

PIA

Product Information - Automotive **Spark plugs**



BOSCH

Invented for life



At a glance: PIA spark plugs



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Automotive Product Information for spark plugs, or PIA, supplements existing information on the Bosch spark plug line. It combines the most important facts and provides a quick, up-to-date overview item by item. In this way it provides standard argumentation for all spark plugs. In addition, the PIA provides information on technical features, customer service and the comprehensive competence of Bosch in the field of spark plugs.

In the tradition of progress

Bosch presented the first spark plug in combination with a high-voltage magneto over 114 years ago. This reliable ignition system for engines with ever-higher speeds solved the ignition problem once and for all. Together with industrial manufacturing techniques, the Bosch spark plug provided the breakthrough for the continuously increasing production of automobiles in the following decades.

Today, modern vehicles must satisfy ever more demanding requirements. They are measured by low fuel consumption, low emissions and maximum possible enjoyment when driving. It is no longer enough to refine individual components further in order to meet these requirements. Progress requires a holistic approach. Bosch uses its system know-how about the complex relationships between the subsystems to achieve new, pioneering solutions across systems.

In cooperation with leading automakers, Bosch develops and manufactures individual components such as spark plugs as well as complete systems. This experience and the high quality standards for OEM equipment are incorporated in their entirety into Independent Aftermarket (IAM). This is why Bosch offers a product range that is characterized by exceptional quality and reliability as well as by wide market coverage. In addition, Bosch offers professional assistance to retailers and workshops.

Global customer solutions: Worldwide manufacturing

Spark plug know-how

Leading automakers rely on the system expertise of Bosch for their OEM equipment and the high quality standards of Bosch spark plugs. As a pioneer in the field of ignition, Bosch offers a wide range of products for automobiles (including gas-powered engines), two-wheeled vehicles, small engines and industrial applications.

Common manufacturing standards worldwide

An international network of manufacturing sites develops and produces the entire line of spark plugs in 5 countries. This standardization ensures the consistently high quality of Bosch products regardless of the country of manufacture. Worldwide manufacturing produces about 300 million spark plugs per year.

Plants worldwide



The high quality standards at a world-class level are documented and monitored by various certifications. Good to know: All plants must comply with the same high quality standards of Bosch.

- + Over 114 years of experience**
 - ▶ Bosch is the inventor of the spark plug
 - ▶ Bosch manufactures about 300 million spark plugs annually
 - ▶ Worldwide manufacturing to the same, high quality standard
 - ▶ Spark plugs for every segment of the market and almost every application

Bosch spark plugs – A success story

Bosch introduced its spark plugs with a high-voltage magneto over 113 years ago. With this product, Bosch solved the ignition problem of early automobiles. Through the possibilities offered by industrial manufacturing, automobiles became affordable for all. On January 7, 1902, Bosch received the patent for its spark plug and the string of successes began. Since then, Bosch has developed more than 22000 types of spark plug.

Only the best is good enough

To ensure quality, Bosch products undergo continuous development. As a result, the performance of the Bosch spark plug has improved continuously since its invention. The result: Spark plugs have become more rugged and today have – depending on the application – a service life of up to 60000 km without the use of precious metals. Spark plugs with precious metals may even achieve up to 100000 km.

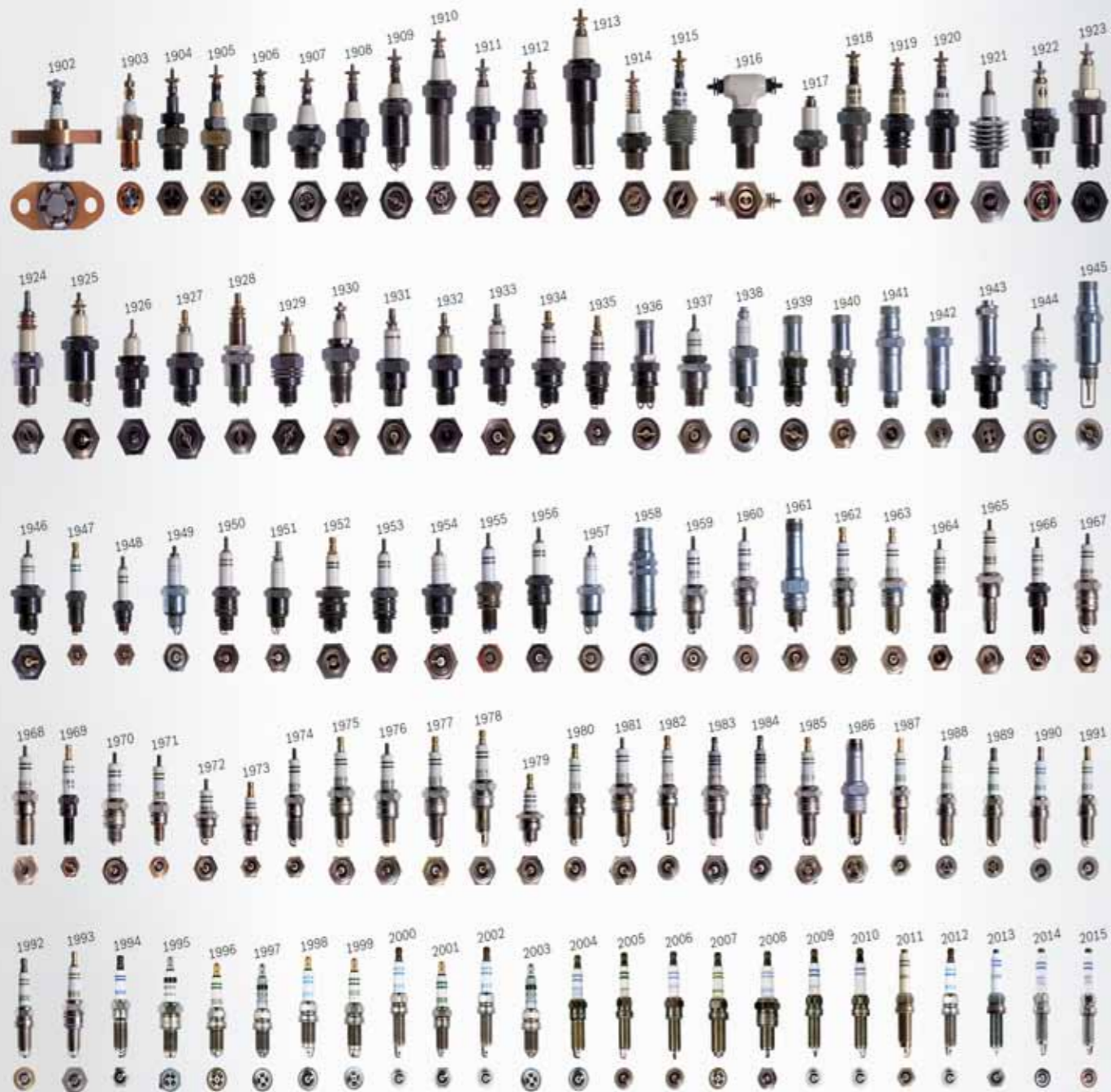


1902 – The first spark plug with a high-voltage magneto is developed by Bosch and revolutionizes motoring.



Over 114 years old –
As innovative as on its first day

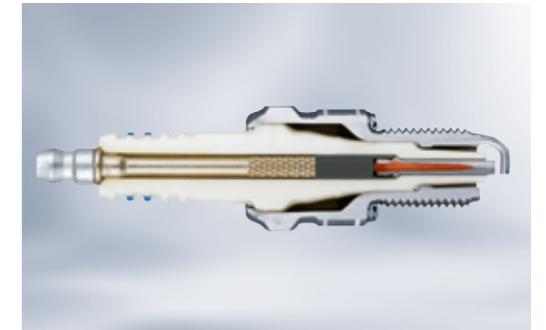
Spark plug innovations since 1902



Copper-cored center electrode

For better thermal conduct committee, the center electrode has a copper core. To reduce wear, the copper core is surrounded by a nickel-alloy.

1975



Platinum plus line

The Platinum plus spark plugs from Bosch feature a sintered center electrode of pure platinum. This provides better protection against soot buildup.

1983



Surface discharge technology

Multiple ground electrodes are positioned such that only surface air-gap sparks form. This creates a larger flame core, considerably improving combustion.

1992



Laser-welded double platinum

Platinum pins are laser-welded (center electrode) or inlaid (ground electrode), assuring better ignition and a considerably longer service life.

1998



Research, development, inspection: Quality does not happen by chance

International research and development

Bosch continuously adapts spark plugs to further developments in engine technology. Whether four-valve technology, lean-burn engine or fuel-efficient gasoline direct injection – the many applications of Bosch spark plugs result from design modifications and the use of especially resistant metals such as platinum and iridium or the rare earth element yttrium. Bosch will continue to develop new spark plugs in the future as well and guarantee the high quality of Bosch products.

- Research: To exploit synergies, Bosch cooperates with many scientific institutes and universities around the world.
- Development: In cooperation with vehicle manufacturers, Bosch uses its system of competence for fuel injection systems.
- In this way, Bosch develops spark plugs that satisfy all regional requirements worldwide.

Bosch guarantees quality

Bosch spark plugs can be used in all engines based on catalogue application recommendations issued by Bosch. Bosch provides a guarantee of quality and freedom from defects. The guarantee covers material and manufacturing defects for 24 months worldwide and includes repair as well as replacement of defective parts.

Intentional deception with "stolen" appearance

Manufacturers of knockoffs copy the design of Bosch spark plugs in an attempt to give an impression of quality that they do not offer: the high quality of Bosch. With the "stolen" appearance, they intentionally mislead retailers and consumers.

Low-cost production, poor-quality raw materials

Bosch spark plugs are based on time-consuming research, careful production and more than 100 years of experience. Spark plug knockoffs cannot offer this.

Deceptively similar – But without the same performance

Even knowledgeable professionals often have difficulty distinguishing the original from counterfeits on the basis of the external appearance of the product or the packaging. Sometimes the lower price can be an indication of a cheap copy.

The value inside is what matters

How good a spark plug really is can be seen only by inspecting what is inside. It takes a look at the "inner workings" to see the faulty workmanship and inferior material that result in poor performance.

Cheap copies with expensive shortcomings

The poor quality of imitations can have fatal consequences for the engine: misfiring, false starts and even costly engine damage. Bosch has carefully examined various imitations with regard to design, material and workmanship. The results show serious shortcomings in all of the imitations examined.

High-quality Bosch spark plugs are available only from your authorized speciality retailer.

Whoever intentionally purchases or sells imitations is liable to prosecution!

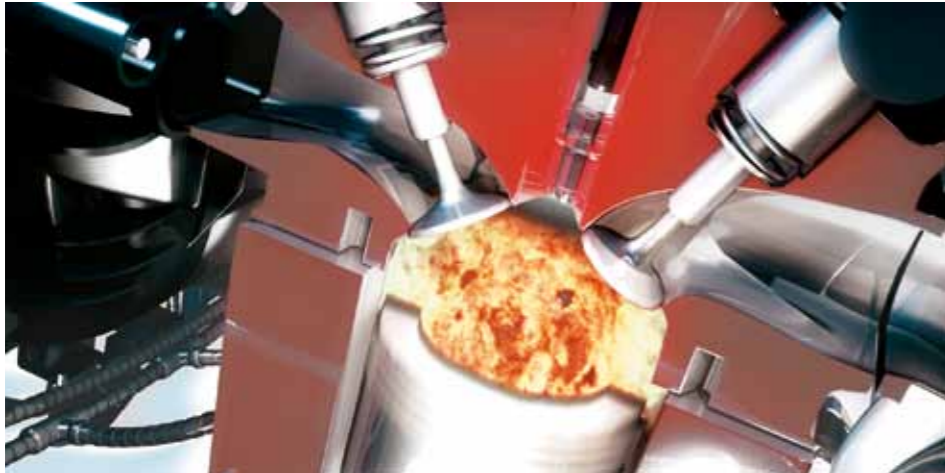


Many years of know-how and intensive continuous development of spark plugs in close cooperation with almost all vehicle manufacturers make Bosch one of the world's leading suppliers in terms of OEM equipment and the retail trade.

Cheap imitation: Externally hardly distinguishable from the original, but noticeably inferior in terms of quality.



Choice for quality: Vehicle manufacturers rely on Bosch



The igniting spark for our vehicles: spark plugs control the "pulse" in gasoline-powered engines.



The task of the spark plug

Actually quite simple: The spark plug must ignite the air-fuel mixture in the combustion chamber of a gasoline-powered engine by means of an electric spark. Always reliable, always at the right moment, many thousand times per minute. It

- ▶ must guarantee a reliable cold start
- ▶ must function over the entire service life without misfiring
- ▶ must not overheat even after long operation under maximum load

Applications

Spark plugs are the 'heart' of gasoline engines powering a variety of vehicles and equipment:

- ▶ Passenger cars
- ▶ Commercial vehicles
- ▶ Motorcycles
- ▶ Boats
- ▶ Agricultural and construction machinery
- ▶ Power saws
- ▶ Gardening tools
- ▶ Snowmobiles

For many leading vehicle manufacturers, spark plugs from Bosch are the right decision from the very start. And that has good reasons. After all, when it comes to gasoline injection and ignition Bosch stands for exceptional quality and innovation, extensive know-how and an exemplary product line. With continuous development of innovative spark plugs, Bosch guarantees reliable and high-quality products based on cutting-edge technology.

Close cooperation – exceptional results

Bosch develops all spark plugs for use as original equipment in close cooperation with automakers – They are tailored to the individual engines.

A benefit for retailers and workshops

Even in the aftermarket, Bosch offers original equipment quality – now and in the future. Bosch spark plugs bring the current trends in original equipment directly to retailers and workshops. Just two examples: aligned and welded ground electrode and interference-suppression resistor.

New technology for reliable ignition:

The aligned and welded ground electrode

The aligned and welded ground electrode ensures greater reliability of ignition through optimal positioning with respect to the injector.

Additional benefits:

- ▶ Greater cold-start reliability
- ▶ Engine/catalytic converter protection through optimal combustion
- ▶ Reduced fuel consumption through prevention of misfiring

Uncompromisingly good:

Spark plugs with an interference-suppression resistor

Spark plugs with an interference-suppression resistor are being used increasingly as original equipment in order to shield the electronics in the vehicle from electromagnetic interference. This is why Bosch also offers spark plugs with such a resistor on the replacement part market:

- ▶ Maximum interference suppression
- ▶ Reliable operation of all electronic systems such as ABS, ASR and ESP®
- ▶ Interference-free radio reception



Bosch spark plugs supplied as original equipment:

- | | | |
|-----------------|-----------------|--------------|
| ▶ Audi | ▶ Holden | ▶ Renault |
| ▶ Bajaj Auto | ▶ Honda | ▶ Seat |
| ▶ BMW | ▶ Jeep | ▶ Škoda |
| ▶ BYD | ▶ Maruti | ▶ Smart |
| ▶ Changan | ▶ Mercedes-Benz | ▶ Suzuki |
| ▶ Chery | ▶ Mini | ▶ Tata |
| ▶ Dodge | ▶ Mitsubishi | ▶ Vauxhall |
| ▶ Fiat-Chrysler | ▶ Opel | ▶ Volkswagen |
| ▶ Ford | ▶ Peugeot | ▶ Volvo |
| ▶ Geely | ▶ Porsche | ▶ Weichai |

The choice of winners: Bosch spark plugs lead the field



At the DTM, Bosch spark plugs always come out first.



Bosch spark plugs stand up to any comparison

When requirements are demanding, Bosch spark plugs are the reliable choice. It's no wonder that they are used successfully in international motor-sports.

Pole position for Bosch quality

Whether at the 24-hour race of Le Mans, the IndyCar Series, the NASCAR® races or the DTM – Bosch spark plugs show their winning qualities. The innovative yttrium alloy with the extreme ruggedness and wear resistance guarantees maximum performance on the racetrack. Bosch also supplies spark plugs to most of the teams competing in Formula 1 races.

High tech from motorsports adopted for volume production

Bosch spark plugs are leading in motorsports – thanks to their special technical features and standards as well as high-quality materials such as yttrium or Alloy 602. Innovations designed especially for the demanding requirements in motorsports are also incorporated into spark plugs supplied as original equipment. Frequently, they are even developed further and then mass-produced for retailers and automobile mechanics.



DTM

Bosch shows its colors in motorsports

For many years now, Bosch has participated in the DTM. The most popular international touring car race, which is now broadcast live not only in Europe and Africa, but also in China and North America, is one of the motorsports events that draws the largest audiences. The Bosch brand is always visible: on the windshield and rear window, the vehicle and the inboard cameras at the pit lanes.



DTM

Bosch technology: The driving force for victory

Bosch is active as both a sponsor of the DTM and as a supplier of equipment used in the races. After all, the teams rely on top-of-the-line products. Thus, all DTM vehicles are fitted with Bosch spark plugs. Moreover, the entire engine management system is supplied by Bosch Motorsport, including the displays in the cockpit, the sensors, the injectors, the starters and alternators.



Bosch – An active participant in motorsports

Spark plugs must withstand a lot

Able to take the stress and still perform

Everything from a single source

Spark plugs are not only subjected to extreme stresses; they must also function reliably. Even the smallest flaw can cause expensive engine damage. That is why Bosch manufactures each component in-house for every spark plug – the only manufacturer to do so.

Requirements: Electrical properties

- ▶ Voltages of up to over 45,000 V must not cause electrical breakdown of the insulator
- ▶ The electrical resistance of the insulator must be assured even at temperatures of 1000 °C

Requirements: Chemical properties

- ▶ Resistance to all chemical processes in the combustion chamber
- ▶ Even at combustion temperatures up to 3000 °C
- ▶ Resistance to aggressive deposits contained in the fuel

Requirements: Thermal properties

- ▶ Resistance to rapid, extreme temperature changes (hot combustion gases and a cold fuel-air mixture)
- ▶ Good dissipation of the heat in the cylinder head

Requirements: Mechanical properties

- ▶ Reliable gas tightness at pressures of over 100 bar
- ▶ Ability to withstand tightening torques during installation

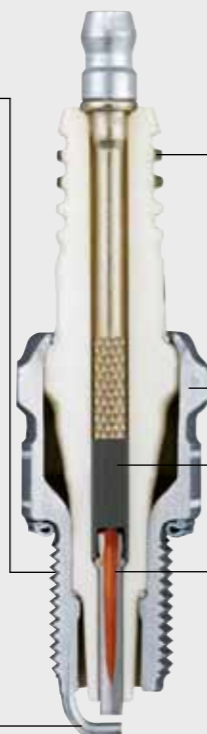
Structure and function:

Nickel-plated spark plug shell with thread

To protect against corrosion and seizing of the thread in the aluminum cylinder head.



In precious metal spark plugs, precious metal pins are laser-welded to or inlaid in the center electrode.



Effective leakage current barriers:

Prevent flashover and thus misfiring.

Shrink fit assembly:

Guaranteed absolute gas tightness and exact heat range.

Interference-suppression resistor:

Reliable operation of all electronic systems and interference-free radio reception.

Multi-material center electrode:

Highly conductive copper core in a wear-resistant chrome-nickel jacket for rapid attainment of the operating temperature. Protects against thermal overloading, corrosion and spark erosion.



Cup terminal technology

In order to make engines more efficient, vehicle manufacturers are reducing the displacement or the number of cylinders (downsizing) while simultaneously increasing the charge air pressure. This necessitates a higher ignition voltage, which in turn requires an insulator with greater flashover resistance. Bosch has specifically developed spark plugs for this purpose. On these spark plugs, the insulator is approx. 8 mm longer. To compensate for this increased length the spark plug now has a stud with a cup to act as the contact connection. The contact pressure spring of the spark plug connector is centered in the cup.

Pin-to-pin spark plugs from Bosch

The innovative pin-to-pin spark plugs from Bosch are tailored to the special requirement profile of engines with gasoline direct injection with their high exhaust gas recirculation rate: The lean fuel-air mixture requires efficient energy transfer for ignition. To compensate for the poor ignition resulting from a small electrode gap (quenching losses), Bosch has developed pin-to-pin spark plugs. In pin-to-pin technology the spark plug has two particularly thin electrodes that cause very low quenching losses. This ensures high power transmission and reliable ignition.

Continuous improvement of a good idea: engineering the spark plug of tomorrow

Smaller, more efficient, more durable

With a significant investment in research and development and in close cooperation with international automobile Manufacturers, Bosch brings new spark plugs that meet the requirements of modern gasoline engines to a level of manufacturing readiness. This means above all: better fuel economy, lower emissions, reduced dimensions and optimal performance.

Exceptional precision as the starting point

Modern internal combustion engines are highly complex systems where every detail must be matched precisely to every other. The spark plug is an important component in this regard and must meet entirely new requirements from the latest generation of direct injection systems, for instance. The starting point for meeting these requirements is almost tolerance-free production as well as new developments in the areas of materials, geometry and manufacturing processes.

New materials

Modern engines operate at especially high combustion temperatures. This also stresses the spark plugs. Electrode wear is greater and must be addressed through use of more resistant materials. This is why Bosch uses high-quality alloys such as platinum, iridium or rhodium, among others.

Defined ignition spark orientation

The stratified charge approach used with modern direct injection requires exact orientation of the ignition sparks toward the region of the combustion chamber that contains the ignitable mixture. An exactly defined spark orientation provides the required reliability.

Aligned and welded ground electrode

Precision-manufactured spark plugs with welded ground electrodes that are already aligned during production ensure reliable ignition in engines with spray-guided direct injection. The installation angle and installation orientation with respect to the injector are defined on the basis of the engine type. Tight manufacturing tolerances, modern measuring systems and, of course, close cooperation with engine manufacturers assure optimal alignment of the ground electrodes in this regard. The wrong installation angle can cause malfunctions.

Smallest installation dimensions

Powerful, efficient engines require a significant amount of air to ensure optimal combustion of the fuel. More air, however, means bigger channels in the intake and exhaust valves. This leaves less space available for installation of the spark plug. Or, said in a different way: The smaller the diameter of the spark plug, the more options engine designers have.

The perfect spark plug

The trend to ever more efficient and cleaner engines results in increasingly demanding – and sometimes contradictory – spark plug requirements. The perfect spark plug is thus always adapted to the particular engine. The spark plug must reliably ignite the fuel-air mixture under all operating conditions. At the required electrode operating temperatures of between 500 and 800 °C, they must withstand the high voltages of the sparks as well as wear for an extensive period of time.

At an early stage in engine development, the initial models are created on a computer and their suitability is confirmed virtually through various simulations before they are built physically and tested in the real world. As an important part of the engine, the spark plug subsequently contributes to energy-efficient operation of modern, environmentally friendly vehicles with low emissions.

At critical operating points in the full load, partial load and idle regions, optimized spark plugs ensure:

- ▶ Increased ignition reliability
- ▶ Improved fuel economy and lower emission levels through optimized combustion
- ▶ The best possible protection of the catalytic converter

Current development trends

Modern, supercharged gasoline engines with direct injection require – especially with a centrally positioned injector – further advances in the development of spark plugs. In the future, spark plug developers will have to address demanding requirements:

- ▶ Spark plugs with an M10 thread
- ▶ Operation at an even higher ignition voltage (up to 50 kV)
- ▶ Increased dielectric strength
- ▶ Greater thermomechanical and mechanical ruggedness to withstand sporadically occurring, irregular combustion
- ▶ Reduced electrode temperatures
- ▶ Minimization of wear (or retention of life expectancy despite complex requirements)

To develop the best possible spark plug, Bosch engineers work closely with vehicle and engine manufacturers as well as renowned universities.



Gasoline direct injection from Bosch

Developed to withstand extreme loads: High-performance spark plugs



High-performance spark plug

- 1 Aligned and welded ground electrode for optimum ignition
- 2 Extremely fine precious metal center electrode welded using the Continuous Wave laser welding process
- 3 Newly developed design of the insulator base
- 4 Special ceramic material with maximum dielectric strength
- 5 Optimized insulator design

More power, less fuel

Today, providing power and economy are the most challenging requirements in the performance specifications for modern engines. Only vehicles that are comfortable and a pleasure to drive have chances of succeeding in global markets. Globally, the laws are increasingly stringent regarding reduction of emissions and fuel consumption.

Modern gasoline direct injection system with stringent requirements for spark plugs

"Intelligent" injection systems, like the gasoline direct injection system, are not making it easy for the ignition systems. If the injection pressures in the combustion chamber are between 100 – 120 bar in case of normal combustion, they can be as high as 250 bar in a modern turbo engine. The ignition voltage requirements also increase due to the higher working pressures. Bosch high-performance spark plugs not only withstand this, but also ensure reliable ignition of the fuel-air mixture at all the operating points.

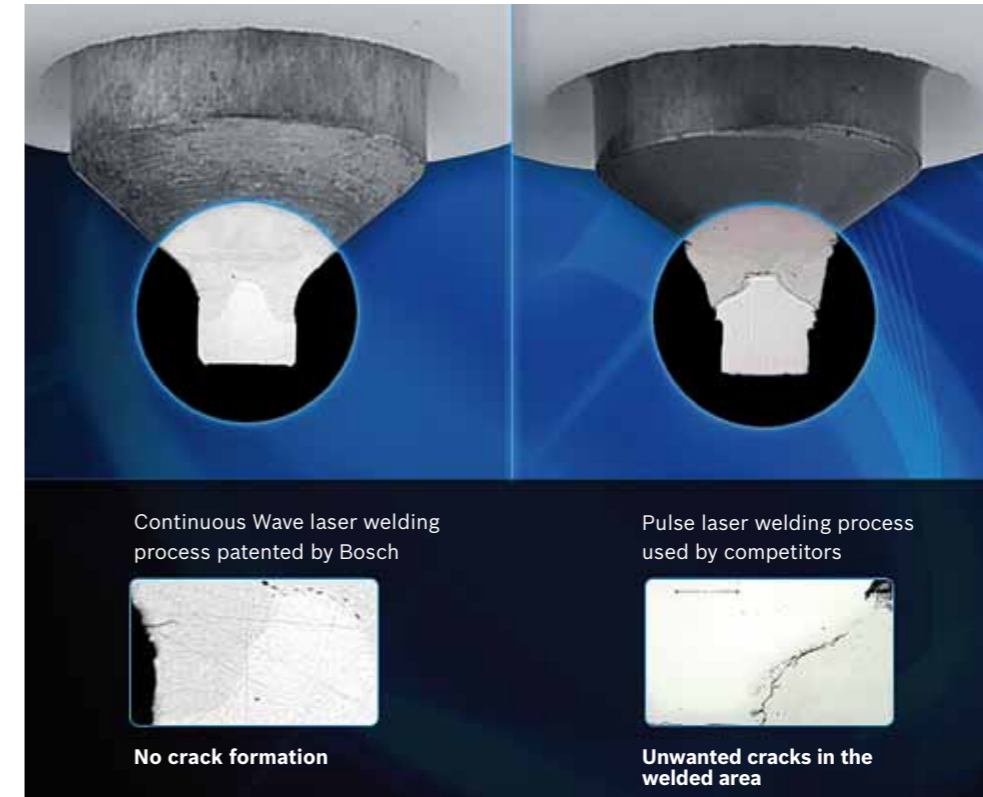
Material development and design

The electrodes need to be stable under these difficult engine conditions. High exhaust gas recirculation rates and high thermal as well as electrical loads have to be withstood. Through continuous development of the ceramic material and specific design modifications, the high-performance spark plug has been designed for maximum electrical, thermal and mechanical strength. The head bending strength has been improved by increasing the wall thickness of the insulator. At the same time, the high-performance spark plug has a dielectric strength exceeding 45,000 V and meets the Original Equipment Manufacturers' stringent wear and tear requirements.



+ High-performance spark plugs in the workshop range

Bosch offers high-performance spark plugs for modern, supercharged engines with direct gasoline injection even in the workshop range. Thus, the aftermarket benefits from Bosch's experience and know how as an OEM.



In the pulse laser welding process (used by competitors), there is a risk that the precious metal pin (center electrode) can be detached as the result of cracks caused by the high combustion chamber pressure. This threatens engine damage. These cracks do not form in the CW laser welding process patented by Bosch.

Precious metal and CW laser welding process

It is now more than 114 years ago that Bosch patented the spark plug. More than a century of experience in developing and manufacturing goes into Bosch spark plugs. During this time, spark plug technology has been perfected by Bosch. Many more patents have been granted along this journey. Continuous Wave (CW) laser welding is one of them and is used in production only by Bosch. Use of this process significantly increases the service life of the spark plug; the center electrode is stabilized against formation of cracks and consequently withstands the high pressures in the combustion chamber.

New material alloy 602

The high-performance spark plug from Bosch does not have only a center electrode with an extremely fine precious metal pin (fine wire). A new material has been used for the center electrode: the nickel

alloy 602 with a higher proportion of chromium than in standard nickel alloys. The advantage compared to the previously used nickel alloys is the resistance of alloy 602 to high-temperature corrosion, which contributes to the higher service life of the spark plug.

Exclusive "high-voltage end-of-line test"

A product can meet the highest quality requirements only if appropriate quality assurance measures and tests are conducted. The quality requirements at Bosch are particularly challenging and a so-called "high-voltage end-of-line test" is carried out. At the end of production, all high-performance spark plugs are tested under conditions that are similar to those in the combustion chamber without exception. This happens only at Bosch.

Original equipment quality for the aftermarket: The Bosch spark plug program

Bosch spark plugs: As many different types for as many engine designs there are

The Bosch spark plug program has the right spark plug for every vehicle – always tailored to the requirements of the particular engine.

Structure of portfolio: Clearly organized, making products easy to find

Despite its big range, the Bosch spark plug program is easy to navigate. Different electrode alloys have different benefits to meet the requirements of a particular engine. They are named by the electrode alloy used. Thus, the spark plugs have names such as Bosch Platinum, Bosch Double-Platinum, Bosch Iridium, Bosch Double-Iridium, Bosch Silver or just Bosch*.

*Previously: Bosch Super, Bosch Super plus

New, modern packaging design

- ▶ Technology-oriented, modern packaging design
- ▶ Fast orientation when placed on the shelves
- ▶ Quick and easy identification of the Bosch brand by means of white stripe with Bosch logo on blue packaging
- ▶ Product image, information field with electrode gap and tightening torque as well as installation instructions directly on the packaging
- ▶ Reliable protection of the spark plugs during transportation and storage
- ▶ QR code for fast access to additional information



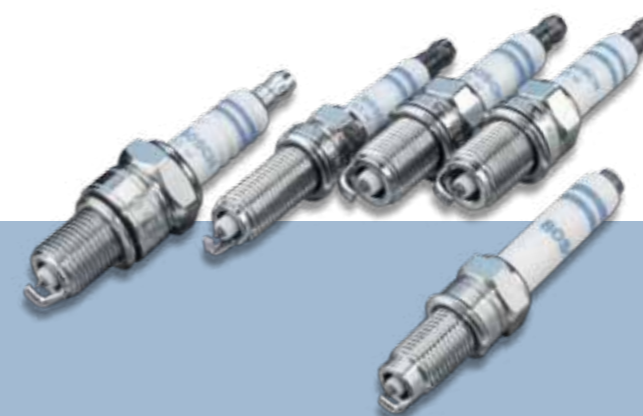
New Global Packaging Design:

Ordering numbers, applications, type codes, quick-search numbers and EAN codes remain the same.

The advantages for the workshop from leading spark plug technology

The advantages at a glance

Original equipment quality	<ul style="list-style-type: none"> ▶ From one of the world's leading original equipment suppliers ▶ Direct knowledge transfer to the workshop product line
Extensive market coverage	<ul style="list-style-type: none"> ▶ The right spark plug for almost every engine ▶ Over 95% market coverage in Europe
Innovative alloys	<ul style="list-style-type: none"> ▶ With nickel and yttrium or precious metals (platinum or iridium) ▶ For a longer service life and better transmission of the ignition energy
Optimized electrode geometries	<ul style="list-style-type: none"> ▶ Profiled ground electrode, pin-to-pin, multi-ground electrodes ▶ For ideal ignition characteristics
Heavy-duty ceramic	<ul style="list-style-type: none"> ▶ Specifically for the requirements of modern engines ▶ Optimal dielectric strength at high voltages with reduced wall thickness of the spark plug ceramic
Advanced laser welding technology	<ul style="list-style-type: none"> ▶ Maximum reliability and life span
Copper core	<ul style="list-style-type: none"> ▶ Improves heat conduction ▶ Protects against pre-ignition and soot buildup
Also for gas-powered engines	<ul style="list-style-type: none"> ▶ All Bosch spark plugs provide peak performance with gasoline as well as gas (CNG, LPG) as fuel
Innovations from motorsports	<ul style="list-style-type: none"> ▶ Are incorporated into spark plug production for passenger cars



Without a doubt, the "Best Brand" for motorists

For the 11th time in succession, they selected Bosch as their favorite brand in the spark plug category. Over 115 000 readers of the magazine "auto motor und sport" participated in the 2016 survey.

At a glance: The Bosch spark plug program for workshops and DIY customers



Bosch (Automotive)

- ▶ Bosch
- ▶ Bosch Platinum
- ▶ Bosch Double-Platinum
- ▶ Bosch Iridium
- ▶ Bosch Double-Iridium
- ▶ Bosch Silver



Super 4 Premium Line For passenger cars



Bosch (Non-automotive): for two-wheelers and small engines (in blister packaging for installation by user)

The widest range of spark plug technologies combined in a single line:

- ▶ Precious metal
- ▶ Without precious metals



High-end spark plugs for older engines

- ▶ Four thin ground electrodes
- ▶ Surface air-gap principle



Chrome-nickel ground electrode: for all non-automotive applications



Sales arguments at a glance: Spark plugs with and without precious metals

Advantages of spark plugs with precious metals


Precious metals	Customer benefit	Reason why
Platinum	<ul style="list-style-type: none"> ▶ Longer interval between service compared to Silver spark plugs ▶ Very good corrosion and oxidation resistance as well as erosion resistance ▶ Consistent ignition performance over the entire service life 	<ul style="list-style-type: none"> ▶ High melting point of platinum ▶ High chemical resistance ▶ Less wear
Iridium	Longer service life than Silver spark plugs	Extremely high erosion resistance of iridium
Silver	<ul style="list-style-type: none"> ▶ Thinner center electrode for better accessibility by the mixture ▶ Longer service life than standard spark plugs 	<ul style="list-style-type: none"> ▶ Maximum thermal conductivity ▶ Exceptional chemical resistance against lead-free fuels

Precious metals: Depending on the application and load, alloys with platinum or iridium are used. Engine, fuel quality and other parameters determine which alloy is used for a given spark plug type.


Advantages of spark plugs without precious metals


No precious metals	Customer benefit	Reason why
Standard spark plugs	<ul style="list-style-type: none"> ▶ Great reliability ▶ Good price-performance ratio ▶ Wide range of application 	<ul style="list-style-type: none"> ▶ Extensive experience (continued development since 1902); proven materials ▶ Large quantities without the use of precious metals ▶ Electrodes made from high quality nickel-based alloys with copper core
Super 4	<ul style="list-style-type: none"> ▶ Longer service life than standard spark plugs without the use of (expensive) precious metals ▶ Improved cold-start characteristics 	<ul style="list-style-type: none"> ▶ Erosion distributed over 4 ground electrodes ▶ Smaller ground electrode takes less energy from the spark

Sales arguments at a glance: Original equipment quality for the independent aftermarket (IAM)


Type	Customer benefit	Reason why
<p>Original equipment quality for the IAM: The Bosch spark plug program</p> 	<ul style="list-style-type: none"> ▶ Long service life: Achieves or exceeds the replacement intervals recommended by the vehicle manufacturer ▶ Reduced fuel consumption, improved acceleration and corrosion resistance ▶ Improved cold-start ability, even at a low battery voltage ▶ Protects the housing against corrosion <ul style="list-style-type: none"> – fast and easy replacement – No seizing of the threads, especially in aluminum cylinder heads ▶ Quick installation <p>1st and 2nd trade level:</p> <ul style="list-style-type: none"> ▶ Original equipment quality ▶ Product line for automobiles of every age and any vehicle class ▶ Fast and easy ordering ▶ Technologically at the latest level with the newest trends and innovations <p>1st trade level: A variety of different packaging</p>	<ul style="list-style-type: none"> ▶ Worldwide market coverage of 95%. ▶ Precious metal alloys based on the best erosion-resistant materials such as platinum, iridium, nickel, nickel-yttrium or silver ▶ Highly wear-resistant electrodes made from nickel and precious metal alloys with copper core offer high thermal conductivity ▶ Lower ignition requirement and optimum ignition through use of pointed and profiled ground electrode and taper-cut center electrode ▶ Nickel-plated spark plug housing and threads is a standard on all Bosch spark plugs ▶ Pre-set electrode gap <p>Europe's preferred OEM supplier based on high quality standards</p> <ul style="list-style-type: none"> ▶ Extensive product line for almost every vehicle ▶ Easy quick-search number system and marketing numbers ▶ Technically up-to-date product line based on close cooperation with auto-makers worldwide ▶ Available in ten-packs, four-packs and blister packaging

Sales arguments at a glance: Spark plugs for CNG/LPG-powered engines and older passenger cars



Type	Customer benefit	Reason why
<p>Bosch spark plugs for CNG/LPG-powered engines</p> 	<p>1st and 2nd trade level:</p> <ul style="list-style-type: none"> ▶ Benefits from the growing market for CNG/LPG-powered vehicles ▶ The highest market coverage in the segment ▶ Product line for automobiles of every age and all vehicle classes ▶ Special spark plug recommendations <p>End consumer: Stress-free dual-fuel operation</p>	<ul style="list-style-type: none"> ▶ Nickel-plated spark plug housing and standard threads for the best ignition performance when using CNG/LPG ▶ Spark plugs designed for more severe electrode wear and higher operating temperatures when using CNG/LPG as fuel ▶ Replacement intervals: <ul style="list-style-type: none"> – 15000 km for Bosch spark plugs – 30000 km for Bosch precious metal spark plugs ▶ Heat range stated clearly ▶ Nickel-plated housing – standard on all Bosch spark plugs ▶ No separate product line necessary

Type	Customer benefit	Reason why
<p>Bosch Super 4</p> 	<p>End consumer:</p> <ul style="list-style-type: none"> ▶ Premium product for older engines ▶ Improved engine response ▶ Stronger acceleration ▶ Greater fuel efficiency <p>1st trade level:</p> <ul style="list-style-type: none"> ▶ Extensive product line ▶ Better margins 	<ul style="list-style-type: none"> ▶ Adapted to the ambient conditions of modern engine management systems ▶ Long, energy-rich sparks for the lean-fuel operating conditions that frequently occur in older engines ▶ Thin electrodes for high energy transfer ▶ Surface-gap technology prevents soot buildup and reinforces the self-cleaning action of the spark plug <p>Wide operating range is covered by fewer spark plugs.</p> <ul style="list-style-type: none"> ▶ Better sales thanks to unique product benefits in a given segment

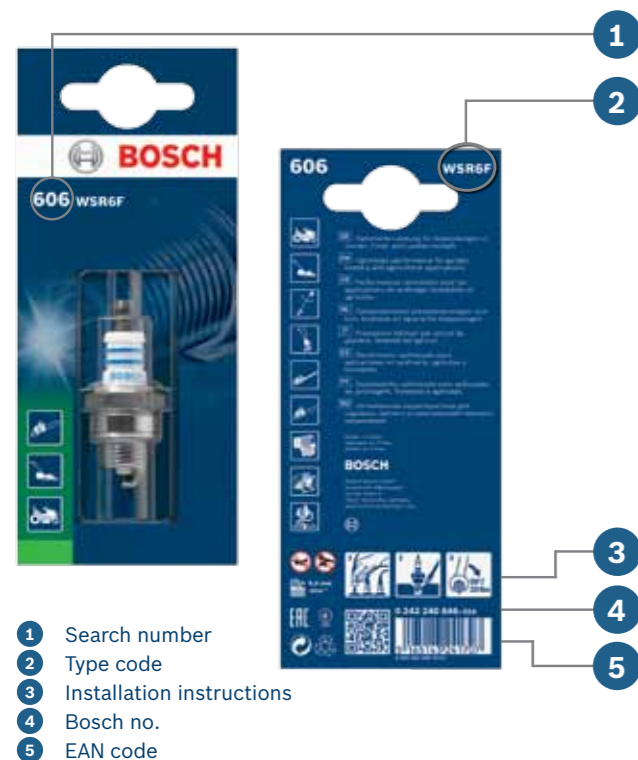
Sales arguments at a glance: Spark plugs for two-wheelers and small engines

Type	Customer benefit	Reason why
<p>Bosch spark plugs for two-wheelers and small engines</p> 	<p>1st and 2nd trade level:</p> <ul style="list-style-type: none"> ▶ Extensive market coverage with a few types ▶ Housing protected against corrosion and thread seizing ▶ Fast installation <p>End consumer:</p> <ul style="list-style-type: none"> ▶ OEM know-how and reliable commitment to quality ▶ Extensive market coverage ▶ Reliable quick starts ▶ Quick installation 	<ul style="list-style-type: none"> ▶ Removable SAE connection nut ▶ One Bosch part number covers several competitors' types ▶ Nickel-plated spark plug housing and rolled threads on all Bosch spark plugs ▶ Electrode gap preset at factory <p>▶ Leading OE supplier for market-leading manufacturers</p> <ul style="list-style-type: none"> ▶ High market coverage ▶ Optimized design: Nickel center electrode for reliable starts ▶ Electrode gap preset at factory

Sales arguments at a glance: Competence from OE experience and motorsports

Type	Customer benefit	Reason why
<p>Original equipment competence</p> 	<p>1st and 2nd trade level: Leading in technology and quality</p>	<ul style="list-style-type: none"> ▶ Direct knowledge transfer from original equipment products to IAM program ▶ Successful cooperation with all leading automakers ▶ Preferred original equipment supplier in Europe ▶ More than 114 years of experience in the development and production of spark plugs
<p>Motorsports competence</p> 	<p>1st and 2nd trade level: Latest motorsports technology transferred to the aftermarket</p>	<p>Latest technologies – developed in cooperation with international motorsports teams: Whether in 24-hours races in Le Mans, the IndyCar Series, the Brazilian Stock Car Series or the DTM – the motorsports elite relies on spark plugs from Bosch. For a good reason. Bosch also supplies spark plugs to teams that participate in Formula 1 racing.</p>

The specialists for spark plugs: For all motorized equipment



Few types, high market coverage:

The compact product line from Bosch

Whether for the hobby gardener or professional – motorized, mobile work equipment is becoming ever more popular and the variety of gardening and forestry equipment is growing accordingly. With only a few spark plug types, the Bosch line of spark plugs for small engines covers all commonly encountered equipment. In this way, the customer is offered the correct spark plug in a small sales area:

- ▶ Leaf blowers
- ▶ Hedge trimmers
- ▶ Leaf vacuums
- ▶ Power generators
- ▶ Lawn trimmers
- ▶ Snow throwers
- ▶ Garden tractors
- ▶ Chainsaws
- ▶ String trimmers
- ▶ Lawn mowers
- ▶ Snow blowers
- ▶ Water pumps

Self-explanatory sales support

The blister packaging is an attractive and self-explanatory sales aid that provides ideal sales support for the retailer. The simple system with search number, type code and Bosch number ensures that customers immediately find the appropriate spark plug. All important information for safe and professional installation is provided as well.



Spark plugs by Bosch: Moving two wheeled vehicles

Spark plugs contribute decisively to optimal performance and reliable operation of the engine.

Motorcycle spark plugs from Bosch are specially designed for the particular requirements of engines on two wheeled vehicles:

- ▶ Quiet operation
- ▶ Reliability without misfiring over the entire service life
- ▶ Reliable cold starts
- ▶ Optimal combustion and high fuel economy
- ▶ Extensive product line with applications for many brands and engine types
- ▶ Factory-preset electrode gap, designed for the specific engine
- ▶ Easy and quick change without seized spark plugs
- ▶ High insulating capability even at temperatures above 1000 °C
- ▶ Able to withstand pressures up to about 100 bar
- ▶ High mechanical strength for safe installation
- ▶ Resistant to chemical processes in the combustion chamber and aggressive residues
- ▶ Resistant to thermal shock from hot exhaust gases alternating with incoming cold fuel-air mixture
- ▶ Good dissipation of heat by insulator and electrodes
- ▶ Bosch system competence for motorcycles



Spark plugs must withstand special stresses in motorcycle engines in particular because of their high rpm.



Reliable, well-organized, practical: Motorcycle spark plugs from Bosch are available individually packaged, in 10-packs or in blister packaging.

Reliable ignition for gas engines: Bosch offers the right solution

A different fuel, a different spark plug

When motorists decide in favor of gas engines, they obtain information on many things: fuel economy, safety, availability of the fuel etc. Above all, service shops must be familiar with the special technology of gas engines. Important for a conversion: When powered by gas, the engine needs new spark plugs with the appropriate characteristics.

Convert: Improve performance, protect the engine

Spark plugs used in gas-powered engines are subject to greater wear than in gasoline-powered engines. For this reason, they must be changed at intervals of 15,000 km or 30,000 km. Usually, manufacturers of conversion kits cannot provide any binding information about the spark plug needed, because they do not know in advance in which engine the kit will be installed. This is where the retailer and service shop with its competence and knowledge are needed to identify which spark plug is the right one and how often it needs to be changed.



Change the spark plugs when converting from gasoline to gas as fuel!



+ Equipped for the special needs of gas engines

- ▶ The right spark plug for every gas application
- ▶ Perfectly designed for the special requirements of gas engines
- ▶ Platinum spark plugs resist high wear

Adapting spark plugs to gas engines

Spark plugs from Bosch can be designed perfectly for the requirements of gas engines: A gas control unit automatically compensates for the higher ignition voltage required if an ignition timing advance mechanism is incorporated. If this is not done, Bosch recommends that a spark plug with an electrode gap of 0.7 mm be used or the gap be adjusted appropriately.

Bosch spark plugs: Also ideal for gas engines

Bosch spark plugs impress with their high quality. In addition, the right spark plug is available for virtually every vehicle. Because of their material, Bosch platinum spark plugs in particular experience less wear and achieve a longer service life, making them ideal for gas as fuel.

The differences between gasoline and gas engines

Converting from gasoline to gas as fuel results in special requirements for the engine:

- ▶ Gas requires a higher ignition voltage than gasoline. While a gasoline-powered engine needs 14 kV, for instance, a gas-powered engine requires 16 kV for reliable ignition under the same conditions.
- ▶ A higher operating temperature occurs in the combustion chamber when gas is the fuel.
- ▶ The higher ignition voltage and the higher operating temperature in the combustion chamber mean that the electrodes reach the end of their service life faster.

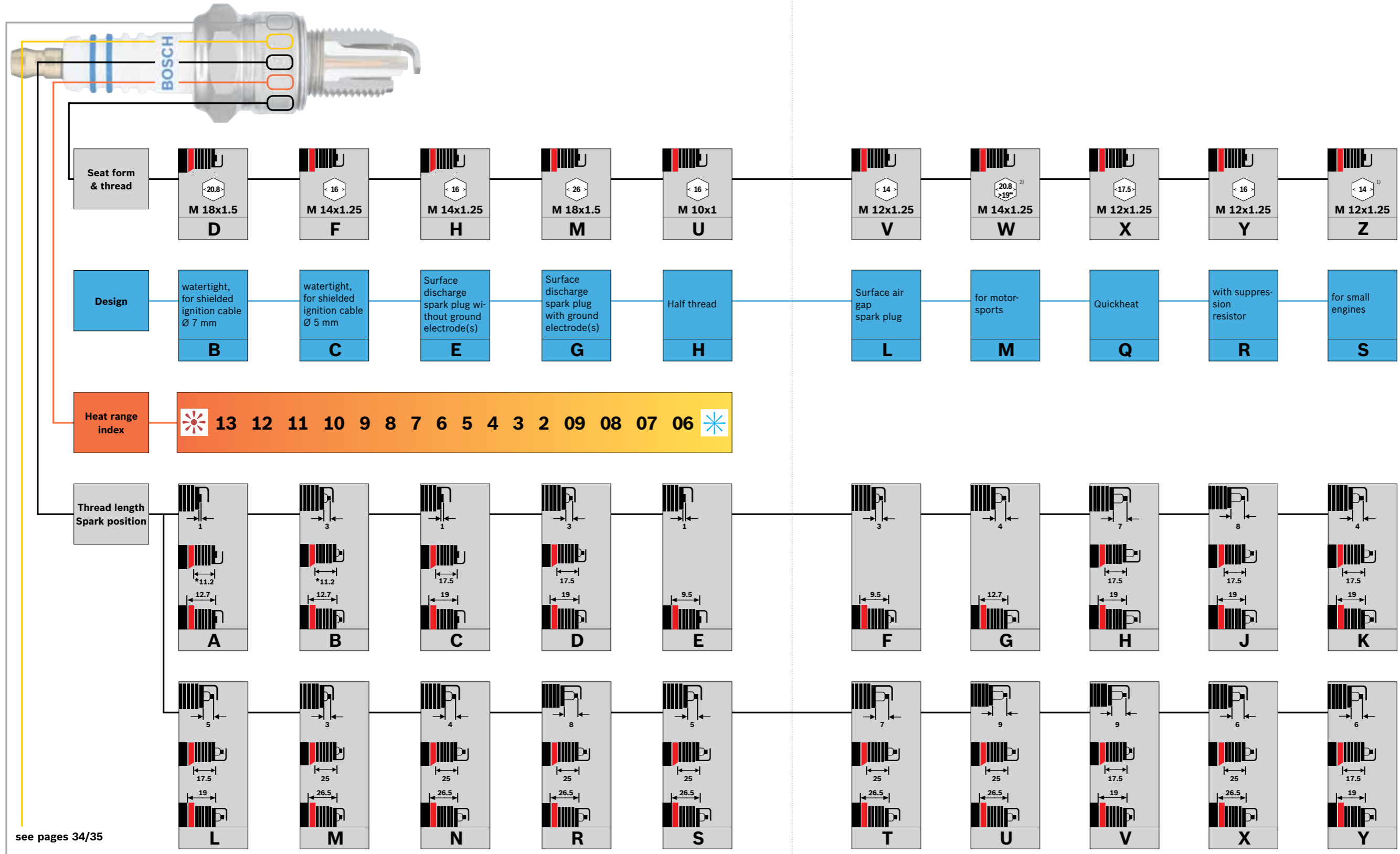


Gas engines reduce fuel costs, protect the environment – and need the right spark plugs for their special requirements.

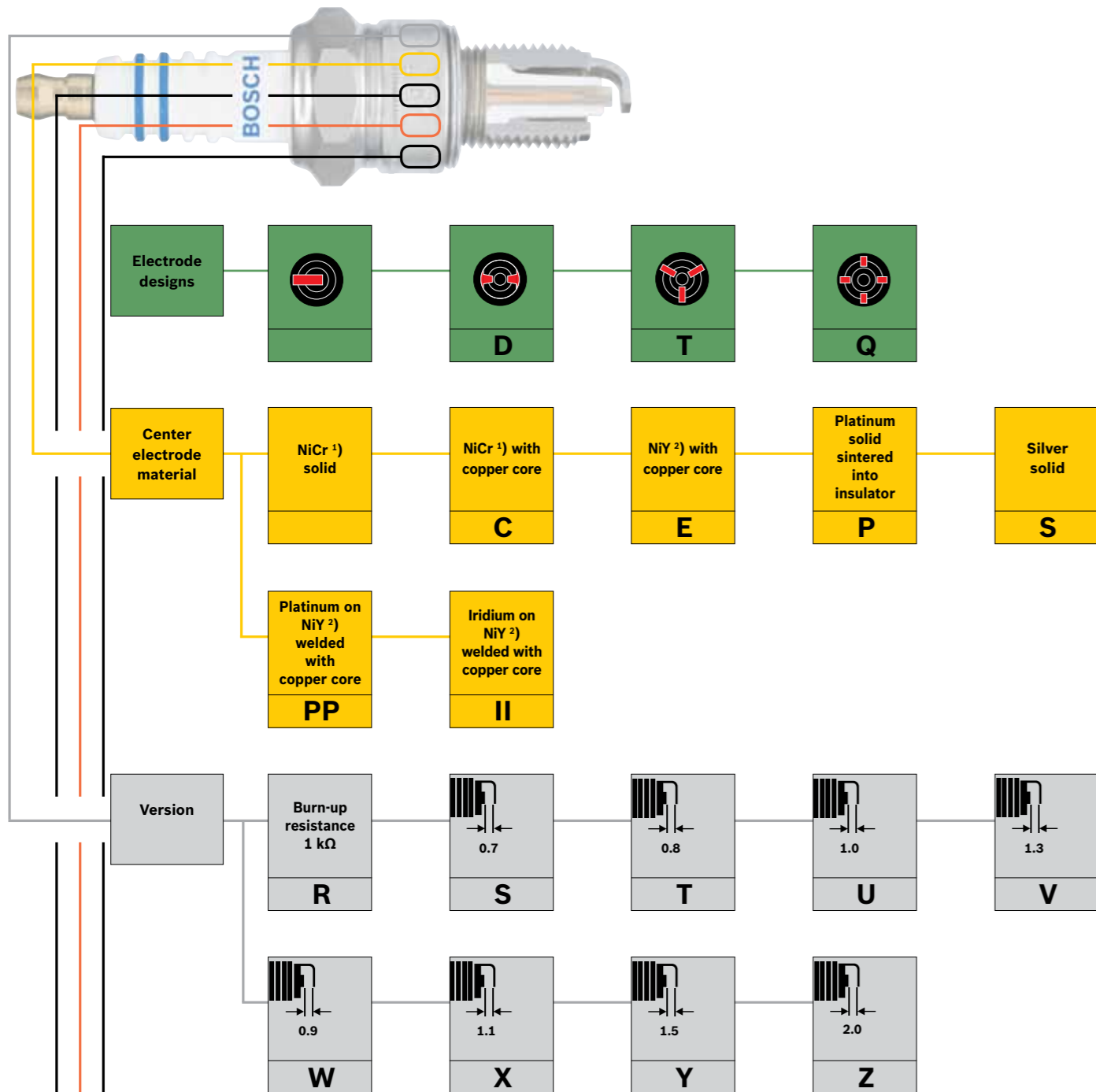
This is how you find the right type: Type code for Bosch spark plugs



+ No need for a long search; instead, find what you need quickly:
Seat form and thread, heat range code number, thread length and spark length – here you can see at a glance what the code on the spark plug means.



Design and materials: Type code for Bosch spark plugs



see pages 32/33

¹⁾ Nickel-chromium
²⁾ Nickel-yttrium



+ Find important information quickly:
Here you can see at a glance the type of design and which materials are used in the spark plug.

Version	Deviation from the basic design	P0 version with NiCr ¹⁾ ground electrode	Copper core in ground electrode	Thread with special length	reduced clearance, extended insulator nose
	0	1	2	3	4
	Pin-to-pin technology	Aligned and welded ground electrode	PSA special version for 30 Tkm	Profiled, chisel-shaped ground electrode	
	5	8	9	+	
	Center electrode: Platinum wafer Ground electrode: no precious metal	Center electrode: Platinum wafer Ground electrode: no precious metal	Center electrode: Platinum wafer Ground electrode: Platinum pin laser-welded	Center electrode: Platinum pin laser-welded Ground electrode: no precious metal	Center electrode: Platinum pin laser-welded Ground electrode: Platinum pin laser-alloyed
	10	15	22	30	33
	Center electrode: Platinum pin laser-welded Ground electrode: Platinum pin laser-welded				
	35				
	Center electrode: Platinum wafer Ground electrode: no precious metal, with copper core	Center electrode: Platinum wafer Ground electrode: Platinum pin laser-alloyed, with copper core	Center electrode: Platinum pin laser-welded Ground electrode: no precious metal, extended shell	Center electrode: Platinum pin laser-welded Ground electrode: no precious metal, with copper core	Center electrode: Platinum pin laser-welded Ground electrode: Platinum pin laser-alloyed, small hex
	202	222	300	302	330
	Center electrode: Platinum pin laser-welded Ground electrode: Platinum pin laser-alloyed, with copper core	Center electrode: Platinum pin laser-welded Ground electrode: Platinum pin laser-alloyed, BMW special version	Center electrode: Iridium wafer res.-welded Ground electrode: Iridium wafer res.-welded, small hex		
	332	339	360		
	Center electrode: Platinum pin laser-welded Ground electrode: no precious metal, extended shell, with copper core	Center electrode: Platinum pin laser-welded Ground electrode: no precious metal, extended shell, with copper core	Center electrode: Platinum pin laser-welded Ground electrode: Platinum pin laser-alloyed, with copper core, aligned and welded		
	3002	3320	3328		

Troubleshooting at a glance: Look at the “face” of the spark plug



Normal

Insulator nose from gray-white/gray-yellow to fawn brown color. Engine is OK. Heat range correctly selected. Mixture setting and timing OK, no misfiring, cold start aid functioning properly. No residues from fuel additives containing lead or alloying constituents from engine oil. No thermal overload.



Carbon-fouled

Insulator nose, electrodes and spark plug shell covered with velvet-like dull black soot deposits.

Cause: Incorrect mixture setting (carburetor, injection): Mixture too rich, air cleaner severely fouled, automatic choke not OK or manual choke actuated too long, predominantly short distance driving, spark plug too cold, heat range code number too low.

Effect: Misfiring, poor cold starting performance.

Remedy: Set mixture and starting device correctly, check air cleaner.



Oil-fouled

Insulator nose, electrodes and spark plug shell covered with shiny soot or carbon deposits.

Cause: Too much oil in combustion chamber.

Oil level too high, heavily worn piston rings, cylinders and valve guides. In two-stroke gasoline engines, too much oil in mixture.

Effect: Misfiring, poor starting performance.

Remedy: Overhaul engine, correct fuel/oil mixture, new spark plugs.



Partially melted center electrode

Center electrode partially melted, blistered, spongy, soft insulator nose tip.

Cause: Thermal overload due to auto-ignition, e.g. excessively advanced ignition timing, combustion residue in combustion chamber, defective valves, defective ignition distributor and poor fuel grade. Heat range possibly too low.

Effect: Misfiring, loss of power (engine damage).

Remedy: Check engine, ignition and mixture formation. New spark plugs with correct heat range.



Melted center electrode

Center electrode melted, ground electrode also severely corroded.

Cause: Thermal overload due to auto-ignition, e.g. excessively advanced ignition timing, combustion residue in combustion chamber, defective valves, defective ignition distributor and poor fuel grade.

Effect: Misfiring, loss of power, possibly engine damage. Overheated center electrode may cause insulator nose to crack.

Remedy: Check engine, ignition and mixture formation. New spark plugs.



Partially melted electrodes

Cauliflower-like appearance of electrodes. Possibly precipitation of material not originating from the spark plug.

Cause: Thermal overload due to auto-ignition, e.g. excessively advanced ignition timing, combustion residue in combustion chamber, defective valves, defective ignition distributor and poor fuel grade.

Effect: Loss of power prior to total failure (engine damage).

Remedy: Check engine, ignition and mixture formation. New spark plugs.



Severe center-electrode wear

Top edges of the center electrode rounded by erosion and corrosion. The electrode spacing has increased significantly.

Cause: Spark plug replacement interval not observed.

Effect: Misfiring, particularly during acceleration (ignition voltage no longer sufficient for large electrode gap). Poor starting performance.

Remedy: New spark plugs.



Severe lead deposits

In places, brownish yellow glaze on insulator nose which may also have a greenish tinge.

Cause: Fuel additives containing lead. Glaze develops under heavy engine load after lengthy operation under partial load.

Effect: With heavy loading, coating becomes conductive and causes misfiring.

Remedy: New spark plugs; cleaning has no effect.



Ash fouling

Thick ash coating from oil and fuel additives on insulator nose, in scavenging area (annular orifice) and on ground electrode. Loose to cinder-like structure.

Cause: Alloying constituents, particularly from oil, may deposit such ash in the combustion chamber and on the spark-plug face.

Effect: Can lead to auto-ignition with loss of power and engine damage.

Remedy: Repair engine. New spark plugs, possibly use different oil.



Ferrocene

Ferrocene on insulator nose, electrodes and part of the spark plug shell coated with red-orange adherent deposits.

Cause: Fuel additive containing iron. The deposits occur after a few thousand kilometers of normal operation.

Effect: The iron-containing coating is electrically conductive and causes misfiring.

Remedy: New spark plugs; cleaning has no effect.



Severe ground-electrode wear

The cross-section of the ground electrode has been reduced severely by erosion and corrosion. The electrode spacing has increased significantly.

Cause: Aggressive fuel and oil additives. Unfavorable flow conditions in combustion chamber, possibly due to deposits, engine knocking. No thermal overload.

Effect: Misfiring, particularly during acceleration (ignition voltage no longer sufficient for large electrode gap). Poor starting performance.

Remedy: New spark plugs.



Cracking of insulator nose

The ceramic insulator on the combustion chamber side is broken. Parts of the insulator base are missing.

Cause: Mechanical damage due to impact, dropping or pressure on the center electrode resulting from incorrect handling.

In marginal cases – especially after excessively long use – the insulator nose may crack due to deposits between the center electrode and insulator nose, and due to corrosion of the center electrode.

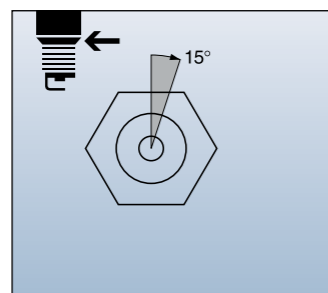
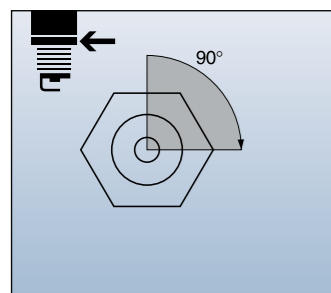
Effect: Misfiring, sparkover at points not reliably supplied with fresh mixture.

Remedy: New spark plugs.

From actual practice: The Bosch tip for spark plugs

	①	②
M 10 x1	12	12
M 12 x1.25	25	23
M 14 x1.25 < 13 mm	20	17
M 14 x1.25 > 13 mm	30	28
M 18 x1.5	40	38

	①	②
M 14 x1.25	20	15
M 18 x1.5	25	20



Spark plug installation with a torque wrench

Tightening torque (N • m): 10 N • m ≈ 1 kpm for dry, non-greased and non-oiled threads and new gaskets. For lubricated threads, reduce the specified torques by 1/3.

Exception: Spark plugs with aligned ground electrode. Follow the instructions on the packaging.

① in cast iron ② in aluminum

Spark plug installation without a torque wrench

Screw in spark plug by hand until it is seated in the cylinder head. Spark plugs with flat seat and a new gasket are then turned about 90° further with the spark plug wrench. Spark plugs with conical seat and spark plugs with a used flat gasket are then turned about 15° further.

Spark plugs with a solid gasket may only be installed using a torque wrench.

Please note!

The spark plug recommendations are issued by Bosch, where not originating from the vehicle or engine manufacturer. The recommendations apply under normal operating conditions for production models, not to racing, special-purpose or high-performance vehicles (unless specifically listed). Use of heat ranges other than those recommended may be necessary because of special operating conditions. If spark plugs with the specified electrode gap are not available, the electrode gap must be adjusted. For this, we recommend using the Bosch spark plug gage.

Know-how and technology for fast diagnoses: ESI[tronic] 2.0 software and test equipment

Bosch: Specialist for passenger car equipment

Complex networked systems in vehicles require ever more qualified diagnoses in service shops and extensive know-how for repair. For this reason, Bosch offers service shops extensive system expertise and a complete line of test equipment from a single source. Modern, powerful diagnostic equipment and the ESI[tronic] 2.0 software for service shops assist with all repairs and service work.

ESI[tronic] 2.0: Custom-designed for the service shop

Simple operation, fast access and a standardized system for all brands make the ESI[tronic] 2.0 software a user-friendly diagnostic tool. Extensive market coverage and ongoing updates are part of the offer. Thanks to the modular design, an ignition system specialist can subscribe to only the types of information relevant to him.

ESI[tronic] 2.0: Diagnosis with troubleshooting instructions

ESI[tronic] 2.0 (Electronic Service Information) offers a great deal more than just control unit diagnosis. The troubleshooting instructions SIS (Service Information System) provide step-by-step guidance for troubleshooting. And all information needed for maintenance and service – whether passenger car, van or truck – is immediately available at the vehicle. Relevant service and repair data for new vehicle models is available in ESI[tronic] 2.0 starting six months after the vehicle appears on the market.

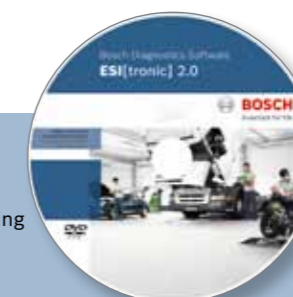
Especially for ignition systems:

- ▶ ESI[tronic] 2.0 information type C
Control unit diagnosis, including troubleshooting
- ▶ ESI[tronic] 2.0 information type M
Information on gasoline systems



ESI[tronic] 2.0 and test equipment from Bosch: A successful duo for diagnosis and repair

- ▶ A high level of functionality in conjunction with simple operation saves time
- ▶ Accurate diagnoses for successful correction of problems
- ▶ Fast and reliable repairs for a high level of customer satisfaction
- ▶ A combination of troubleshooting instructions (SIS) and control unit diagnosis (SD) across makes
- ▶ For gasoline and diesel engine management systems and passenger car brake systems; from Bosch and other manufacturers
- ▶ Modular concept, tailored to the needs of the individual service shop
- ▶ Exceptional diagnosis with Bosch test equipment
- ▶ Extensive range of test equipment for control unit diagnosis, vehicle system analysis, emissions analysis, air conditioning service, battery service, brake tests, tire service and headlight aiming



Knowledge for a competitive edge: Service training, Technical Hotline and knowledge database



Even experienced automotive experts face unknown problems or new systems developed by the automotive industry. The continually updated training offering and the Technical Hotline with the Bosch knowledge database support you in more quickly localizing problems, repairing more vehicles, and reducing the wait times of customers. Moreover, the methodic procedures that are taught ensure faster and more productive work.

- +** Knowledge transfer in theory and practice:
- ▶ Modern training centers worldwide
 - ▶ Up-to-date, extensive training program
 - ▶ Online database available around the clock
 - ▶ Technical Hotline with expert assistance
 - ▶ Remote Diagnosis – on the service shop PC
 - ▶ Detailed, informative publications

Learning at the highest level: Bosch Service Training

With the new developments in the area of vehicle technology, the technical know-how requirements in service shops are constantly increasing. For service shops to keep up with technology, continuing education is essential. The technical and commercial training offered by Bosch is updated continually to match the state of technology. In this way, service shop professionals always receive up-to-date training.

Technically always up to date: Technical training

There are suitable training courses for every target group – whether novice or pro. The training courses are offered in different technical areas and training series (e.g. gasoline injection, diesel injection, or electrical systems). Extensive know-how is presented for all commonly encountered automotive systems from Bosch and other manufacturers.

Business promotion: Commercial training

The commercial training courses offer service shops a broad spectrum of opportunities to maintain their position over the long term in a highly competitive industry, and to grow. Professional company management, technology for sales personnel, self- and time

management are major topics. The commercial training courses from Bosch are aimed at owners, shop managers, chief executive officers, employees from service and sales, and car dealerships.

Fast information: Technical Hotline

In addition to telephone assistance, the Bosch Technical Hotline offers the knowledge database. All Hotline cases processed are documented there and can be searched for solutions with the aid of search filters. If a solution is not available a so-called trouble ticket is issued and processed immediately by a Hotline expert. The How2Fix app offers mobile access (Android/iOS).

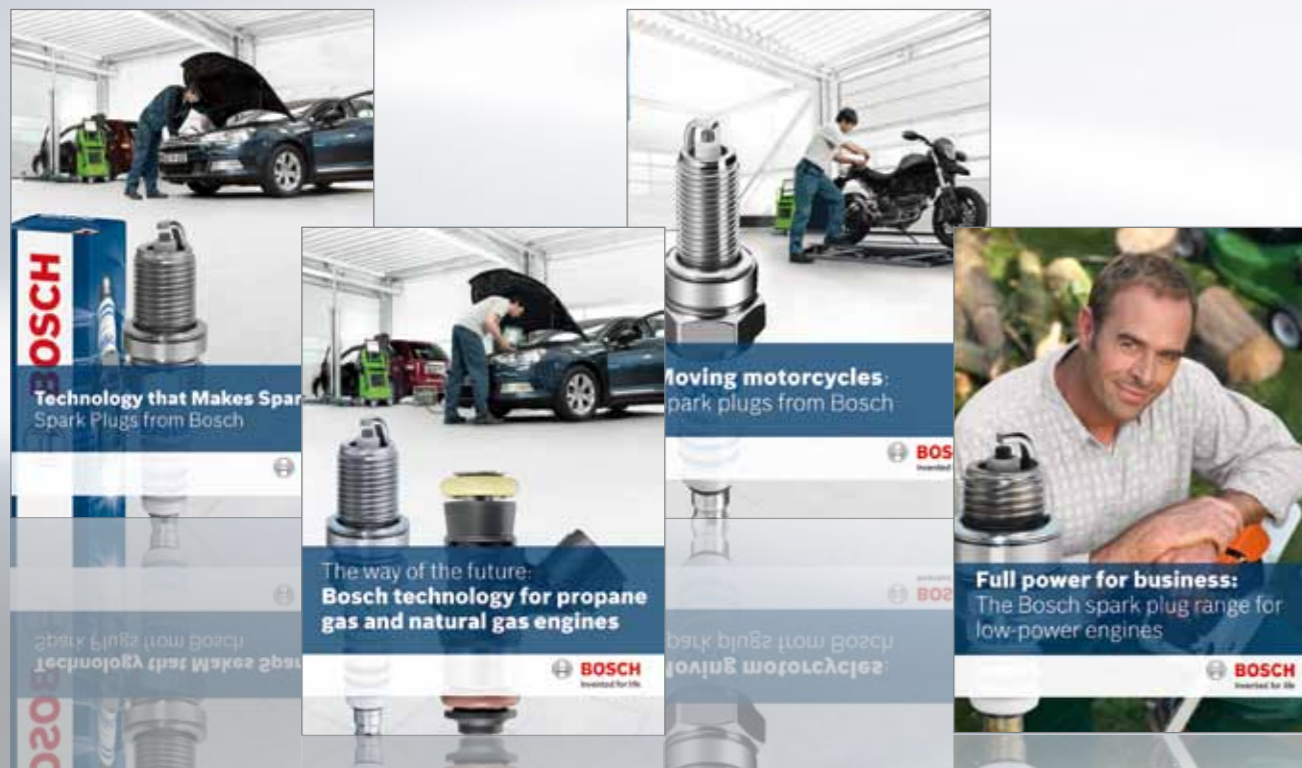
Direct access: Remote diagnosis

Especially fast assistance from the Technical Hotline is available in the form of remote diagnosis. In this case, a Bosch technician connects his computer directly to the PC in the service shop and together with the service shop employee carries out help functions and test equipment applications.



Advise, inform, convince: Sales promotion at the highest level

- +** Extensive advertising and information material
- ▶ Greater name recognition and brand acceptance based on media presence
 - ▶ Complete advertising material from displays to catalogs and brochures



Information for the service shop

Being well-informed also means: selling better. Customers love to receive information about their vehicle. The more that service shops and automotive parts retailers know about service shop products, the better they can provide specific information for customers.

What you need to know: Information brochures

Clearly organized, detailed information about special topics focusing on Bosch spark plugs.

- ▶ Spark plug brochure – Provides a comprehensive overview of the entire line of spark plugs from Bosch
- ▶ Spark plugs for motorcycles – An overview of the extensive Bosch product line for motorcycles
- ▶ Small engines – Everything you need to know about spark plugs in small engines
- ▶ Cast gas applications – What is essential to know about gas-powered vehicles



Know-how on a large scale: Service shop posters

Clear, detailed and perfectly made to hang where the information is needed – Service shop posters from Bosch.

- ▶ Spark plug faces: Effect and causes
- ▶ Spark plug construction: Technology down to the smallest detail



The more knowledge the service shop has about spark plugs, the better the customer can be informed

Complete and fast information: Catalogs, drop-down list box

All products, all services. Clearly organized and ready to be found quickly.

- ▶ Spark plug catalog
- ▶ Spark plug catalog for two wheeled vehicles
- ▶ Spark plug and glow plug catalog
- ▶ Drop-down list box for rapid matching of the appropriate spark plug to the specific vehicle model

At a glance: Data and facts about spark plugs



Terminals nuts

Provides contact between the spark plug connector and center electrode of the spark plug. Conducts the ignition voltage to the electrode.

Battery-coil ignition

Use of an ignition coil to generate a high voltage and help create the spark.

Gasoline direct ignition

With this modern approach, gasoline is injected under pressure through a common rail system directly into the combustion chamber of the cylinder. This permits stratified mixing with less fuel than in conventional injection.

Torque

Unit of measure, to be observed especially when installing spark plugs.

Sintered center electrode

With the aid of a high-temperature process, the center electrode is bonded tightly to the ceramic through shrinkage.

Single-ground electrode

Spark plugs employing the air spark principle with only one ground electrode.

Electrode gap

The electrode is the shortest distance between the center electrode and ground electrode. The voltage plays an important role with regard to the electrode gap. If the voltage is too low, the spark cannot jump the gap.

Spark duration

The duration of the ignition spark between the electrodes (about 2 ms). It must be maintained long enough for the air-fuel mixture to be ignited.



Surface gap

Path that the spark follows when it first moves over the surface of the insulator tip and then jumps to the ground electrode. Along this path, it burns away disturbing deposits and combustion residues.

Homogeneous mixture

For engines with intake manifold fuel injection. Lambda is the same everywhere in the combustion chamber. Even engines with a lean mixture (high amount of air in the combustion chamber) are operated with a homogeneous charge.

Inner gasket

It provides the gas-tight connection between the insulator and metal body, and dissipates heat.

Insulating paste

Used between the spark plug connector and ceramic. The use of insulating paste prevents head sparkovers.

Insulator

The insulator consists of an aluminum oxide ceramic and insulates the center electrode with respect to ground for up to more than 45,000 V.

Insulator nose

Projects into the combustion chamber and its design has a major impact on the heat range of a spark plug.

Head sparkover

Discharge of a high voltage as the result of dirt or moisture. When head sparkover occurs, the spark discharges travel from the high-voltage terminal nut to the shell via the ceramic.



Leakage current barrier

It prevents the high voltage running along the outside (head sparkover). For this reason, the upper region of the insulator has corrugations around it.

Air spark gap

Path that the spark follows between the electrodes to ignite the air-fuel mixture in the combustion chamber.

Air/surface gap

Spark paths that can occur in the air and on the insulator. Electrode burn-up can be reduced through a combination of mutually independent air and surface gaps. This extends the service life of the spark plug considerably.

Air-fuel mixture/lambda

For complete combustion of the air-fuel mixture in the combustion chamber, the components of this mixture must be present in a stoichiometric ratio. This is the case for 14.7 kg of air for 1 kg of fuel. This ratio is designated "lambda". At a stoichiometric ratio, lambda equals 1.

Lean mixture

The fuel-air mixture contains more air than necessary. The consequence is misfiring. Fuel consumption increases, power decreases. Once a certain proportion of air is reached, the mixture can no longer be ignited. Use of a pin-to-pin spark plug is beneficial.

Multi-ground electrode

Spark plugs employing the surface or air/surface principle with two, three or four ground electrodes.



Shunt

Branch of a parallel arrangement of electrical power consumers.

Rich mixture

The air-fuel mixture contains more fuel than can be burned. For a cold start, a larger amount of fuel must be injected to compensate for the losses occurring as the result of condensation of fuel.

Stratified charge

The air-fuel mixture is prepared in such a way that at the moment of ignition a combustible mixture exists only in the region of the spark plug (lambda = 1). The rest of the combustion chamber contains only a very lean, poorly combustible mixture (lambda ~ 10). This improves the efficiency of the engine in terms of emissions and fuel consumption.

Self-cleaning temperature

High temperature at which residues on the insulator nose are burned off. The spark plug is cleaned at approx. 450 °C.

Auto-ignition temperature

This temperature occurs at about 850 °C. Above this value, auto-ignition can become a problem. The air-fuel mixture can auto-ignite on overheated components in an uncontrolled manner, without ignition sparks, and damage or even destroy the engine.



Thermal ignition

The term "auto-ignition" is used to describe ignition of the fuel-air mixture that occurs independently of spark plugs and usually at hot surfaces (e.g. on the overly hot surface of the insulator nose of a spark plug with too high a heat range). Based on their time of occurrence relative to the moment of ignition, they can be divided into two categories:

a) Post-ignition

Post-ignition occurs after electrical ignition, but is not critical for practical engine operation, since the electrical ignition always occurs earlier. To determine whether the spark plug is causing thermal ignition, the electrical ignition spark must be suppressed during this measurement. When post-ignition occurs, the ion current increases noticeably only after the moment of ignition. However, since ignition is being triggered, a pressure increase and thus torque output can also be registered

b) Pre-ignition

Pre-ignition occurs before electrical ignition and can cause serious engine damage because of its uncontrolled behavior. Because of the premature triggering of combustion, not only does the pressure maximum shift to top dead center; the maximum combustion chamber pressure shifts to higher values as well. This increases the thermal load on components of the combustion chamber. This is why the spark plug must be designed so that no pre-ignition occurs.



Type code

The spark plug specifications are contained in the type code. It contains all key characteristics of the spark plug.

Shrink fit process

Used to bond the nickel-plated spark plug shell gas-tight to the insulator.

Heat range

The term "heat range" was introduced by Bosch. The term applies to specification of the thermal design of a spark plug. It is an indication of the maximum thermal load established on the spark plug when there is equilibrium between heat absorption and heat dispersal.

Ignition energy

The let-through current and design parameters of the ignition coil determine the amount of energy that is stored in the ignition coil and used as ignition energy (ignition spark). The correct ignition energy is important for ignition of the air-fuel mixture, as only efficient ignition guarantees high power and low emissions.

Ignition

The ignition process is controlled by the engine. The ignition system generates a high voltage in a periodic manner. This voltage causes, in the form of a spark, an electric discharge between the electrodes of the spark plug. This spark ignites the compressed air-fuel mixture in the combustion chamber.

Frequently asked questions about spark plugs: Know-how from experts for experts

What is the function of the spark plug and why are spark plugs "essential" for operation of the engine?

The spark plug must ignite the air-fuel mixture in the combustion chamber of a gasoline-powered engine by means of an electric spark. During operation, the spark plug becomes soiled and is subject to wear. The larger electrode gap that results increases the ignition voltage required. If the ignition voltage required exceeds the ignition voltage supplied by the ignition coil, misfiring results. For this reason, spark plugs must be replaced regularly.

Is the electrode gap set during manufacturing?

Electrode gaps are set during manufacturing. Readjustment of the electrode gap usually is not necessary when changing spark plugs.

The electrode gap for every vehicle application is listed in the Bosch spark plug catalog. The electrode gap is stated on the spark plug packaging.

What is pre-ignition?

When an unsuitable spark plug is used, pre-ignition or glow ignition may occur. That is why it is especially important that the appropriate spark plug be selected with the aid of the catalog.

Pre-ignition (glow ignition) is an uncontrolled ignition process where the temperatures in the combustion chamber can increase to such a level that serious damage to the engine and spark plug occurs. During operation under full load, glow ignition can occur at the following locations:

- ▶ At the tip of the insulator nose on the spark plug
- ▶ At the exhaust valve
- ▶ At protruding cylinder head gaskets
- ▶ At loose deposits

What is knocking in an engine?

When an unsuitable spark plug is used, knocking can occur in the engine. That is why it is especially important that the appropriate spark plug be selected with the aid of the catalog.

The term "knocking" describes uncontrolled combustion with a very rapid pressure increase. Such uncontrolled combustion occurs in auto-igniting portions of the mixture that ignite without a spark. The combustion takes place considerably faster than normal combustion. Pressure fluctuations with high peak pressures and high frequencies occur and are superimposed on the normal pressure curve. When the combustion pressure reaches the walls of the combustion chamber, metallic knocking noises are created. If the cause of knocking is not corrected in time, engine damage can result.

What is the heat range of a spark plug?

The heat range is used to specify the thermal design of a spark plug. It is an indication of the maximum thermal load established on the spark plug when there is equilibrium between heat absorption and heat dispersal.

Can the same spark plugs be used if the engine output has changed?

If the output of an engine is increased, e.g. through use of a turbocharger, a blower system or other systems, the recommended spark plug cannot be used. A spark plug with a lower heat value must be used to compensate for the additional heat generated by the engine. In such a case, Bosch recommends consulting a qualified engine builder to assist with determination of the correct heat range.

What replacement intervals are recommended for spark plugs?

Usually, the spark plug replacement interval is stated in the vehicle manual. Bosch recommends that the spark plugs be inspected annually and, if necessary, replaced in order to ensure optimal engine output.

What are the loads on a spark plug?

A spark plug must meet electrical, mechanical, chemical and thermal requirements.

- ▶ Electrical requirements: The spark plug must function under extreme conditions. During ignition, voltages of up to 40,000 V and combustion chamber temperatures greater than 1,000 °C occur. Optimal insulation is a prerequisite.
- ▶ Mechanical requirements: Spark plugs must be able to withstand an alternating pressure of about 100 bar in the combustion chamber. They must retain their mechanical integrity under all operating conditions.
- ▶ Chemical requirements: Resistance to chemicals in the combustion chamber and aggressive (corrosive) residues from the combustion process.
- ▶ Thermal requirements: Thermal shock resistance (hot gases and cold incoming air-fuel mixture). Good thermal conduction by the insulator and the electrodes is a prerequisite for reliable operation.

Why are there ribbed and smooth insulators?

The shape of the insulator depends on the high-voltage connection or spark plug connector used. For closed boot connectors, smooth insulators (i.e. without ribs) are used. For open connectors, insulators with leakage current barriers (i.e. with ribs) provide benefits.

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