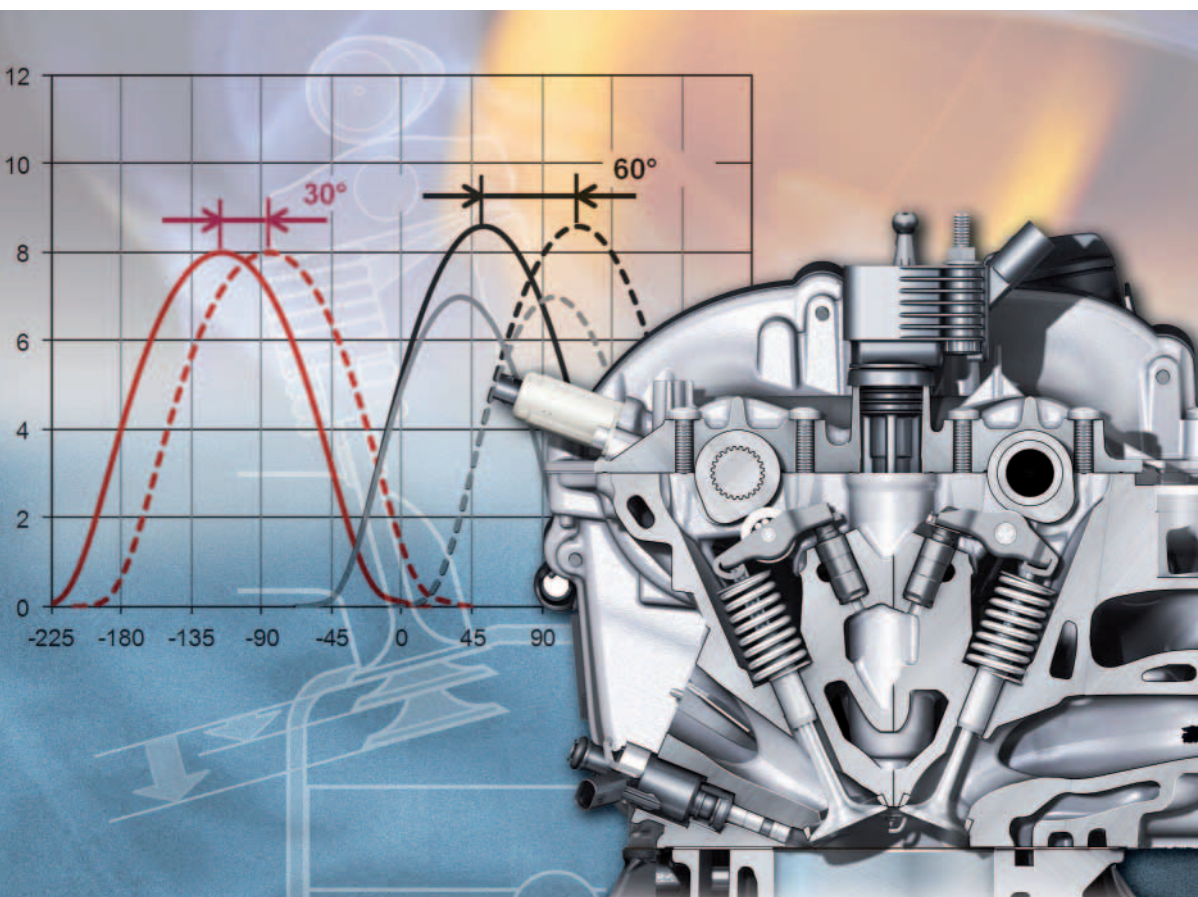




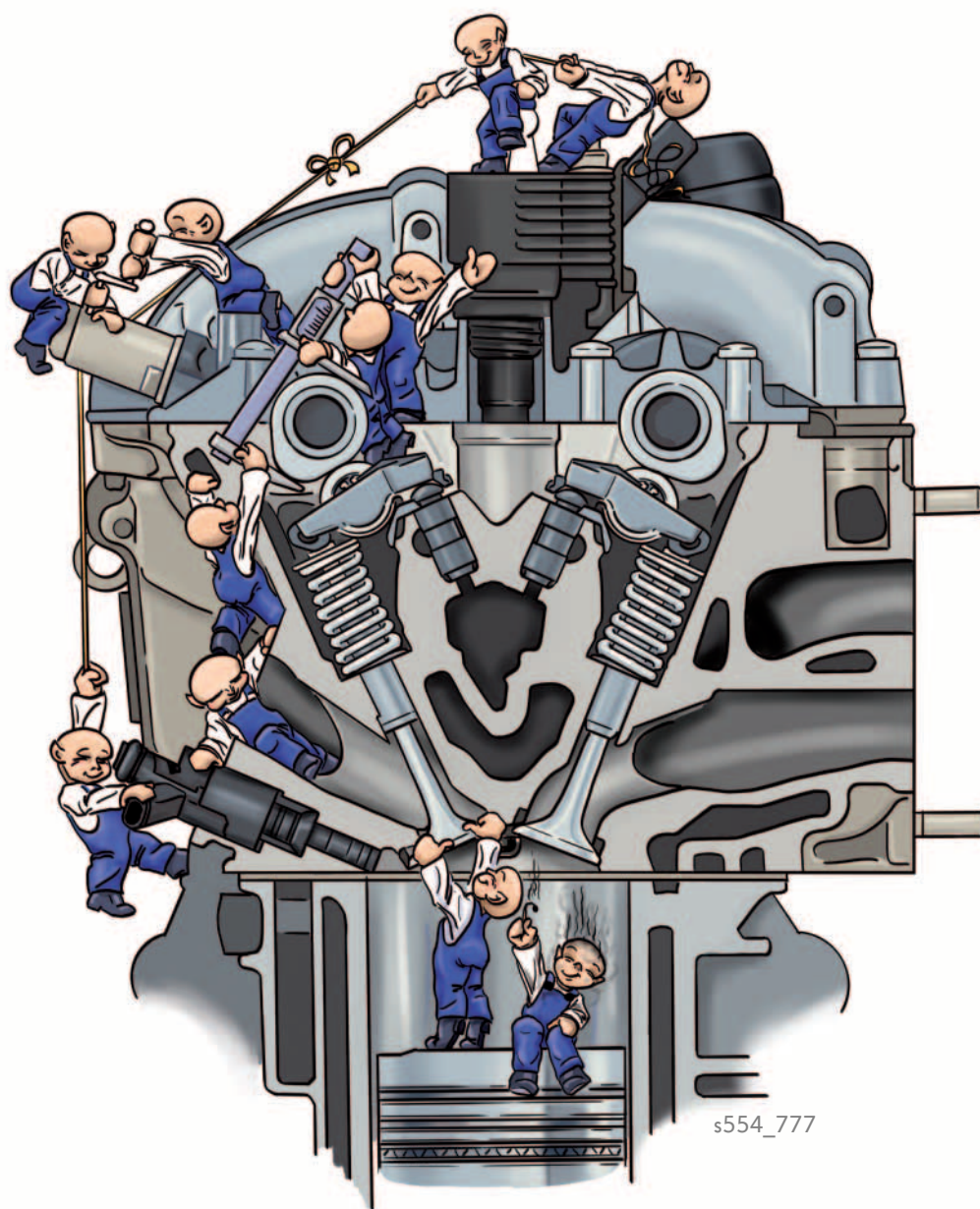
Self-study Programme 554

The 2.0 l 132 kW TSI engine

Design and function



The 2.0 l 132kW TSI engine from Volkswagen is from the EA888 series.
During development, the emphasis was on reducing consumption and CO₂ as well as particulate emissions.



For more information about engines of the EA888 series, see Self-study Programme 522
“The 2.0 l 162kW/169kW TSI engine”.

**The Self-study Programme shows the design and function of new developments.
The contents will not be updated.**

For current testing, adjustment and repair instructions, refer to the relevant service literature.



**Important
note**

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Introduction

Development of the 2.0 I 132kW TSI engine

Following on from the trend in recent years towards the development of smaller engines (downsizing), the next step now is towards further optimisation of the engines. This means that during the development of an engine, special attention is placed on harmonising the displacement, performance, torque and fuel consumption as well as the operating conditions in an optimal manner.

The customer drives their vehicle mainly in the part load range. Thus, the engine has been especially improved in this load range. This results in the consumption benefits of a smaller power unit.

At higher loads, the benefits of a higher displacement unit are taken advantage of. An optimal ratio between efficiency and performance throughout the whole engine speed range is thereby achieved.



s554_095



Please bear in mind that there are quite a few new special tools for this engine.

Technical features

Engine mechanics

The mechanics of the engine are largely identical to those of the 2.0 l 162 kW TSI engine from the Volkswagen programme. The following components and assemblies have been modified due to the optimised combustion process:

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

Engine management system

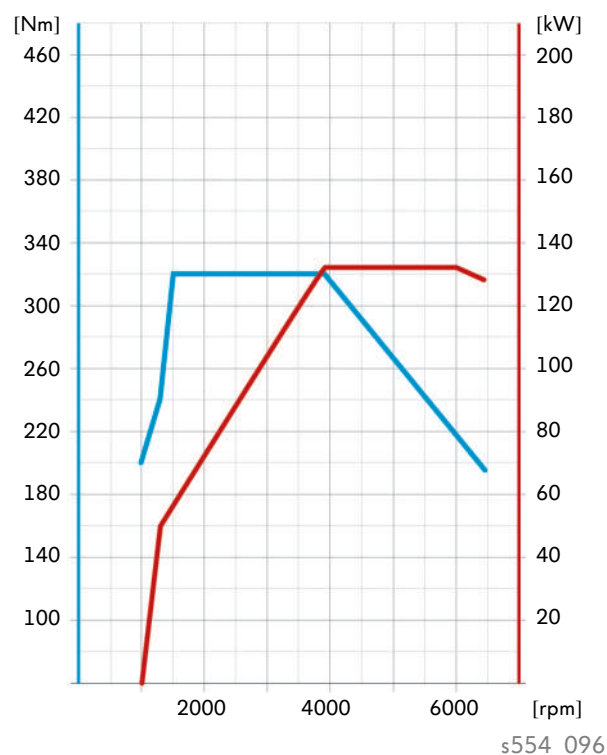
The engine management system has the following characteristics:

- Valvelift system on the intake side
- Injection pressure increased to 250bar
- Air mass meter G70 between turbocharger and air filter housing
- Engine control unit with quad core processor
- Intake camshaft and exhaust camshaft adjustment
- Dual injection system with TSI and SRE injectors (combined direct injection and intake manifold injection)
- Innovative thermal management with rotary valve regulation (actuator for engine temperature regulation N493)
- On-demand piston cooling jets
- Intake manifold flaps

Technical data

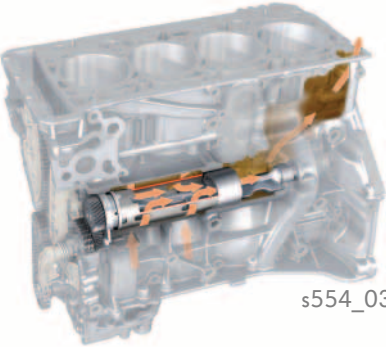
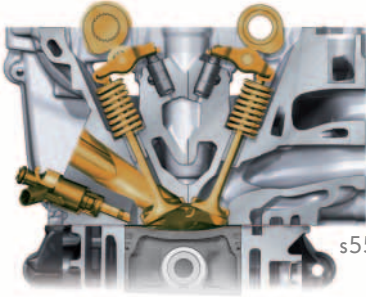
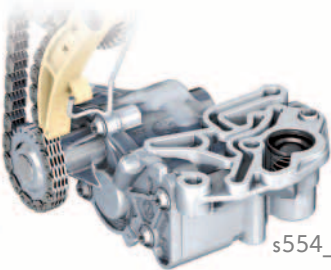
Engine code	CZPA
Type	4-cylinder in-line engine
Displacement	1984 cm ³
Bore	82.5 mm
Stroke	92.8 mm
Valves per cylinder	4
Compression ratio	11.6 : 1
Maximum output	132 kW at 3940 to 6000 rpm
Maximum torque	320 Nm at 1500 to 3940 rpm
Engine management system	Bosch MG1
Fuel	RON 95
Exhaust gas treatment	Three-way catalytic converter, a broadband lambda probe upstream of the turbocharger and a step-type lambda probe downstream of the catalytic converter
Emission standard	EU6

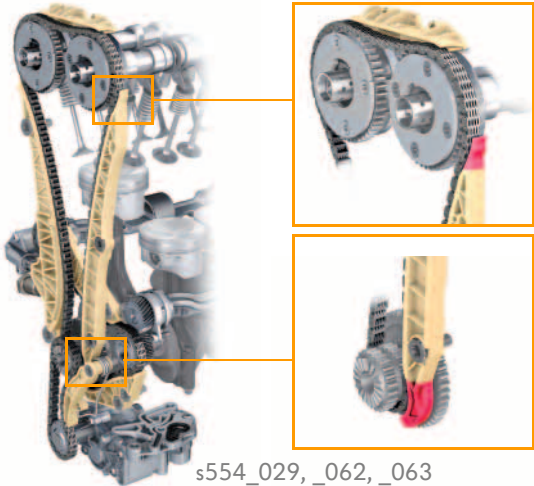
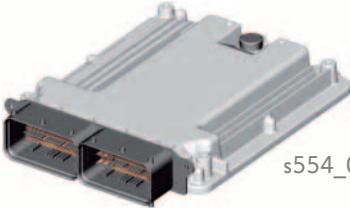
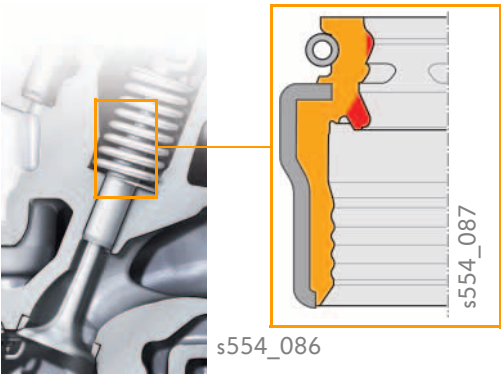
Torque and power diagram



The technical changes

The following is an overview of the main changes to the 2.0 l 132 kW TSI engine.

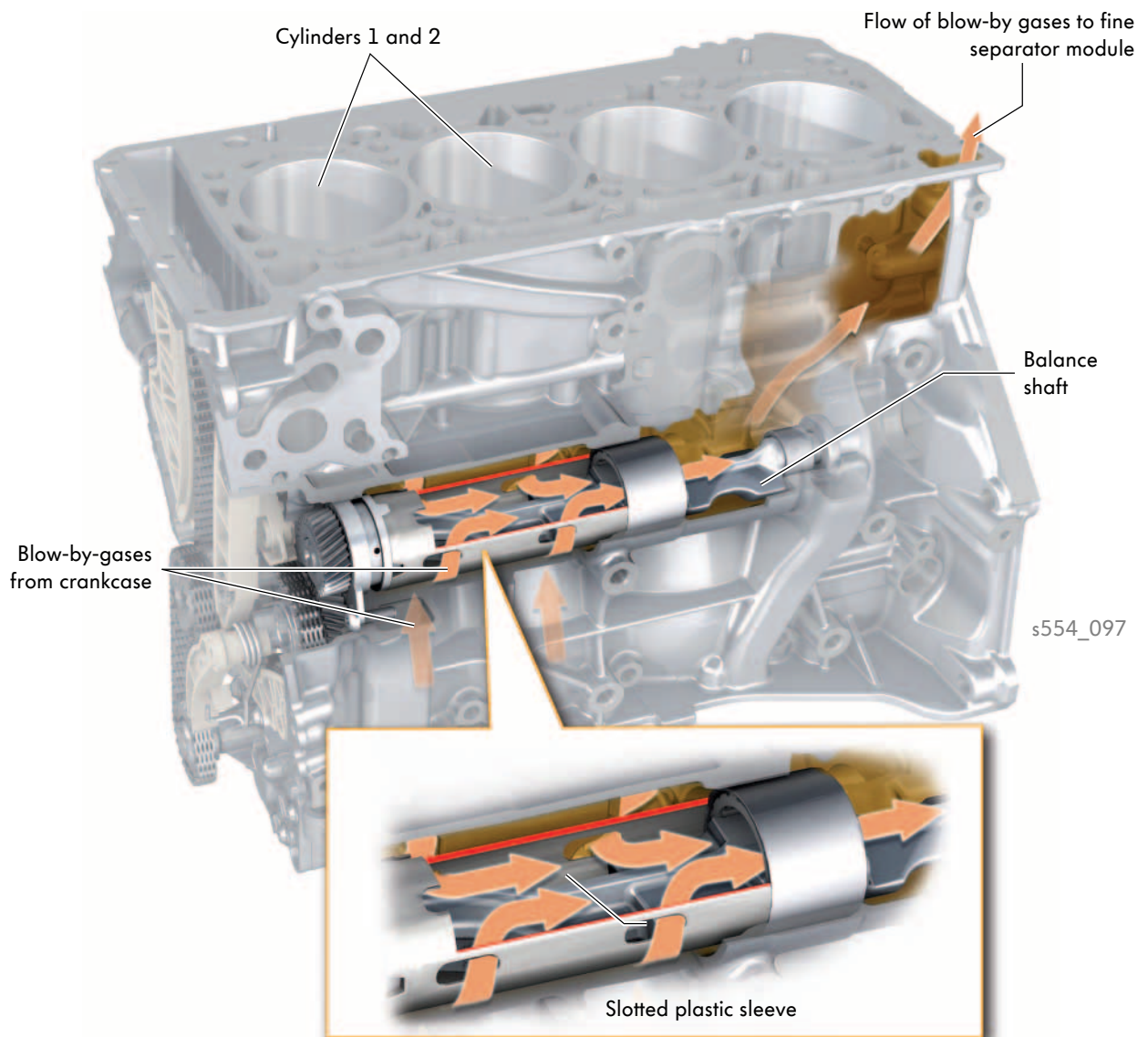
Component	Change
Cylinder block  s554_032	- Blow-by gases passed via balance shaft on inlet side through slotted plastic sleeve. - More precision required for installation of piston cooling nozzles on account of changes to crankcase breather system (see workshop manual).
Cylinder head  s554_024	- Valvelift system on intake side. - Inlet 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 installation of piston.
Oil pump  s554_085	- Oil pump drive gear with 22 teeth instead of 24 teeth for higher ratio. - Faster build-up of oil pressure.

Component	Change
Chain drive  s554_029, _062, _063	- Longer guide rail to prevent timing chain slipping. - Crankshaft sprocket comprises three chain sprockets: • Oil pump drive • Balancer shaft drive • Camshaft drive - Camshaft chain sprocket is designed to be off centre to reduce chain forces on timing chain.
Fuel system  s554_021	- Increase of injection pressure to 250bar, resulting in finer atomisation of fuel in combustion chamber.
Engine management system  s554_020	- Bosch MG1 with four core processors.
Valve stem oil seal  s554_086 s554_087	- Valve stem oil seals of exhaust valves have a double lip for better sealing.

Crankcase ventilation

Changes to the crankcase breather system were necessary owing to the valvelift system on the inlet side. The blow-by gases exit the crankcase in the area of cylinders 1 and 2 and make their way via the balance shaft on the inlet side to the fine separator module in the cylinder head. The balance shaft features a slotted plastic sleeve for this purpose to allow the blow-by gases to flow through.

A large amount of the oil from the blow-by gases is separated (centrifugal effect) through rotation of the balance shaft and flows back into the oil sump. In this way, the balance shaft is responsible for the function of the coarse oil separator.

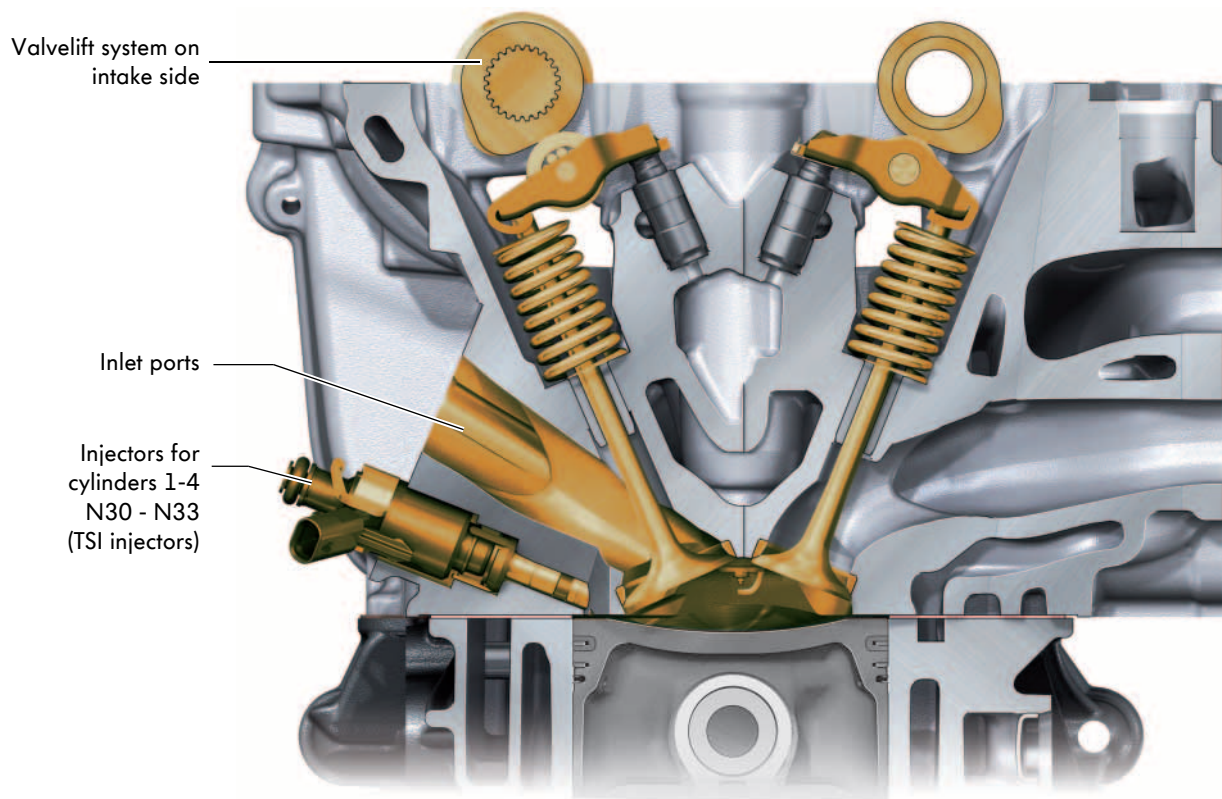


Cylinder head

Changes to the cylinder head were necessary to facilitate an optimised combustion process. Smooth running was subsequently improved as too, was the reduction in knock.

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 9 mm
 - modified piston crown
- Injectors located closer to combustion chambers
- Inlet ports designed to be straighter in order to optimise the inlet air flow
- Valve stem oil seal of exhaust valves with double lip

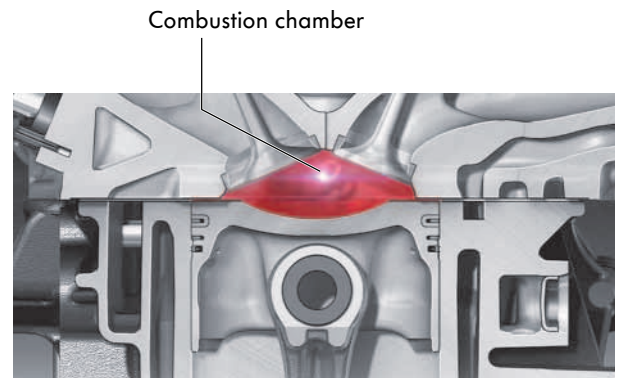


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The combustion chamber design

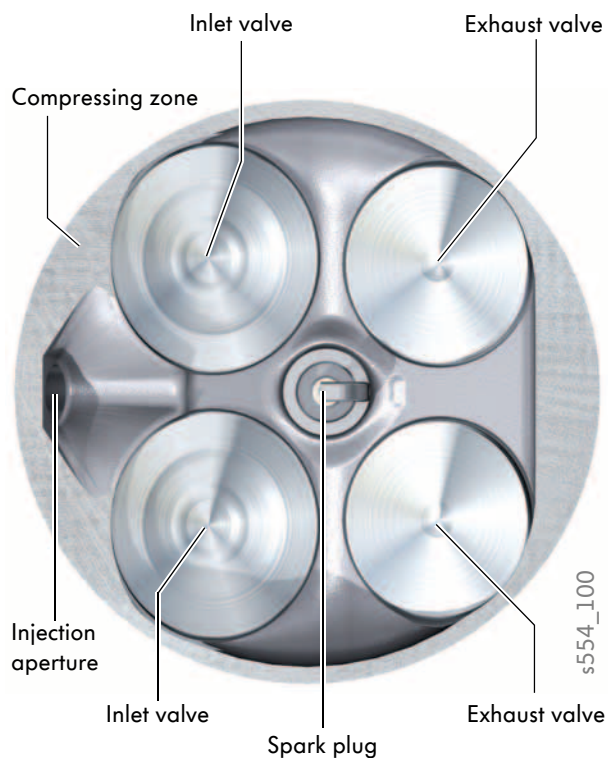
The combustion chamber is formed by the shape of the combustion chamber depression in the cylinder head and the gas flow recess in the piston crown. The combustion chamber depression has a larger compression zone, which necessitates the use of smaller inlet valves.

The larger compressing zone facilitates better mixing of the fuel and air in the cylinder. To coincide with this, the valve pockets and the gas flow recess have been optimised on the piston crown.

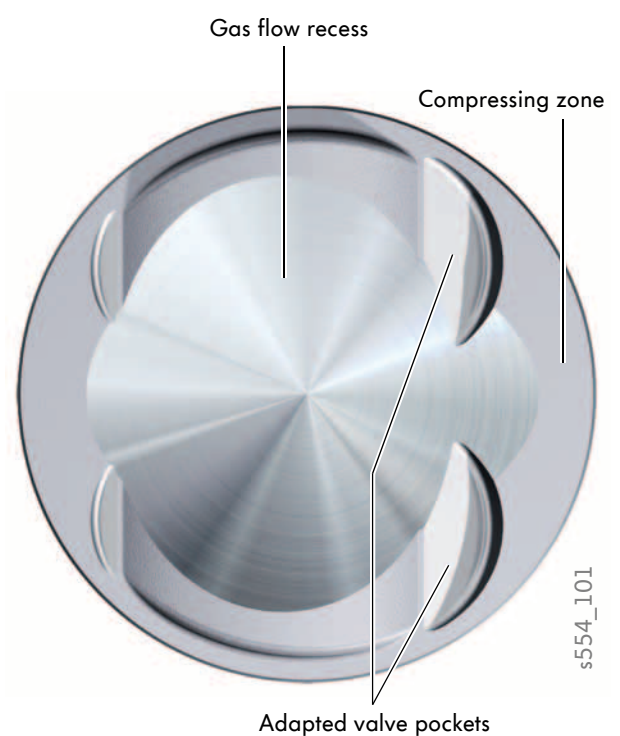


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Combustion chamber depression in cylinder head

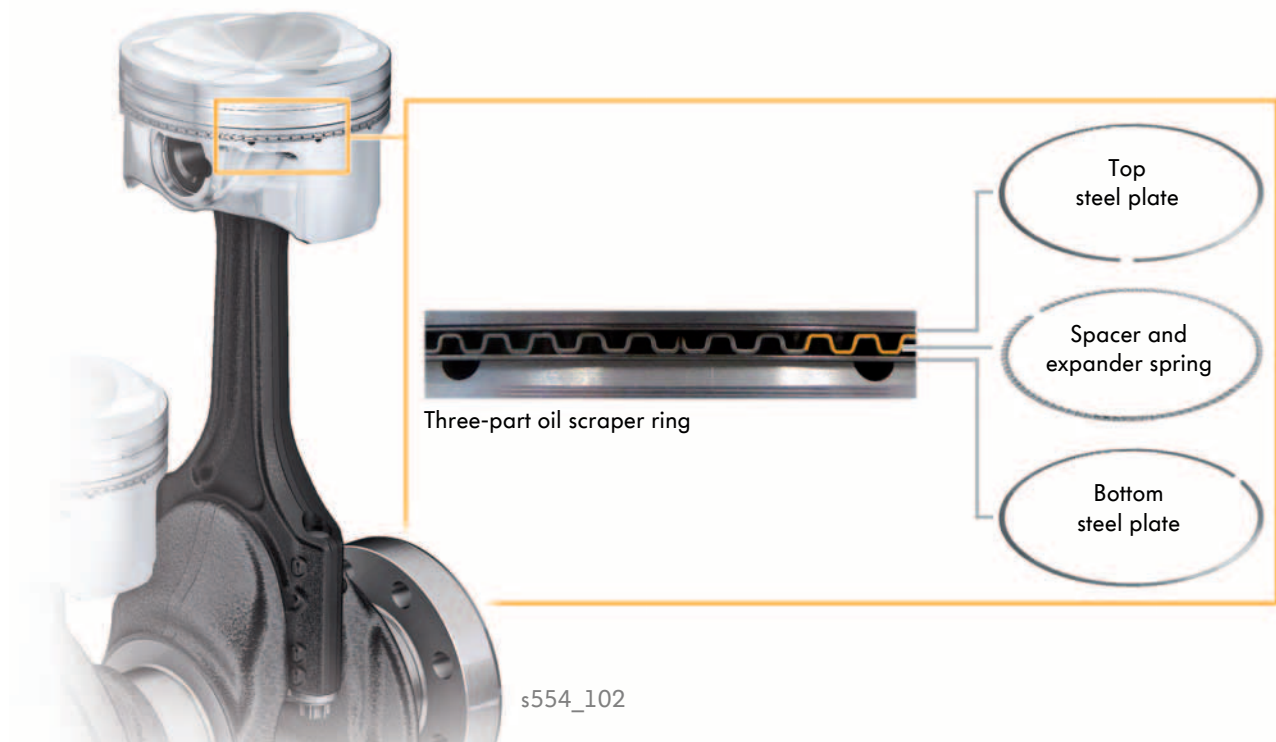


Combustion chamber design in piston crown



The three-part oil scraper ring

Every piston has a three-part oil scraper ring. It consists of 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 that are supplied with the rings pre-installed.

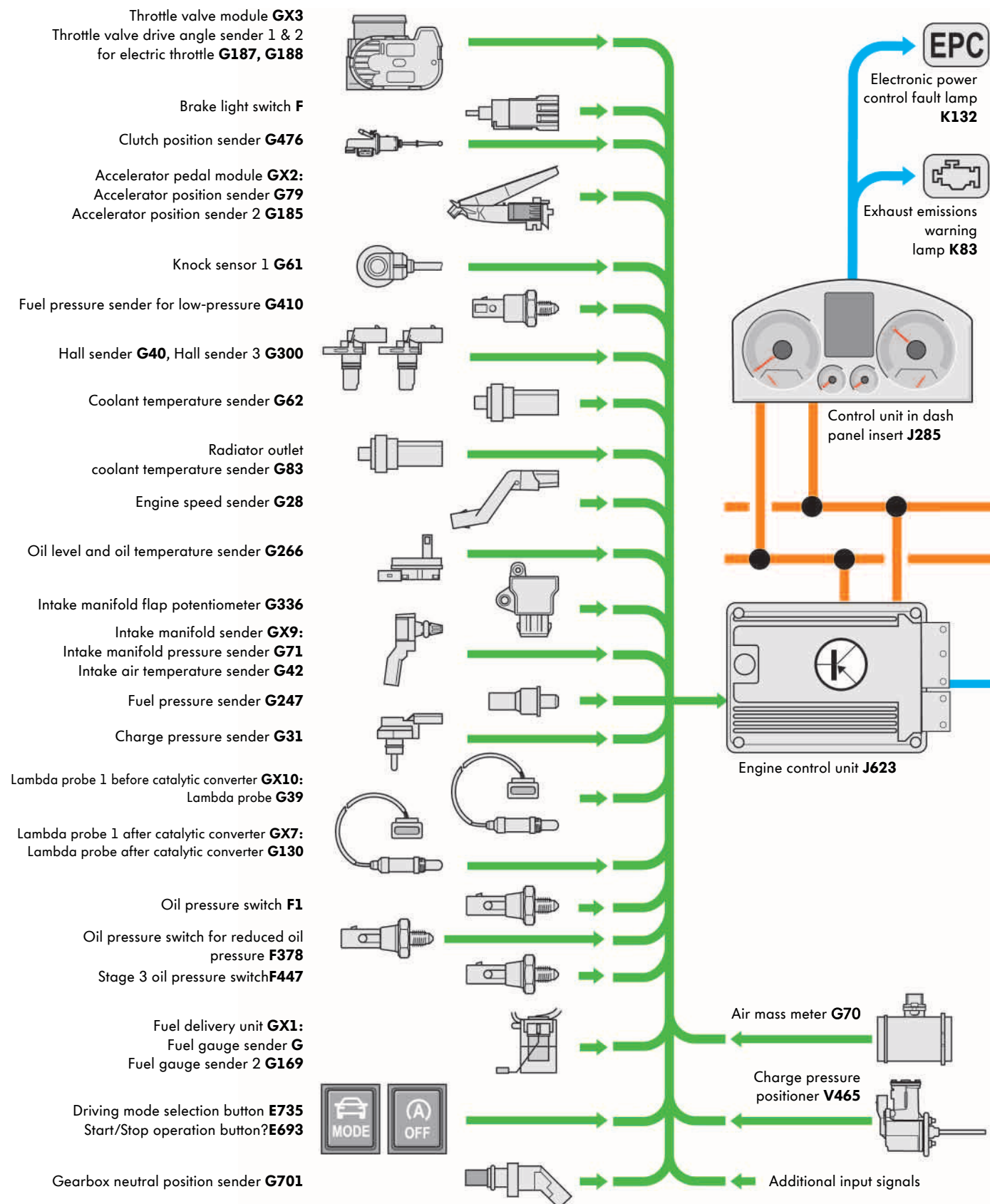
There is a risk that the ends of the springs could have shifted above each other.

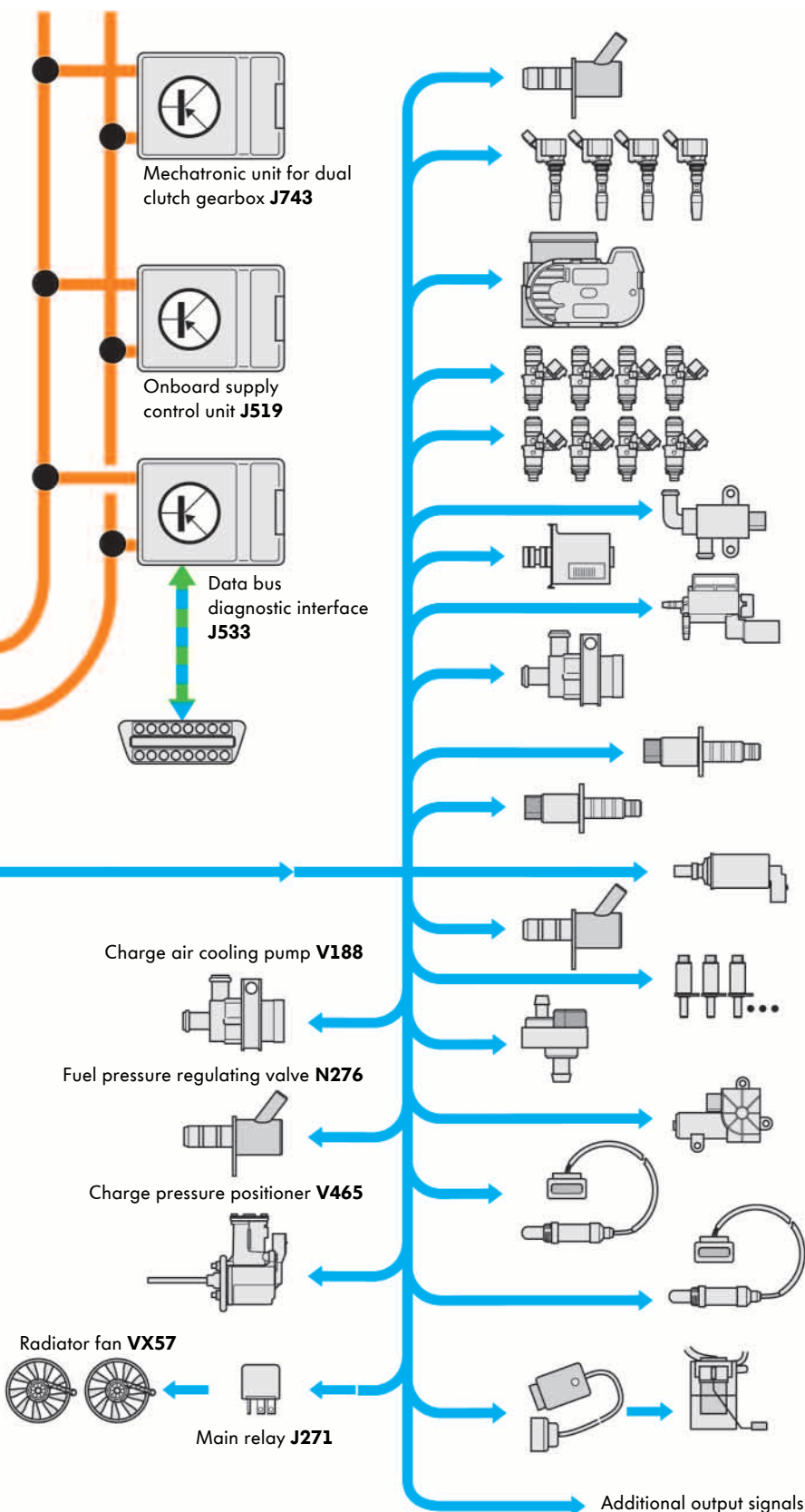
Both ends of the expander spring therefore have a coloured marking so that the exact position can be better determined. The expander spring must not overlap as otherwise the oil scraper ring will not work. The ends of the three-part oil scraper ring must be rotated by 120° during installation.

Engine management system

System overview

Sensors





s554_077

Actuators

Engine management system

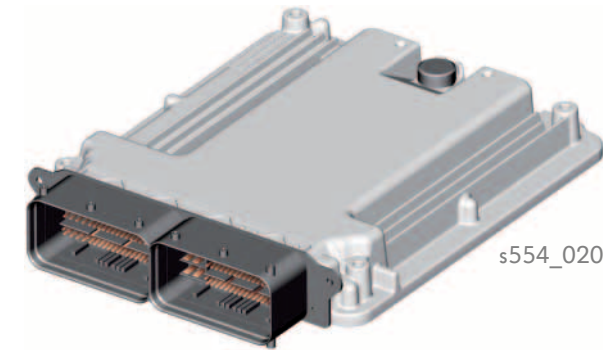
Engine control unit J623

The engine management system has the designation "Bosch MG1". **Bosch:** Manufacturer of control unit
M: Motor (engine), **G:** Gasoline, **1:** 1st processor generation

A 32bit, 300MHz quad core processor is used in the engine control unit.

Two main processors are responsible for the actual computing work. Two additional processor cores monitor the computing steps of the main processors. In this way, the control unit has impressive computing performance and flexibility.

These attributes make it possible to perform various operating modes without reaching the engine control unit's performance limits.



The air mass meter G70

This air mass meter with backflow detection measures the air mass in the intake port.

It is needed because, with the optimised Miller combustion process, the inlet valve closes prematurely.

Here, the intake air flows back into the intake port from the closed inlet valve.

As this air mass flows back, it is measured by the backflow detection feature.

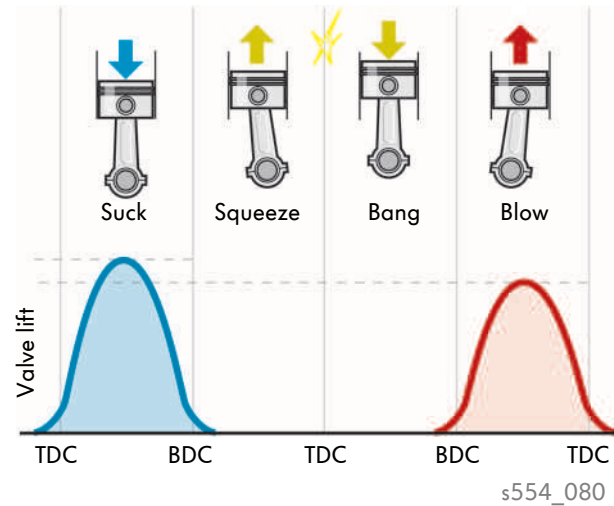


The principle of 4-stroke combustion

Background

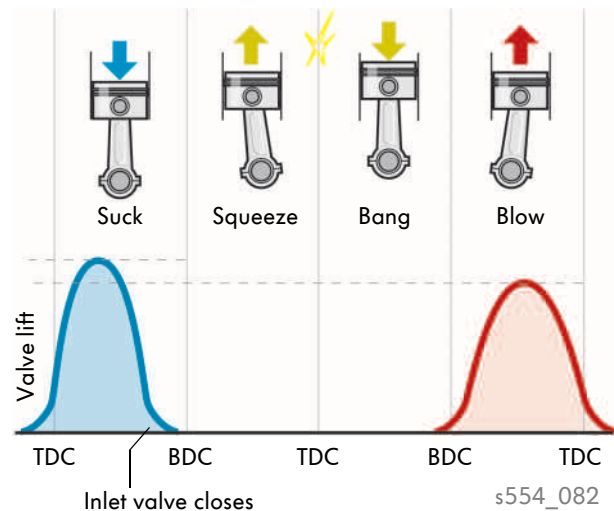
Principle of 4-stroke combustion according to Otto

To improve the efficiency of petrol engines compared with the original 4-stroke combustion process developed by Nicolaus August Otto, various approaches have been adopted in the past. Essentially, achieving more power from the fuel-air mixture was always the aim.



Combustion process according to Miller

Ralph Miller optimised the combustion process from Otto and had his design patented in 1947. It involves closing of the inlet valve before bottom dead centre is reached. This results in an increased combustion chamber size. As the piston makes its downward stroke towards bottom dead centre, the air is decompressed and cooled. As bottom dead centre is passed, the air is compressed. In this way, the degree of efficiency of the fuel-air mixture is increased.



Engine management system

The optimised Miller combustion process from Volkswagen

In the part load range of the 2.0 I TSI engine with the optimised Miller combustion process, the engine is optimised in terms of consumption and exhaust emissions.

The valvelift system on the inlet camshaft makes it possible to switch between short and long valve lift, depending on the engine load. At idling speed and in the part load range, the valve lift is shorter. When the engine is placed under greater load, a switch to the large valve lift is made. Furthermore, the inlet and exhaust time can be changed through variable valve timing.

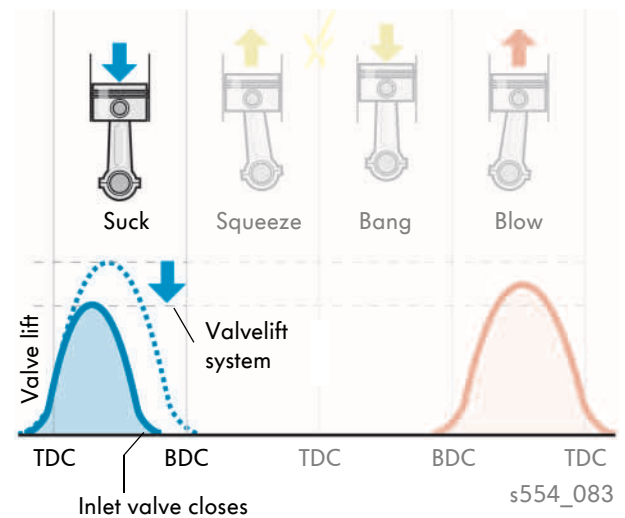
Short valve lift in the optimised combustion process

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

Another effect of the shorter valve lift is that the cross section of the inlet opening is reduced, the effect of which is faster air flow. This improves mixing of the fuel and air. And this is supported by the geometrical shape of the combustion chamber.

In summary, this results in:

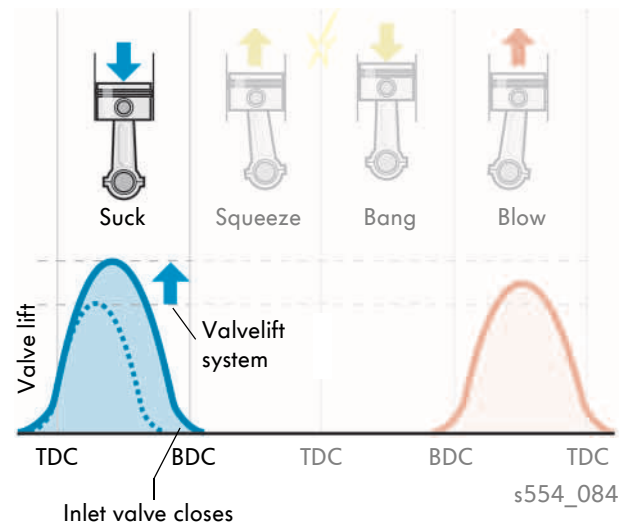
- a greater degree of efficiency in the fuel-air mixture
- lower fuel consumption
- fewer harmful emissions



Long valve lift in the petrol combustion process

When the engine is placed under greater load, a switch to the long valve lift is made. Together with a retarded setting of the variable valve timing, the inlet valve closes after BDC.

In this way, the combustion chamber is filled to a greater degree and the whole of the engine's power is available.



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. In this way, the catalytic converter is brought up to operating temperature more quickly.

Warm-up phase

- Up to a coolant temperature of 70°C, TSI injection occurs between one and three times. The system switches to MPI injection depending on the speed, load and temperature.

Warm start

- The inlet 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 optimised Miller combustion process or full load depending on the load requirement.

Engine management system

Engine running in optimised Miller combustion process

- The new combustion process is active at idling speed and in the part load range, the result of which is a greater degree of efficiency thanks to the interplay of various factors.
- The inlet camshaft is on the small cam profile (small valve lift).
- Up to an engine speed of 2700rpm, injection takes place via the MPI injectors in the low and part load range.
- The intake manifold flaps are adjusted according to the load and speed.
- The throttle valve is opened as far as possible.

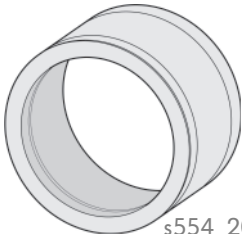
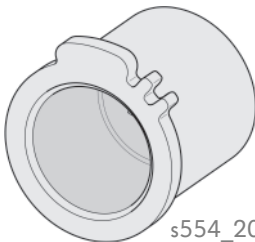
Engine running in full load range

- Valve lift switch to large inlet cam profile and thereby to the large valve lift. An inlet phase with a crankshaft angle of 170° is achieved here.
- The intake manifold flaps are opened in the full load range.
- Fuel injection takes place with map-control by means of TSI injection.
- Up to three injection sequences can be made depending on requirement.
The injection quantity and also the commencement of injection can be varied here.

Using driving mode selection to influence engine operation

- If the vehicle is equipped with driving mode selection, the engine torque is adapted in the various driving modes.

Special tools

Name	Tool	Use
T40347 Piston assembly tool	 s554_202	For installing the piston Under no circumstances should a piston ring compressor be used as the oil scraper ring could be damaged beyond repair.
VAG1763/13 Screw-in adapter	 s554_203	For testing compression pressure
T10567	 s554_204	For turning the camshafts

Test your knowledge

Which answers are correct?

One or several of the given answers may be correct.

1. What are the special features of the new 2.0 I 132 kW TSI engine?

- ☐ a) The injection pressure has been increased to 350bar.
- ☐ b) Engine control unit with 8 core processors.
- ☐ c) Blow-by gases flow through balance shaft.
- ☐ d) Extended guide rail on chain drive to prevent chain from slipping.

2. How is the valvelift system configured on this engine?

- ☐ a) Valvelift system on inlet side.
- ☐ b) Valvelift system on exhaust side.
- ☐ c) Valvelift system on inlet and exhaust side.

3. What should be noted when installing the three-part oil scraper ring?

- ☐ a) The openings of the rings must be above each other.
- ☐ b) All openings must have an offset of 120°.
- ☐ c) The coloured marking on the spacer and expander springs must be aligned.
- ☐ d) The spacer and expander springs must not overlap.

4. With the optimised Miller combustion process from Volkswagen ...

- ☐ a) The working stroke is shortened with the aid of the valvelift system.
- ☐ b) A shorter valve lift results in a shorter inlet time with the aid of the valvelift system.
- ☐ b) A shorter valve lift results in a shorter exhaust time with the aid of the valvelift system.

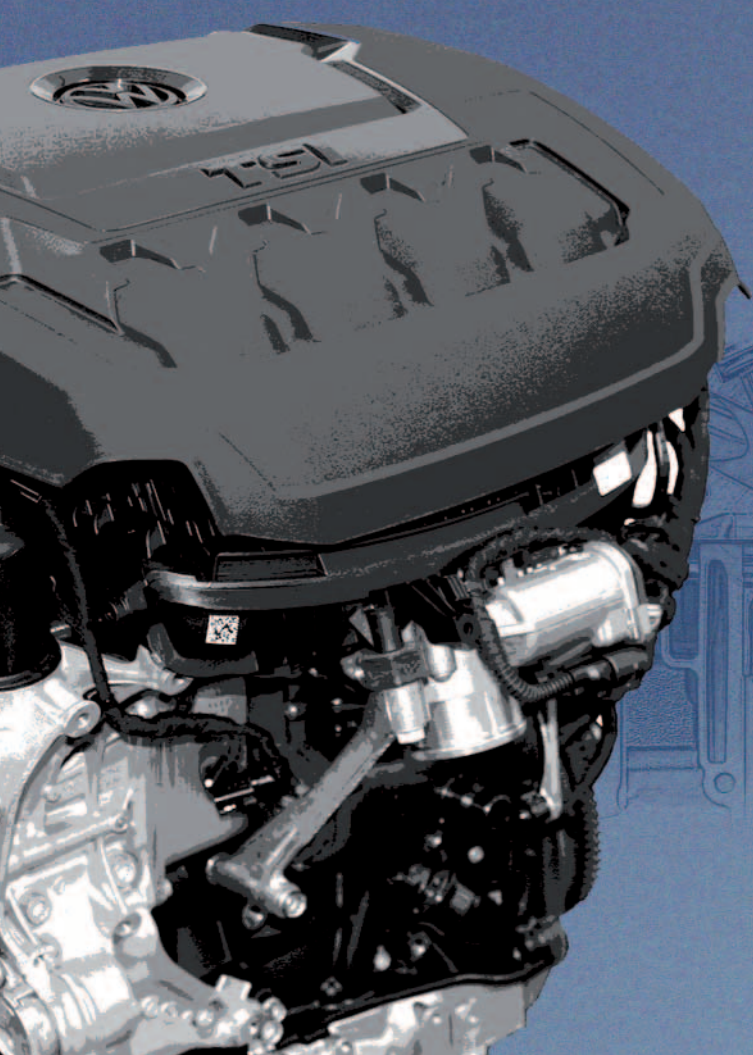
Answers:
1. c), d); 2. a); 3. b), d); 4. b);

Notes

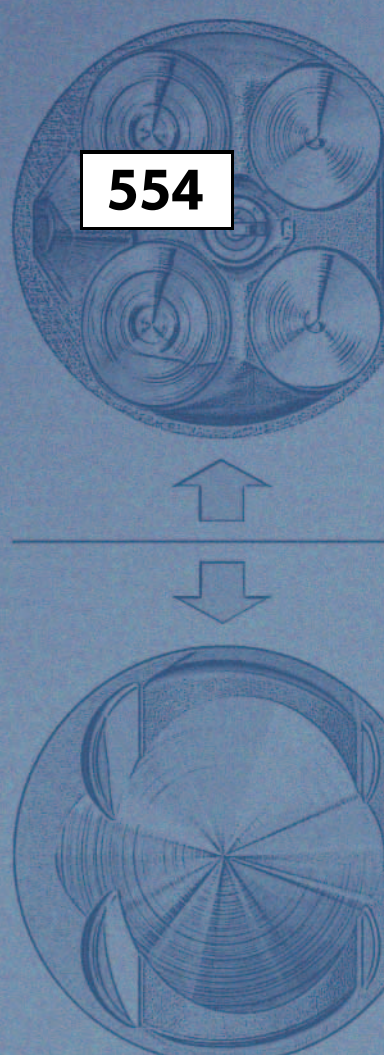
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