

# Tips & Technology

For Bosch business partners

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## Gasoline injection

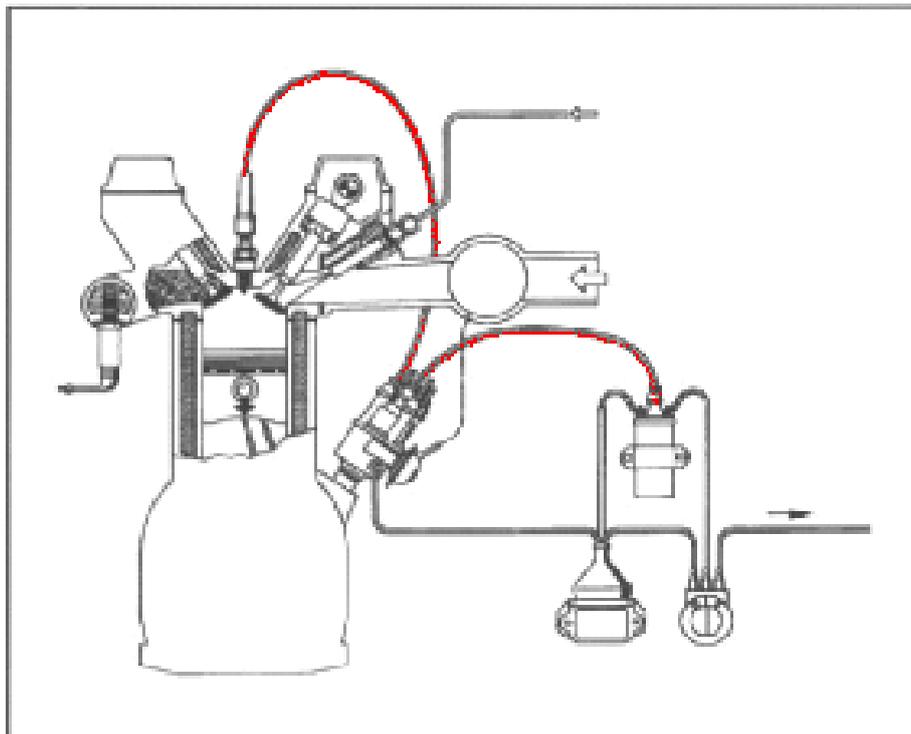


**BOSCH**

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## Ignition cables – technical information

In gasoline engines, the high voltage required to ignite the fuel/air mixture is generated by ignition systems. The ignition cables act as "veins". It is their task to ensure loss-free transmission of the high voltage from the ignition coil via the distributor to the spark plugs. A further function is to dampen the high-frequency interference arising from voltage or current peaks which could otherwise cause malfunctioning of the vehicle electronics.



Defective ignition cables can lead to misfiring, increased fuel consumption, poor emission values and even destruction of the catalytic converter. If ignition cables do not provide adequate suppression, electromagnetic interference can result in the failure of electronic systems of relevance to safety such as ABS or airbags. Ignition cables therefore have to satisfy a variety of demands:

Mechanical requirements:

- Reliable contact
- High tensile strength
- Accuracy of fit

Electrical requirements:

- High-voltage strength to above 40,000 V
- Good interference suppression, minimum influence of ignition system on engine electronics

Thermal requirements:

- Thermal stability (- 60°C to + 200°C)
- Non-flame propagating

Chemical requirements:

- Resistance to corrosive substances (gasoline, oil, acid, salt, cold cleaning agent)

The Silicone Power resistance ignition cable and the Silicone Copper copper core ignition cable from Bosch correspond to original equipment quality and thus satisfy all these requirements.

**Design of ignition cables**

Ignition cables consist of an inner conductor, inner conductor insulation, a fiber-glass braid, an outer sheath and two connectors. The inner conductor is the actual current conductor. A distinction is made between resistance ignition cables and copper core ignition cables depending on the design of the inner conductor.

Inner conductor insulation

The inner conductor transmits high voltages of up to 40,000 V. Any losses can result in arcing or misfiring. The inner conductor is therefore provided with insulation to guard against losses.

Fiber-glass braid

Top quality ignition cables such as Silicone Power and Silicone Copper from Bosch have a fiber-glass braid located between the inner conductor insulation and the outer sheath. The fiber-glass braid enhances the mechanical tensile strength of the ignition cable.

Outer sheath

The outer sheath provides additional insulation, protects the internal parts of the ignition cable against damage and helps to prevent voltage loss.

Connectors

Connectors connect the ignition cable to the ignition coil, the distributor or the spark plugs and provide electrical contact between the ignition system components. Support sleeves at the contact connections prevent the ingress of moisture.

A distinction is made between the connectors on the ignition coil and distributor end and those on the spark plug end. The reason for this distinction is the higher thermal load on the connector at the spark plug end.

## Resistance ignition cables

### Inner conductor

Depending on the design of the inner conductor, a distinction is made between resistance ignition cables based on the reactance principle and those with interference suppression resistor. Both types offer good conductivity but differ considerably in terms of the quality of interference suppression. Resistance ignition cables with interference suppression resistor provide good suppression in both the VHF and MW range, whereas those employing the reactance principle only provide good suppression in the VHF range.

### Resistance ignition cables based on the reactance principle

Resistance ignition cables employing the reactance principle consist of a wire coil with ferromagnetic core. This results in

- + Good conductivity
- + Low resistance
- + Good interference suppression in the VHF range, however
  - Added inductive reactance
  - Poor interference suppression in the MW range (due to the inductive reactance)
  - Risk of wire break when working on ignition cable

### Resistance ignition cables with interference suppression resistor

Resistance ignition cables with an interference suppression resistor consist of a robust carbon-impregnated inner conductor made up of several glass fibers. This results in

- + Good conductivity
- + Good interference suppression in the VHF and MW range
- + Long service life
- + High mechanical strength

### Inner conductor insulation

The inner conductor insulation is usually made of silicone or EPDM (ethylene propylene diene monomer). Both materials exhibit outstanding insulating properties. Silicone is also extremely heat resistant. EPDM is characterized by high heat resistance and a high strength.

### Outer sheath

The outer sheath must exhibit great thermal stability in view of the extremely high ambient temperatures encountered by ignition cables in modern vehicles. Good resistance to chemical substances is also essential. Use is generally made of PVC (polyvinyl chloride), CPE (chlorinated polyethylene), Hypalon and silicone as materials for the outer sheath.

- The thermal stability of PVC is so low (90°C) that there is even a risk of melting in certain situations. The positive aspects are good resistance to chemical substances and inexpensive production.
- CPE possesses good thermal stability (140°C). It is resistant to chemical substances and relatively inexpensive to make.

- Hypalon exhibits good thermal stability (152°C) and is extremely resistant to chemical substances. The drawbacks are that this material is readily flammable and does not meet environmental standards.
- Silicone has the greatest thermal stability (204°C). It is thus the only material to always maintain an adequate safety margin even under extreme conditions. Silicone is also highly resistant to chemical substances. Further advantages over PVC, CPE and Hypalon include flame retardant properties, high environmental standards and a long service life. The high manufacturing costs are however a drawback.

### Connectors

The connectors consist of the connector contact and the sleeve which protects the contact connection against the ingress of moisture. The connector contact is made of a corrosion-resistant material such as brass or stainless steel. The connector quality largely depends on the material used for the sleeve - usually PVC, EPDM or silicone.

- PVC has a very low thermal stability (90°C) and is therefore not suitable for use as sleeve material.
- EPDM has a relatively high thermal stability (150°C) and is a highly suitable material for the sleeve on the ignition coil/distributor end.
- Thanks to its high thermal stability (204°C), silicone is ideal for use as sleeve material on both the ignition coil/distributor and the spark plug end.

### **Copper core ignition cables**

#### Inner conductor

The inner conductor of copper core ignition cables is made up of several copper strands. In top quality ignition cables, these are tinned to prevent oxidation and maintain optimum conductivity.

Copper core ignition cables feature

- + Very low resistance
- + Very high conductivity
- + Very long service life
- + Outstanding mechanical strength
- + Excellent interference suppression over a very broad frequency range

#### Inner conductor insulation

As with resistance ignition cables, use is again made of EPDM or silicone as inner conductor insulation material for copper core ignition cables.

#### Outer sheath

The outer sheath of copper core ignition cables is exposed to the same environment as that of resistance ignition cables. When compared to PVC, CPE and Hypalon, silicone therefore again proves to be the most suitable material for copper core ignition cables.

## Connectors

Copper core ignition cable connectors have a double function. They connect the ignition cable to the ignition coil, the distributor or the spark plugs and additionally provide interference suppression for the ignition system. For this purpose the connector is fitted with an interference suppression resistor which is located close to the source of interference and thus ensures outstanding suppression for the ignition system.

The connector quality depends on both the interference suppression resistor and the sleeve material used. Ideally use should be made of a frequency-dependent interference suppression resistor precisely matched to the vehicle concerned. Silicone is the most suitable sleeve material on account of its high thermal stability and the associated safety margin.

## **Bosch ignition cables**

### Bosch Silicone Power

The Silicone Power high-performance ignition cable was developed specially for vehicles fitted with a resistance ignition cable at the factory.

The robust inner conductor of the Silicone Power cable is made of carbon-impregnated fiber glass. Silicone Power is thus characterized by high conductivity and good interference suppression in the VHF and MW range.

The inner conductor insulation made of EPDM guards against voltage losses. A fiber-glass braid over the inner conductor insulation provides additional reinforcement for the ignition cable.

The silicone outer sheath is resistant to both heat and chemical substances.

The connectors on the ignition coil/distributor end are made of brass or stainless steel. EPDM sleeves provide reliable protection against the ingress of moisture. The connector on the spark plug end is made of stainless steel. A Posilock ring clip ensures reliable connection. A silicone sleeve guards against the ingress of moisture and can withstand the high temperatures on the spark plug end.

Product features:

- Reliable contact
- High strength
- Good radio interference suppression in the VHF and MW range
- High thermal stability
- Great resistance to corrosive substances
- Very low flammability
- Highly corrosion-resistant connectors
- Long service life

### Bosch Silicone Copper

The Bosch Silicone Copper high-performance ignition cable set is available for vehicles fitted at the factory with copper core ignition cables.

The inner conductor of the Silicone Copper cable is made of twisted copper wires. The copper wires are tinned for even greater conductivity.

The inner conductor insulation made of silicone is highly resistant to heat.

A fiber-glass braid over the inner conductor insulation provides additional reinforcement for the ignition cable.

The silicone outer sheath is resistant to heat and not susceptible to chemical influences.

The Silicone Copper connectors have an M4 or SAE contact. The polyester-thermoplastic encapsulation makes them shatter-proof and heat-resistant. Additional heat resistance is provided by sleeves made of high-grade silicone.

In copper core ignition cables, interference is suppressed in the connector. For this purpose, all Silicone Copper connectors are fitted with an exactly matched frequency-dependent interference suppression resistor for outstanding damping action.

Partly shielded versions are also available which have an interference suppression sheath made of galvanized sheet metal or stainless steel over the connector contact for extra shielding. Fully shielded versions are available from Bosch for vehicles such as taxis or ambulances with sensitive two-way radio systems. With these versions, an additional interference suppression sheath covers the entire ignition cable and the connector.

Product features:

- Reliable contact
- Very high strength
- Excellent radio interference suppression over a very broad frequency range
- High thermal stability
- Great resistance to corrosive substances
- Very low flammability
- Highly corrosion-resistant connectors
- Excellent heat dissipation
- Long service life