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Delphi Ionization Current Sensing Ignition Subsystem

▶ Description

Delphi's Ionization Current Sensing Ignition Subsystem (Ion Sense) is a technology based on the principle that electrical current flow in an ionized gas (e.g. during combustion) is proportional to the flame electrical conductivity. By placing a direct current bias on the spark plug electrodes, the conductivity can be measured.

Delphi's Ion Sense Subsystem consists of one ignition coil per cylinder and high-temperature-resistant electronics. Moving parts and high-voltage leads are eliminated to help provide maximum energy supply to the spark plug. In this

Delphi's Ionization Current Sensing Ignition Subsystem started vehicle production in 1999.

design, the spark plug not only ignites the air/fuel mixture but also acts as an in-cylinder sensor to monitor the combustion process. The resulting Ion Sense signal contains combustion information. Processing of the signal allows it to be used for engine control features that require knowledge of combustion characteristics.

Features of production Delphi Ion Sense Subsystems have included coil per plug ignition, all speeds and loads-compliant generation two on-board diagnostics (OBD-II) misfire detection and direct in-cylinder knock detection. Delphi's Ion Sense technology has also been used in motorcycle applications for knock detection and control.

▶ Benefits

- Ion Sense signals provide direct, in-cylinder combustion information to the engine controller. Processing of this information can enable engine control features that require knowledge of combustion characteristics. In addition to improved engine control, development time may be reduced.

- Ion Sense knock detection eliminates vibration-based knock sensors for lower system cost and improved knock sensitivity and detection. Knock detection is robust to valve train and other mechanical noises.

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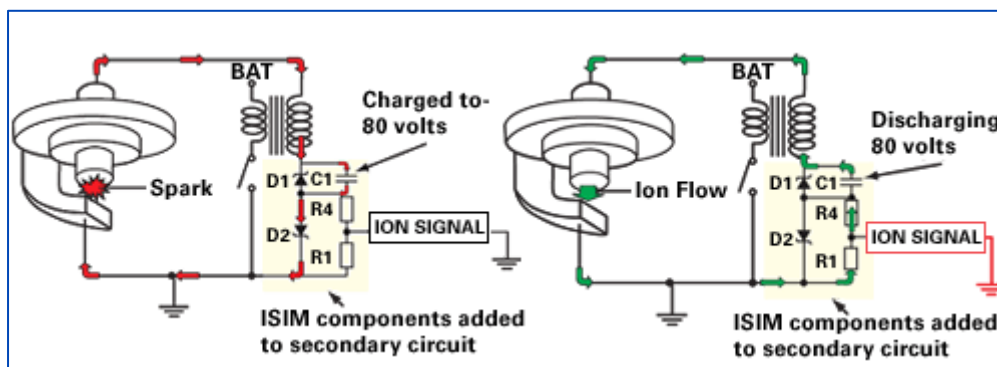Tel: (1) 248.813.2000 | www.delphi.com | **1**

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- Ion Sense OBD II misfire detection improves misfire detection capability.

- Direct in-cylinder measurement of the combustion process provides the ability to compensate combustion due to fuel variation and, thus, helps to reduce cold-start hydrocarbon (HC) tailpipe emissions to help meet PZEV requirements.

- Ramp and fire electronics provide decreased power dissipation and greater efficiency. The igniter, bias, and buffer circuits are fully integrated and encapsulated in the coil as one unit.

▸ Typical Applications

Delphi's Ionization Current Sensing Ignition Subsystem can be used in all current and future two-valve and multi-valve engine programs, including passenger vehicles and small gasoline engine applications such as motorcycles.

▸ Spark Event—Spark Current Flow (left) and Measurement Period—Ion Current Flow (right)
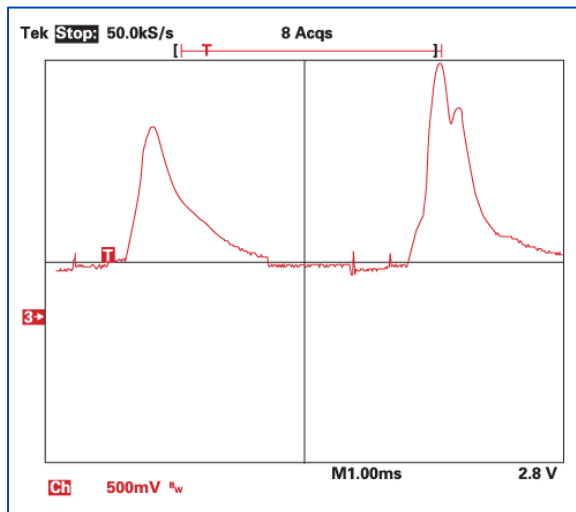

In the configurations shown, the spark current is used to create a bias voltage, eliminating the need for an additional voltage source. The measured spark gap current after the spark event reflects the combustion process. Related parameters are extracted through signal processing.
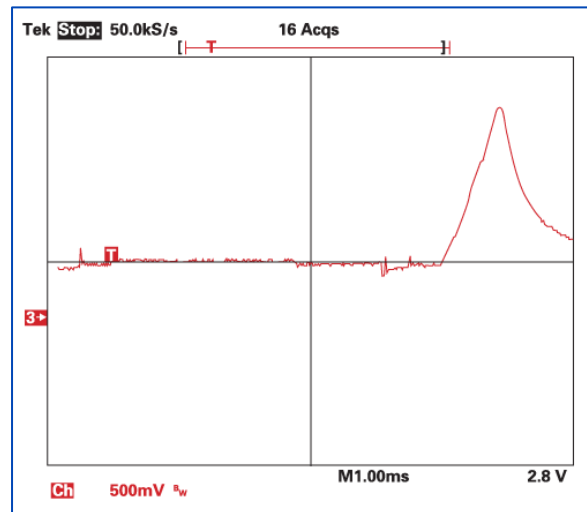

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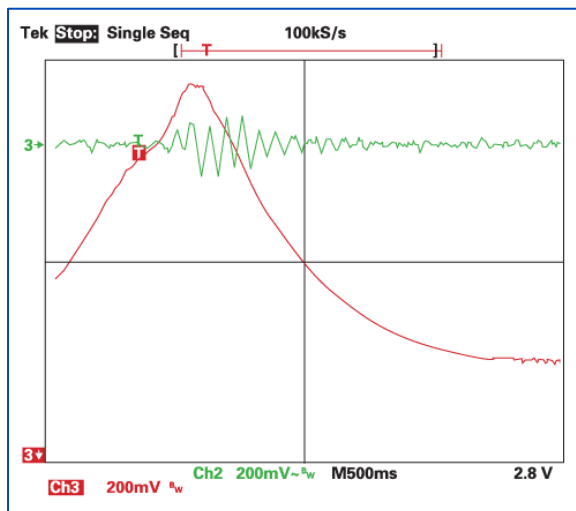
▸ Ion Current Waveforms

Normal Combustion

Misfire in one cylinder

Knock

In addition to the described system performances, Ion Sense systems enable continued development of future functionality and advanced features such as: location of peak pressure (LLP), cold start compensation, dilution control and pre-ignition detection.
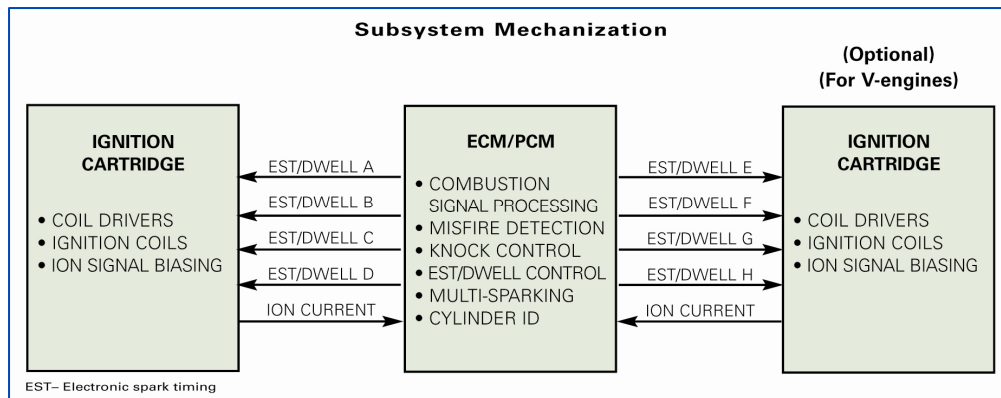

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▶ **Typical Plug Top Ion Sense Coil Performance Specifications (Engine dependent)**

Energy (800 V zener)	40 mJ
Peak secondary current (800 V zener)	175 mA
Secondary voltage available (25 pF)	37 kV, primary clamped
Spark duration (800 V zener)	0.6 ms
Secondary resistance	3.0 kΩ
Primary resistance	0.4 Ω
Primary charge time	1.4 ms
Weight	200 g
Notes	10 A @ 14 V, 23° C

These are example values for a typical package. Other performance levels are available.

▶ **Subsystem Mechanization**

This chart demonstrates a potential in-vehicle application of Delphi's Ion Sense Subsystem.

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▶ Performance Advantages

With Delphi's Ion Sense technology, the conventional spark plug acts as an intrusive sensor in the cylinder to obtain information about each combustion event with minimal influence due to environmental conditions such as vibration, mechanical noise, and temperature. Optimized individual cylinder knock control helps increase engine efficiency and reduce fuel consumption. Through Delphi's Ion Sense technology, misfire detection is OBD II capable and provides very high reliability and robustness compared to many other detection methods. Advanced features of Delphi's Ion Sense Subsystem, such as compensation of combustion due to fuel variation, are also available to help reduce cold-start HC tailpipe emissions.

▶ The Delphi Advantage

Delphi has more than 100 years experience in ignition systems and builds more than 23 million ignition coils and systems each year. With a global network of engineering centers and low-cost ignition systems manufacturing facilities in Europe, Asia, North America, and South America, Delphi can provide just-in-time delivery to support manufacturers around the world.

Delphi has a long history of supplying gasoline engine management systems and components that have helped manufacturers overcome market and regulatory challenges around the world. That experience provides manufacturers with unique systems-level knowledge and analysis capabilities. Only Delphi offers a complete engine management systems product portfolio, including:

- Fuel injection systems
- Ignition systems
- Air and fuel management
- Electronics
- Sensors and actuators
- Valve train systems
- Fuel handling systems
- Evaporative emissions systems

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