

Engine Performance

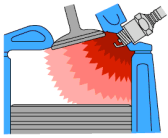
Ignition Systems

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Engine Performance

Spark and Ignition


- An ignition spark must have two qualities:
 - Heat to ignite the air fuel mixture
 - Duration sufficient to start the combustion process properly



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Heat and Ignition

- Increasing the number of electrons flowing across the spark plug electrodes increases the heat
- The spark's heat must be sufficient to ignite the fuel molecules and maintain flame propagation



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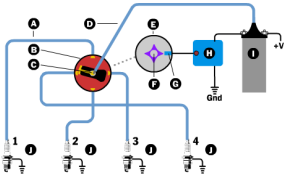
Spark Duration

- Spark duration is the length of time a spark is maintained
- Typically between .8 and 1.5 milliseconds
- Lean mixtures are difficult to ignite because the fuel molecules are far apart
- Rich mixtures are easier to ignite because the fuel molecule are closer together

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Ignition Operation

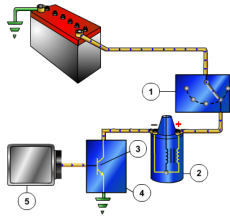
- A. Spark plug wire
- B. Distributor cap
- C. Rotor
- D. Coil wire
- E. Distributor body
- F. Reluctor
- G. Pickup coil
- H. Ignition control module
- I. Ignition coil
- J. Spark plugs



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Primary Circuit

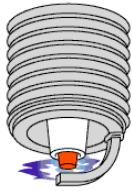
1. Ignition switch
2. Ignition coil
3. ICM transistor
4. ICM
5. PCM
6. Other primary circuit components include the camshaft sensor or crankshaft position sensor and related wiring



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Secondary Circuit

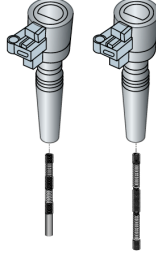
- Coil
- Coil wire
- Distributor cap
- Rotor
- Spark plug wire
- Spark plugs



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Ignition Coil

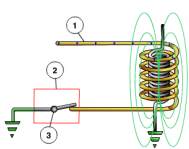
- Converts low voltage into high voltage
- Primary windings
 - 12 to 14.5 volt circuit
- Secondary windings
 - Up to 50 kilovolts on distributor ignition systems
 - Up to 100 kilovolts on distributorless ignition systems



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Ignition Control Module

- The ICM controls the flow of current through the coil's primary windings
- Current flow through the primary windings creates a magnetic field
- The ICM opens the primary circuit and the magnetic field collapses
- A high voltage is induced in the coil's secondary windings

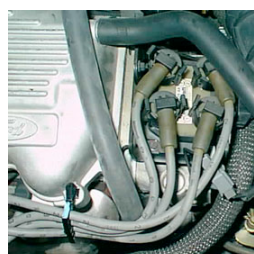


1. Primary windings
2. ICM
3. ICM transistor

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Secondary Wires

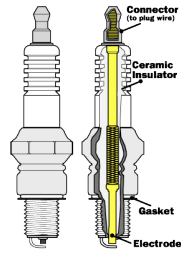
- To reduce radio interference the core is made with carbon particle impregnated strands
- Easily damaged if handled improperly
- 4000 to 6000 ohms of resistance per foot



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Spark Plugs

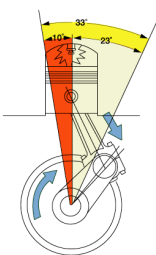
- Connector
- Ceramic insulator
- Resistor
- Center electrode
- Air gap
- Side electrode



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Base Engine Timing

- Ignition timing refers when the spark plugs fire in relation to the piston's position during the compression stroke
- For the engine to operate efficiently the combustion process should be completed approximately 23 degrees after top dead center



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Spark Timing

- Each combustion process takes about the same time to complete
- Spark must occur sooner as engine speed increases
- Timing is advanced to occur earlier during the compression stroke
- Spark advance typically retards as engine speed decreases
- Ignition timing is also affected by variables such as load, air/fuel ratios, engine temperature, intake air temperature and intake air density

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Ignition Requirements

- Starting
- Idle
- Cruise
- Acceleration



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Secondary Waveform

A. Firing voltage

- Primary current flow interrupted
- Voltage required to jump across spark plug electrode gap

B. Spark duration

- Time in milliseconds secondary current is flowing

C. Dwell time

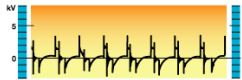
- Time primary current is flowing and saturating coil's magnetic field

Voltage is displayed vertically
Time is displayed horizontally

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Starting

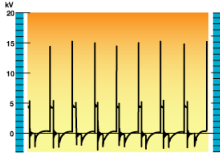
- Requirements for ignition during cranking are typically lower than for other operating modes
- Richer air/fuel mixtures are used during cranking, which reduces secondary voltage requirements



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Idle

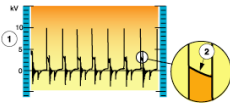
- Ignition timing can vary greatly to help control idle rpm
- Spark is advanced if rpm is too low and retarded if rpm is too high
- KV requirements at idle can also vary from 8KV to 16KV due to engine and ignition system design differences



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Cruise

- Cruise is a light load engine operating condition
- Secondary voltage requirements are less than those required for acceleration mode
- Spark duration increases because the spark KV requirements are low
- As KV requirements increase, spark duration will decrease



1. Secondary voltage

2. Spark duration

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Acceleration

- Combustion pressures in the cylinder are very high
- Ignition secondary voltage increases to overcome high resistance caused by these high pressures

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Distributorless Ignition

- One coil pack is used for each cylinder pair
- Two spark plugs are paired to each coil pack
- The two plugs are wired in series and fired simultaneously
- One cylinder is on the compression stroke and its mate cylinder is on the exhaust stroke
- Because of the exhaust stroke waste spark, each spark plug is fired every 360 degrees of crankshaft rotation

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DIS Coil Pack Operation

1. Ignition switch
2. Spark plugs
3. Coil pack
4. Powertrain control module

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VRS and Trigger Wheel

- The CKP sensor has 35 teeth spaced ten degrees apart which produce an AC signal
- The missing tooth provides a Cylinder ID signal for the PCM
- Can the PCM differentiate whether a cylinder is on the compression or exhaust stroke?

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Coil On Plug Ignition

- CMP
- CKP
- PCM
- COP coil
- Spark plug

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Ignition Related Symptoms

- There are four ignition related conditions that can cause driveability symptoms
 - No spark
 - Loss of spark
 - Weak spark
 - Improper ignition timing

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Spark Related Conditions

Concern	No Spark	Loss of Spark	Weak Spark	Timing
No Start	X		X	X
Stalls		X		X
Misses/Runs Rough		X	X	
Loss of Power			X	X
Spark Knock				X
Poor Fuel Economy		X	X	X

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Basic Testing

- Common tools
 - Test light
 - DVOM
 - Spark tester
 - Break out box
 - Oscilloscopes
 - Timing light
 - Scan tools



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Common Circuit Tests

- Primary Circuit
 - General circuit condition
 - Coil voltage supply
 - Coil primary circuit ground
 - Coil primary resistance
 - Coil dwell - saturation
- Secondary Circuit
 - General circuit condition
 - Coil secondary resistance
 - Secondary wire resistance
 - Secondary required voltage
 - Spark duration
 - Spark plug condition

