use tools that are appropriate to the work and use only replacement parts meeting Volkswagen specifications. Makeshift tools, parts and procedures will not make good repairs.

- Catch draining fuel, oil or brake fluid in suitable containers. Do not use empty food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.

- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque listed.

- Keep sparks, lighted matches, and open flame away from the top of the battery. If escaping hydrogen gas is ignited, it will ignite gas trapped in the cells and cause the battery to explode.

- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond, or lake. Consult local ordinances that govern the disposal of wastes.

- The air-conditioning (A/C) system is filled with a chemical refrigerant that is hazardous. The A/C system should be serviced only by trained automotive service technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.

- Before doing any electrical welding on vehicles equipped with anti-lock brakes (ABS), disconnect the battery negative terminal (ground strap) and the ABS control module connector.

- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.

- When boost-charging the battery, first remove the fuses for the Engine Control Module (ECM), the Transmission Control Module (TCM), the ABS control module, and the trip computer. In cases where one or more of these components is not separately fused, disconnect the control module connector(s).

- Some of the vehicles covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys an airbag in the event of a frontal impact. The airbag is operated by an explosive device. Handled improperly or without adequate safeguards, it can be accidentally activated and cause serious personal injury. To guard against personal injury or airbag system failure, only trained Volkswagen Service technicians should test, disassemble or service the airbag system.

back next

Version 2.0

Cautions & Warnings

- Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.

- Never use a test light to conduct electrical tests of the airbag system. The system must only be tested by trained Volkswagen Service technicians using the Volkswagen Factory Approved Scan Tool (ST) or an approved equivalent. The airbag unit must never be electrically tested while it is not installed in the vehicle.

- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.

- When driving or riding in an airbag-equipped vehicle, never hold test equipment in your hands or lap while the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.

I have read and I understand these Cautions and Warnings.

back OK

Version 2.0