Spark Plugs

Spark Plugs – Product Training
The Otto Engine
The first 4 stroke engine by Nicolaus August Otto, in May 1878

- A major stepping stone in the development of the modern engine
- Utilized a low voltage battery powered ignition that was unreliable and could only allow the engine to function at slow speeds
First High Tension Magneto Ignition Apparatus and Spark Plug 1902

- Robert Bosch addressed the unreliability of the contemporary engine of the time with the High Tension Magneto.

- Spark plugs in production at the time could not keep up with the power of the Bosch Magneto.

- The solution? Create a better spark plug in house.
100+ Years Experience

Since 1902 Bosch has developed over 20,000 different spark plugs
Spark Plugs – Product Training

2013 – 111 years in the SP Business
Regardless of the type of combustion engine, a spark plug is always required.
Spark Plug Type Designation

Type of seat and thread

- Shielded, water-tight, for shielded HT-leads Ø 7mm
- Shielded, water-tight, for shielded HT-leads Ø 5mm <20.8>
- Surface-gap spark plug without ground electrode
- Surface-gap spark plug with ground electrode
- Half-thread
- For small engines

Version

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Heat range code number

- 13
- 12
- 11
- 10
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 09
- 08
- 07
- 06

Thread length

Spark position

*the thread length of spark plugs with seat type D and spark position A or B is 10,9 mm
Heat Range

Operating Temperatures

- Auto ignition
- Safety Area
- Operating Temperature
- Self Cleaning Temperature

Insulator Temperature vs. Engine power output

ColdStart

Operating Temperatures:
- 0°C: Engine start
- 500°C: Self cleaning temperature
- 850°C: Safety area
- 1000°C: Auto ignition

Spark Plug Types:
1. Hot spark plug
2. Medium heat range
3. Cold spark plug
Heat Range
Spark plug market trends

<table>
<thead>
<tr>
<th>Old technology</th>
<th>New technologies</th>
</tr>
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<tbody>
<tr>
<td>W 7 DC</td>
<td>ZR 8 TPP 15</td>
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- **Old technology**
  - High-grade ceramics
  - Electrode alloys with platinum tips

- **New technologies**
  - Reduced diameters
  - Electrode alloys of chrome-nickel-yttrium

➤ IAM: Increasing complexity for wholesalers and workshops
Old technology:
One Spark Plug concept for a variety of engines

W 7 DC

- Service intervals from 15 - 30 Tkm
- Extruded compound electrode, chrome-nickel with copper core
- Customers advice and support limited to heat value application measurements

Lower stocks at wholesalers and dealers, on plug fits different brands and vehicles, relatively low service intervals
Bosch SUPER plus

- Nickel-yttrium alloy
- Suppression resistor
- Pointed and profiled ground electrode
Bosch SUPER 4

- Four thin ground electrodes
- Surface-air-gap technology
- Eight possible spark gaps
- Silver-plated centre electrode
- Factory-adjusted electrode gaps
### Spark plug market trends

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**IAM: Increasing complexity for wholesalers and workshops**
New technologies:
A specific spark plug concept for each engine

- Service interval up to 100Tkm
- Reduced thread diameter from M14 to M12 .. M10
- Very long thread length (> 25 mm)
- Laser or resistor welding techniques for welding precious metal to chrome-nickel alloy
- Precise gapping of multiple ground electrodes
- Customers advice and support extended to
  - Selection and testing of spark plug technology
  - Design of combustion chamber
  - Reduction in fuel consumption and emission

Today spark plugs are a key part of the engine design, each one is designed specifically for a particular engine to optimize combustion.
Spark plugs are becoming smaller to occupy less space, fulfilling OE engine requirements.
Example: Bosch Platinum ZR 8 TPP 15

Laser-welded platinum elements in centre and ground electrode
Spark Plugs - Product Training

Spark plug change with spray-guided fuel injection

**False position of ground electrode**

- **Breakaway torque according specification**
  - Use torque wrench

<table>
<thead>
<tr>
<th>Car make</th>
<th>model</th>
<th>kW</th>
<th>engine code</th>
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<tr>
<td>BMW</td>
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<td>300</td>
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**Standard Spark plug**
- Spray plug spray-guided fuel injection
- cramped seal
- massiv seal

**Car make**
- BMW
- Mercedes

**Model**
- X 6 xDrive 50 i
- 750 i
- 750 Li
- C 350 CGI
- CLS 350 CGI
- E 350 CGI
- E 350 CGI T-Modell

**kW**
- 300
- 300
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**In use since**
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- 12.2007-
- 12.2007-

**References**
- ZR 5 TPP 332 (BMW)
- ZR 6 SII 3320 (MB)
Innovation/ Technical Trends

Reduced space for spark plugs
⇒ smaller and longer plug designs

Higher pressure at ignition timing
require higher ignition voltage
⇒ new specifications for insulators

Need for more central spark position, and more powerful ignition coils result in hotter electrodes subject to more corrosive and erosive wear
⇒ new specifications for electrode materials

Tighter tolerances for the spark position in the combustion chamber
⇒ high accuracy during the installation

Engine management / System know-how gains in importance
due to engine specific spark plugs
Latest spark plug technology

- New: Pin-to-pin technology
- Optimal power transmission of ignition spark
- For supercharged direct gasoline injection engines

- New: cup connection technology
- Modern motors require high ignition voltage
- Insulator extended by 8 mm
- Contact connection: stud with a cup
Spark Plugs – Product Training

Bosch main program

Main Program:

All plugs
Base Package (10 pack)
Material type written on it
All segments same package

Fast Runners
Comes as well in “4 pack” package

Extras:

Super4
Premium plugs for older Vehicles

Super Special
Small Engines
## Spark Plug News - Program development

<table>
<thead>
<tr>
<th>Current Package</th>
<th>Current Program</th>
<th>Future Program</th>
<th>Future – New Packaging design</th>
</tr>
</thead>
<tbody>
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<td>BOSCH Spark Plugs</td>
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Names SUPER, SUPERplus and CrNi, will disappear from the market.
Back Up
Spark Gap Types

Air Gap Type

Semi-Surface Type

Surface Type

Technologies prevent Carbon-fouling on the electrode
Electrode Gap

Failed ignition (no combustion)

Strong spark (safe combustion)

Failed ignition (no spark)
Spark Plug Components

- Terminal nut
- Connection stud
- Insulator
- Shell
- Glass seal
- Outer gasket
- Inner Gasket
- Copper core
- Centre electrode
- Ground electrode
The steel terminal connecting stud is melted, gas-tight, into the insulator with a special conductive glass seal that also serves as the electrical connection to the center electrode. A terminal nut is also attached, which connects to a spark plug wire of ignition coil.
The insulator houses both the center electrode and the terminal stud. The insulator is made of a special ceramic material (sintered aluminum oxide) and its function is to insulate the center electrode and terminal stud from the shell. The special ceramic also ensures high resistance to electrical breakdown.
Spark Plugs - Product Training

Shell

- The shell is made of steel and its function is to secure the spark plug in the engine’s cylinder head. The surface of the spark plug shell has an electroplated nickel coating to prevent corrosion, keep the thread free and to prevent seizing. After the insulator has been inserted into the spark plug shell, it is crimped and heat-shrunk into position.
Outer Gasket

The outer gasket is made of sheet metal and is folded three times. It is compressible and provides a tight seal when the spark plug is screwed into the cylinder head to prevent pressure leakage from the combustion chamber to the atmosphere. This allows for an optimal combustion and therefore optimal engine performance.
The inner gasket is made of sheet metal. It provides a tight seal when the insulator assembly is crimped and heat-shrunk into the shell.
The center electrode projects from the insulator nose. It is melted, gas-tight, into the insulator with the conductive glass-seal. The center electrode can be made of different materials such CrNi, NiY, Ag, Pt. To reduce wear, precious metal alloy is welded to the tip of the center electrode. For better thermal conductivity it is manufactured as composite material with a copper core.
Ground Electrode(s)

- The ground electrode(s) are welded to the shell and usually have a rectangular cross-section. The service life is dependent upon its ability to dissipate heat; To extend service life suitable composite materials are employed to improve thermal dissipation. Thicker ground electrodes, multiple electrodes, or precious metal inlays can also be used to extend service life.
Sintered in Center Electrode Spark Plug

The connecting pin is an aluminum-coated steel wire that serves as the electrical conduit between the center electrode and glass seal.
Sintered in Center Electrode Spark Plugs

- The precious metal center electrode is sintered into the extended ceramic insular nose. This allows the spark plug to reach self cleaning temperatures within seconds of starting the vehicle and provides substantial wear resistance.