# Introduction to Automotive Ignition Systems

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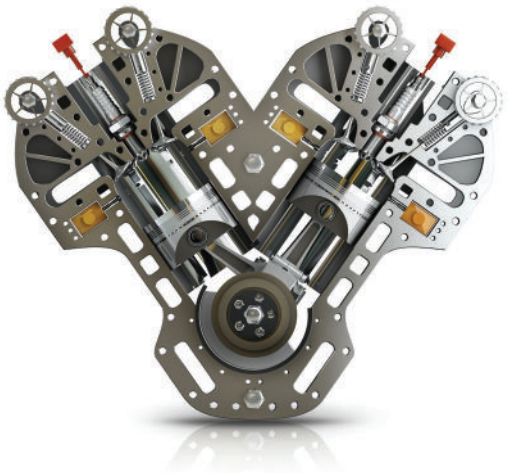
Electric passenger vehicles are still in a nascent phase of development. Currently, only 1% (550,000 vehicles) of the world's cars use electric power. The reasons for such low and slow market penetration is due to the short range of the batteries, the lower price of the electric vehicles for the same power, and/or the scarce number of models available in the market.

Also, the electric grid infrastructure essential to serve this application is incomplete and the number of charging poles unable to support a large electric vehicle fleet.

This is why the US Department of Energy estimates that 82% of all new vehicles will continue to run on fossil fuel for the foreseeable future.

Subsequently, **in order to reduce the environmental impact of cars we must focus on making gas-fueled vehicles "greener".** In other words, we need to optimize the efficiency of the engine. A good design of the vehicle's electronic ignition system offers the best way to guarantee a controlled, safe, and optimal combustion.



## The Inductor Discharge Ignition System (IDI)

To understand a vehicle's electronic ignition system, we created a simplified ignition system diagram below along with a detailed explanation of the IDI system:

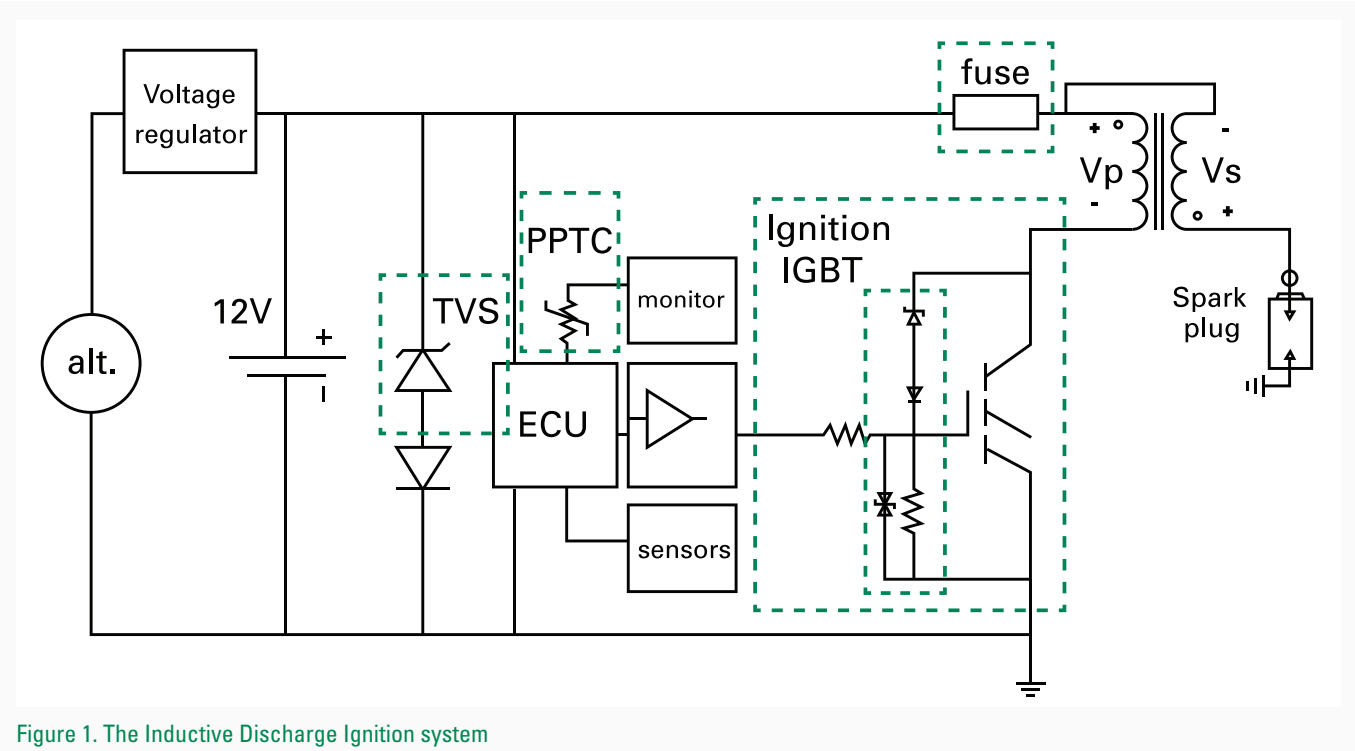



Figure 1. The Inductive Discharge Ignition system

Before we discuss the IDI in detail, remember that the spark event in the combustion chamber of the gasoline engine is controlled by the ignition system.

At the heart of the ignition system is the Ignition Insulated-Gate Bipolar Transistor (Ignition IGBT). Its robustness, precision and proper behavior determine the efficiency of the overall system.

When the Ignition IGBT switches on, it closes the loop battery-primary of the ignition coil-ground. As the current increases in the primary winding of the ignition coil, energy is stored both in the primary inductor and in the transformer core.

When the Ignition IGBT is turned off, the sudden di/dt provokes a high peak of voltage on the collector-emitter of the Ignition IGBT.

The energy stored in the core of the transformer spikes the voltage on the secondary inductor provoking the spark event. Additionally, the energy from the leakage inductance must be absorbed by the Ignition IGBT.

## Protection of the Ignition System

The high voltage spike in the collector-emitter may damage the Ignition IGBT. This is why the Ignition IGBT must be clamped at 350-450V. Also, the gate must be protected against Electrostatic Discharge (ESD) spikes.

The fuse disconnects the electronics from the battery in case of overcurrent. This fuse is regularly subjected to recurring pulses, and must have a high I2t for long life. Voltage across the fuse can be high due to the switching of transformer. These fuses should be able to deal with a harsh environment and high operating temperature.

Another key component in the ignition system is the TVS diode. The ignition system is connected to the car battery, which supplies different loads. Inductive loads or even transients in the alternator may cause voltage spikes along the power line. These transmitted spikes can cause the electronics to malfunction or do serious damage to the Ignition Electronic System. A TVS diode protects the circuitry against these events.

In some type of ignition systems, the health of the ignition system is monitored and feedback is sent to the control unit. If the monitor is physically separated from the control unit, a resettable fuse can help. In this case, the Electronic Control Unit (ECU) is protected if an overcurrent runs across the cable through which the feedback is sent.

## How Littelfuse Ignition IGBTs Help

Littelfuse is a leading manufacturer of auto protection devices with a strong presence in ignition systems. Our Ignition IGBTs are used every year in more than 20 million new cars.

Littelfuse Ignition IGBTs manage and control the current across the coil for a precise spark generation. They contain an integrated clamp structure and gate ESD protection in the silicon. Ignition IGBTs provide an exceptionally low saturation voltage.

Ignition IGBTs can withstand avalanche energies up to around 300 mJ, enough to withstand worst case scenarios (like an open secondary or defective spark plugs).

*Littelfuse Ignition IGBTs features include:*

- DPAK and D2PAK options.
- *Selection of clamping voltages.*
- *Automotive qualified as per AEC-Q101.*

Ignition IGBTs are ideal for coil–on–plug applications and other automotive compact applications, but also for other ignition applications such as motorbikes, garden tools, leisure vehicles, etc.

## Littelfuse Automotive Fuses for Ignition applications

Littelfuse 437A and 440A fuses are 100% Lead-free, RoHS compliant, and Halogen-free fuse series designed specifically to provide overcurrent protection to circuits that operate under high working ambient temperatures up to 150°C and high inrush currents.

The general design ensures excellent temperature stability and performance reliability. These high I²t fuse series are designed to have ultra-high inrush current withstand capability to avoid nuisance fuse open.

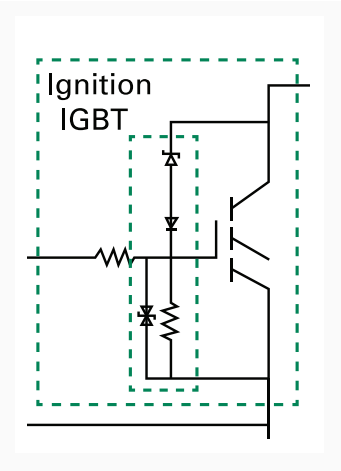
Littelfuse series 437A and 440A fuses provide a high I2t for a reliable, long life which is necessary for the recurring pulses in the ignition system, the harsh environment, and high operating temperature.

Customers rely upon these fuses because:

- They are rated Auto grade.
- They also withstand the high voltage from the switching of the ignition coil.
- Littelfuse offers customized solutions for our customers' variety of automotive applications.

## TVS Diodes for Ignition Applications and PPTCs

As we stated above, Littelfuse TVS diodes TPSMB/C/D and SLD8S are designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events.




They provide protection against transient surges: load dump, ignition coil interruption and other switching spikes.

Our TVS diodes have a fast response time and excellent clamping capability. Furthermore, they are Automotive qualified as per AEC-Q101.

Additionally, the voltage clamp structure integrated in the Ignition IGBT can be done with discrete elements. Two such cases include:

- For C-G clamping: discrete high voltage TVS diodes like TPSMB480CA. The TPSMB series protects up to the 500V range. Its automotive grade qualified.
- For G-E protection: bidirectional TVS diodes like the TPSMB16C.

Littelfuse surface mount resettable fuses PPTC provide overcurrent protection for applications where space is at a premium and resettable protection is desired.

# Final Thoughts

Automotive ignition systems continue to evolve as the demand for efficiency and safety increases. At the heart of the ignition system, choosing the proper IGBT is essential. Littelfuse provides best-in-class Ignition IGBTs with very low saturation voltage and high energy capabilities. With the drive for efficiency, protection must not be forgotten.

Safeguard your ignition system design by protecting the ignition system from external voltage and current spikes. Key protection components include surface mount resettable fuses, fuses and TVS Diodes.

Our extensive experience at Littelfuse in protection devices ensures we can provide you with the devices you need for automotive grade quality applications.

Learn more about these components by reading our Automotive Ignition System Selection Guide. It includes characteristics and consideration factors needed to select the right components for your design.