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Spring 2016 | Volume 9 | Issue 1

TechNews

HIGH STRENGTH STEEL

- High Strength Steels
- Camshaft Control Systems III
- Ignition Systems
- Fuel Injector Diagnosis

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Nissan TechNews is a publication of Nissan North America.

Group Publisher
Christopher M. Ayers Jr.
cayers@automotivedatamedia.com

Editorial Director
Bob Freudenberger
bfreud@automotivedatamedia.com

Managing Editor
Tom Nash
tnash@automotivedatamedia.com

Contributing Editors
Bob Chabot, Paul Cortes, Phil Fournier, Chris Ligocki, Christian Strohm

VP of Business Development
Tamra Ayers Banz
tayers@automotivedatamedia.com

Art Director
Christopher Ayers III
ayersc3@automotivedatamedia.com

Nissan North America
Sr. Planner, Wholesale Channel
Marketing & Promotion
Rachael Even
rachael.even@nissan-usa.com

Nissan North America
Technical Content Advisors
Danny Uhls
danny.uhls@nissan-usa.com

Editorial and Circulation Offices:
134B River Road
Montague, NJ 07827
Phone: 330.620.3929
automotivedatamedia.com

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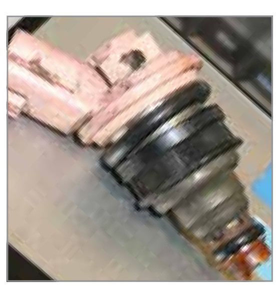

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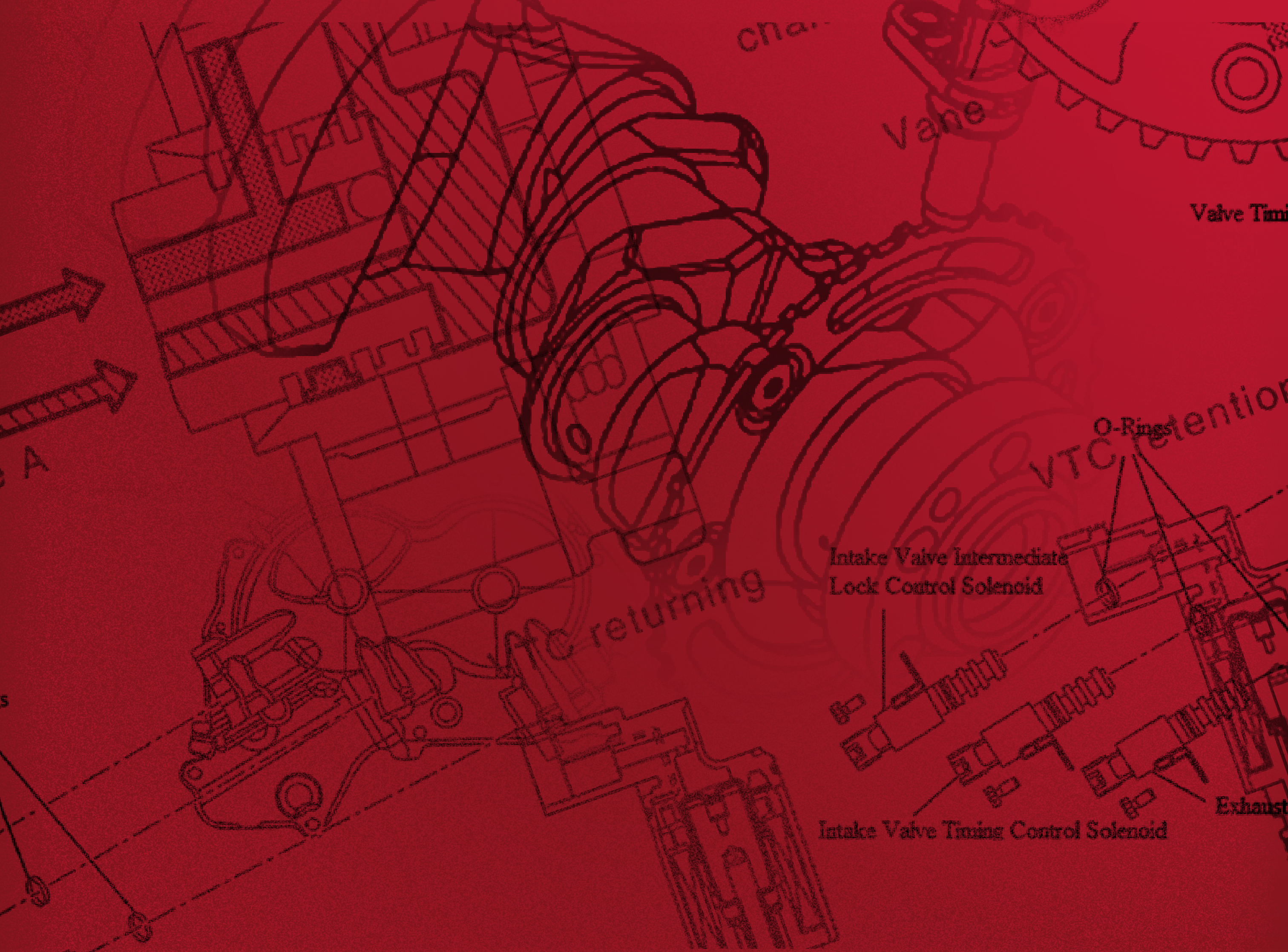
Feature

Understanding Camshaft Control Systems Part III

Camshaft Phasing



In this final article of a series designed to improve understanding of Nissan camshaft control systems, we'll take an in-depth look into the system that controls variable valve timing in Nissan engines, including sensors and solenoids, and how to diagnose problems with them.

In this article, we'll discuss Nissan valve timing systems and how they work, with a focus on the QR25 engine in the 2015 Nissan Altima. We'll learn what camshaft phasing is, and why it is beneficial. Then we'll look at the sensors that are used by the ECM to monitor variable valve timing, and explain how the ECM controls solenoids to achieve proper camshaft timing. Once we understand how all the different parts of the system work, we'll look at common failures and how they affect drivability, and discuss how to diagnose and repair these failures.

Camshaft phasing refers to the change in timing of the camshafts in relation to the crankshaft, and to each other. It's important to understand that the duration and lift of valve opening remain unchanged during phasing. Phasing is beneficial for a few reasons. Power and torque can be maximized at high rpm, while still maintaining drivability at low rpm. Emissions can be reduced by controlling the amount of exhaust gas that remains in the cylinder. Fuel can be conserved by reducing pumping losses. Now let's take a look at some examples of the camshaft phasing implemented on the QR25.

Minimum phasing, also referred to as static timing, takes place when there is no Variable Camshaft Timing (VTC) action. The intake valve opens 5° after TDC, when the piston has just begun traveling downwards in the cylinder. The intake valve closes 69° after BDC, when the piston has already traveled over a third of the way back up the cylinder on the compression stroke.

After the compression stroke, the exhaust valve opens 41° before BDC, when the piston is three quarters of the way down the cylinder on the power stroke. The exhaust valve closes 3° after TDC, when the piston has just begun traveling down on the intake stroke. There is no valve overlap under minimum phasing, as the exhaust valve closes 2° before the intake valve opens. Under light load, this reduces pumping losses and emissions without sacrificing torque.

For a review of the two previous articles on Nissan camshaft controls, you can read the first article; Timing is Everything in the Summer, 2015 issue of Nissan TechNews and Understanding Camshaft Control Systems Part II: Servicing Timing Chains & Sprockets in the Fall, 2015 issue. Both can be viewed on the Nissan TechNews website at NissanTechNews.com.

Maximum phasing takes place when the VTC system is active. Intake valve timing is advanced and exhaust valve timing is retarded. The intake valve opens 35° before TDC, while the piston is still traveling upwards on the exhaust stroke. The intake valve closes 29° after BDC, when the piston is on its way up on the compression stroke.

The exhaust valve opens 4° after BDC, just after the power stroke as the piston begins to travel up on the exhaust stroke. It closes 48° after TDC, when the piston is a quarter of the way down the cylinder on the intake stroke. Under maximum phasing the valve overlap is 83°. This increases power under high load by improving flow through the combustion chamber.

Whenever the engine is turned off, the intake camshaft sprocket will become fixed in intermediate lock by the engagement of two lock keys located inside of the sprocket. If the engine is started with a coolant temperature of less than 140°F, the intake camshaft will remain locked in intermediate phase until the coolant reaches operating temperature. In this phase the intake valve opens 5° before TDC, near the end of the exhaust stroke. It closes 59° after BDC, as the piston moves upwards on the compression stroke. This phase has 8° of valve overlap, which is ideal for reducing emissions when the engine is cold.

The PCM requires a means of determining the engine's position and speed. This is achieved through the use of two sensors. The crankshaft position sensor (POS) and the camshaft position sensor (PHASE). Both are Hall Effect sensors mounted facing a toothed ring called a signal plate. As the engine rotates, and the teeth of the signal plate pass the sensor, the magnetic field in the sensor changes. The change in magnetic field causes a change in the output voltage of the sensor, which is monitored by the PCM.

Crankshaft Position Sensor (POS)

The POS is mounted towards the rear of the engine oil pan facing a signal plate that is mounted on the engine crankshaft. This sensor is used to detect crankshaft speed, position, and fluctuation. The PCM can determine engine speed and fluctuation from the frequency of the voltage pulses, and engine position from the location of the larger gaps in the signal.

Camshaft Position Sensor (PHASE)

The PHASE is mounted on the camshaft position sensor bracket, located just rear of the rocker cover, facing a signal plate mounted on the rear of the intake camshaft. This sensor is used for cylinder identification, and produces a unique pulse for each cylinder. Failure of this sensor can result in hard start/no start condition, rough idle, or misfire.

Exhaust Valve Timing Control Position Sensor

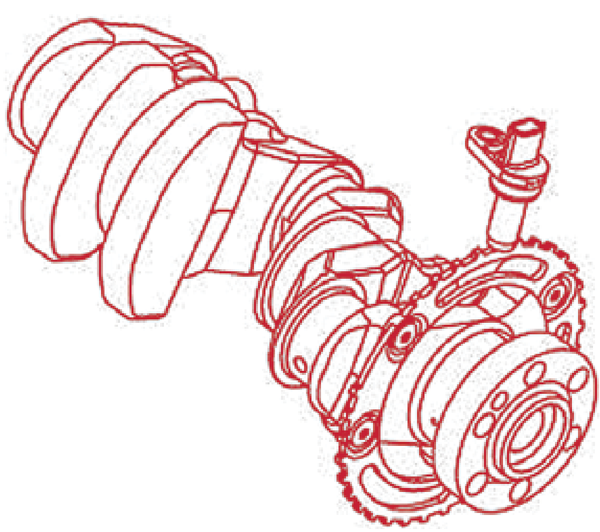
This additional Hall Effect sensor is mounted next to the PHASE sensor, facing a signal plate on the rear of the exhaust camshaft. It is used to monitor the position of the exhaust camshaft, and confirm commanded changes to exhaust valve timing.

Solenoids

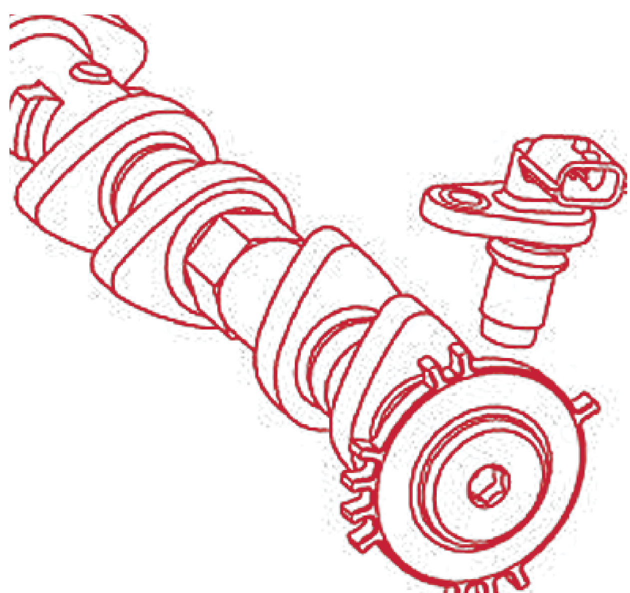
The PCM controls solenoids to implement desired changes in valve timing. These solenoids divert oil pressure to the proper chambers in the camshaft sprockets. The QR25 engine uses three solenoids for valve timing control. The intake valve timing control solenoid and the exhaust valve timing control solenoid are three position solenoids controlled by on/off pulse duty signals generated by the PCM. A duty cycle of less than 50% will retard the camshaft, while a duty cycle greater than 50% will advance the camshaft. A duty cycle of exactly 50% will maintain current camshaft timing. The intake valve intermediate lock control solenoid is a two position solenoid. When commanded on, it drains oil pressure from the intermediate lock keyways. When commanded off, it blocks oil pressure allowing the lock keys to release.

Valve Timing Control DTCs

The DTCs that we will focus on involve the valve timing control system of the QR25. They are:



Here we see the how the POS is oriented facing the signal plate on the rear of the crankshaft. The signal plate has teeth equally spaced, with two larger gaps 180° apart that represent pistons at TDC.



The PHASE is mounted facing the signal plate on the intake camshaft. The four sets of teeth each on the signal plate each correspond with a cylinder at TDC compression.

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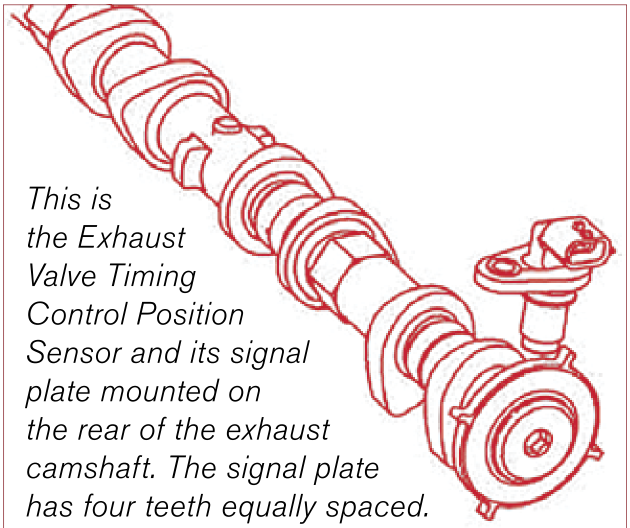
- P0011 IVT control
- P0014 EVT control
- P0075 Intake Valve Timing Control
- P0078 EVT Control Solenoid Valve
- P0335 CKP sensor
- P0340 CMP sensor
- P052A/P052B Intake Valve Timing Control
- P1078 EVT Control Position sensor
- P0643 Sensor Power Supply.

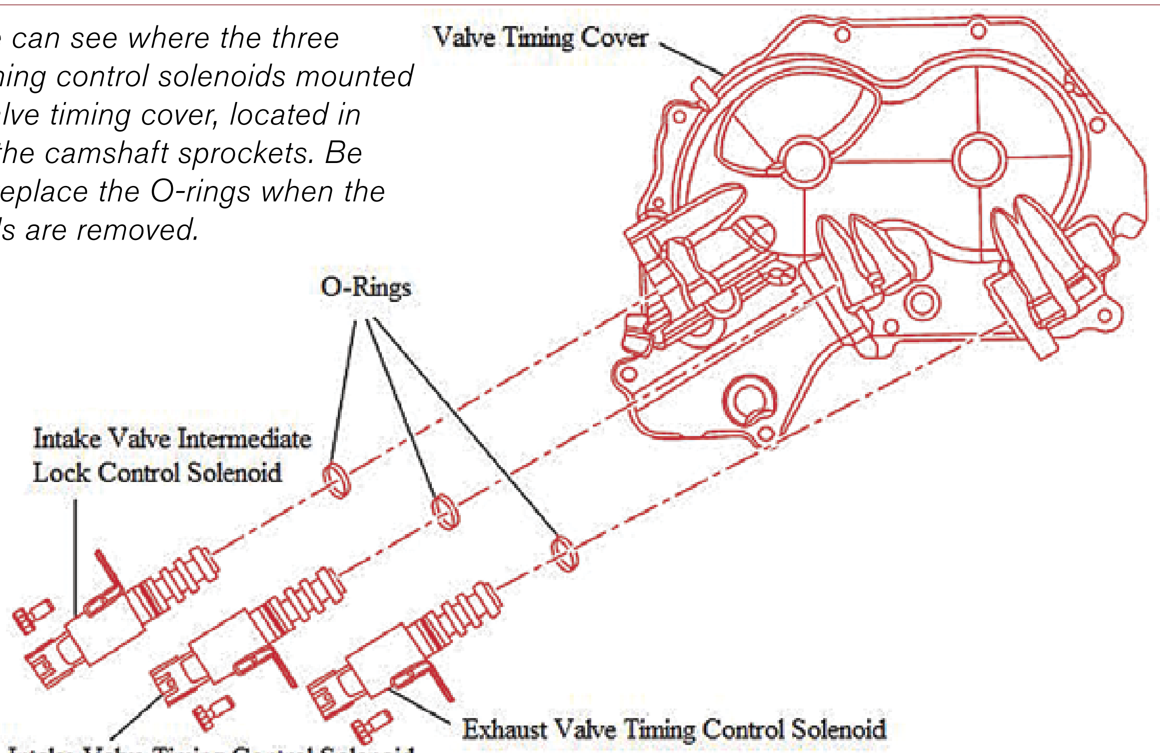


This is the Exhaust Valve Timing Control Position Sensor and its signal plate mounted on the rear of the exhaust camshaft. The signal plate has four teeth equally spaced.

The first step in any DTC diagnosis is always a confirmation procedure. These differ, depending on the conditions under which the DTC was set. In the case of electrical faults, the procedure may be as simple as starting the engine and letting it idle for five seconds. For faults that only occur under certain driving conditions, there may multiple steps to the confirmation procedure. The first step usually involves looking for a 1st trip DTC with the vehicle stationary, and engine running at a specific rpm. If no DTC is set, the next steps usually involve attempting to recreate the conditions in the freeze frame data. Although it may be difficult to recreate every condition exactly, it is important that vehicle speed is within 6 mph, engine speed is within 400 rpm, and coolant temperature is within 20°F. Regardless of procedure, the goal is the same. To ensure the problem is present, so it can be diagnosed accurately and efficiently.

Once the fault is confirmed, diagnosis can proceed. Remember to always check for TSBs first. Also keep in mind that many of these faults can be caused by low oil pressure, almost always due to low engine oil. Access to a CONSULT III plus can be invaluable, as monitoring live data can be more

Here we can see where the three valve timing control solenoids mounted in the valve timing cover, located in front of the camshaft sprockets. Be sure to replace the O-rings when the solenoids are removed.



useful than certain diagnostic procedures. When faced with multiple codes, usually one of the codes will pertain to the actual fault in the system, while the others are just secondary consequences of it. For example, if P0011, P0075, and P0300 are set, we know that intake phase angle is incorrect and we have a random misfire. But the likely cause of the problem is in the intake valve solenoid electrical circuit, so we should begin diagnosis with P0075.

P0643

P0643 will generally be set in addition to other codes, and it should always be addressed first. The PCM sends a 5V reference voltage to many sensors throughout the vehicle. These reference voltage circuits are divided into two groups, each containing half of the sensors. Therefore, if a short circuit develops in one of these circuits, all sensors on that circuit will be affected simultaneously. Procedures for diagnosing this code mainly involve checking for voltage and continuity along various circuits.

P0075 & P0078

When the PCM detects an abnormal voltage in either the intake valve control solenoid, or the intermediate lock solenoid circuit, P0075 is set. P0078 is set when improper voltage is sent the PCM from the exhaust valve timing control solenoid. Despite these codes being phrased differently, they both imply the same thing. There is an open or short somewhere in their respective circuit. The diagnostic procedure for the two is identical, except for the specific solenoids and wiring to be tested.

The procedure involves testing each circuit for power and ground. If the circuit is working properly, the individual solenoids must be tested. The first test is a check for continuity between certain terminals, and then measuring the resistance of the solenoids coil. Resistance specifications vary, but generally should be between 7 and 8 ohms at 68°F. If the solenoid passes the electrical tests, check movement of its plunger. Briefly apply 12V to the solenoid, and then interrupt it. This will cause the solenoid's plunger to move back and forth. Be sure that it moves through its entire range and doesn't bind at any point in its travel. Power should never be applied to the solenoid for more than 5 seconds, or its coil may be damaged.

P0011, P052A, P052B, & P0014

These codes are set when there is a gap between the target angle and the measured angle of the camshaft. P0011 is set when the intake camshaft is out of phase at operating temperature, and P0014 is set when the exhaust camshaft is out of phase. P052A is set when the intake camshaft is over-advanced at cold start, and P052B is set when the intake camshaft is over-retarded at cold start. Possible causes include faulty sensors or solenoids, clogged oil passages or filters, problems with signal plate, and even a stretched or misaligned timing chain. The diagnostic procedures for each of these codes are basically identical.

Diagnosis begins with a check of the appropriate solenoids as outlined in the P0075 diagnostic procedure. If the solenoids are within specifications, the POS and PHASE sensors must be tested. The procedure, as detailed in the service manual, consists of a visual check for any obvious external damage to the sensor or its signal plate, and a resistance measurement across the sensors terminals. These tests are certain to identify a completely failed sensor, but an intermittently failing sensor may pass these tests and still be faulty. The dual trace oscilloscope function of the CONSULT III plus is very useful, and can be used to monitor the signal from both the POS and PHASE and pinpoint fluctuations caused by an intermittently failing sensor.

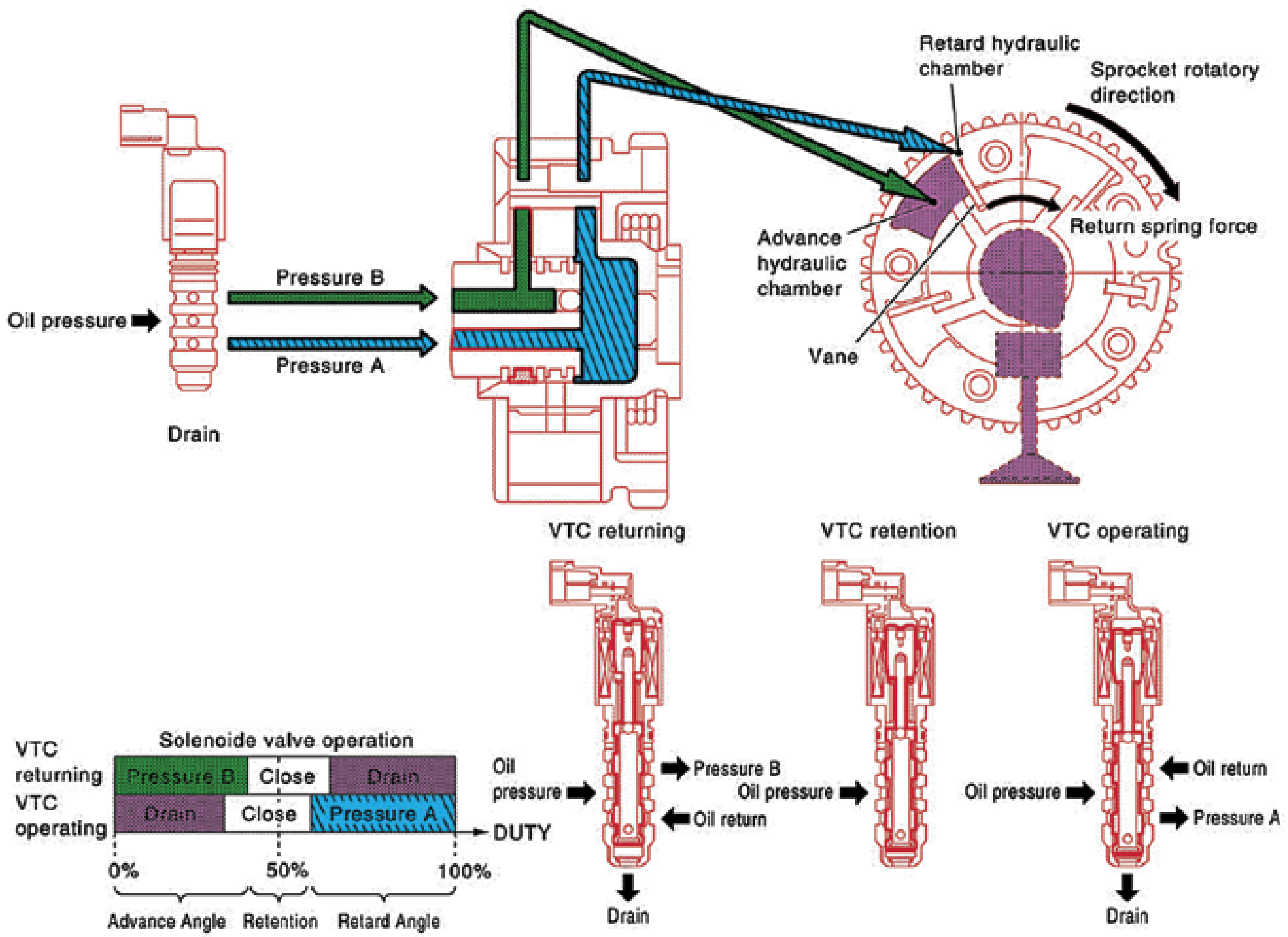
If none of these tests yield a failed component, the final things to be inspected are the timing chain and the lubrication system. The service manual procedure states that checking static timing should only proceed if any recent repairs may have caused timing chain misalignment. However, the timing chain may be stretched, so static timing should be checked regardless of repair history. The procedure is covered in detail in the previous article of this series, but the two best methods for checking static timing involve either checking the alignment of the POS and PHASE signals on an oscilloscope, or removing valve covers and visually checking alignment marks.

Checking the lubrication circuit begins with removing the three timing control solenoids, and disabling the fuel injectors. Then crank the engine and observe whether oil is produced at the oil holes in the valve timing control cover. If no oil is observed, some disassembly of the timing cover may be required to locate the source of the blockage. Small oil filter screens installed in the timing cover are a good place to start.

Intermittent Incident

If no faults are found at the end of any of these diagnostic procedures, we move to intermittent incident diagnosis. This is detailed in the general information section of the repair manual. All of the procedures are designed to simulate the conditions or environment present when the fault occurred. They include lightly tugging on wires to check for loose connections or internally damage, disconnecting connectors to inspect for corrosion, heating or cooling certain components, checking components for water intrusion, or turning on all electrical loads. Every situation is unique, so let the known facts guide you when determining which of these tests are appropriate.

Now that we understand how camshaft phasing works, and how to diagnose and repair faults that may occur, we can service these vehicles confidently and competently. Bear in mind that components can fail without setting a DTC, so always consider failures in this system when diagnosing drivability problems that don't set a code. And remember to always follow procedures listed in the service manual to avoid damaging components or causing injuries.



Here we can see how the exhaust valve timing solenoid works. The exhaust camshaft sprocket is held fully advanced by spring tension until the VTC activates to adjust valve timing.

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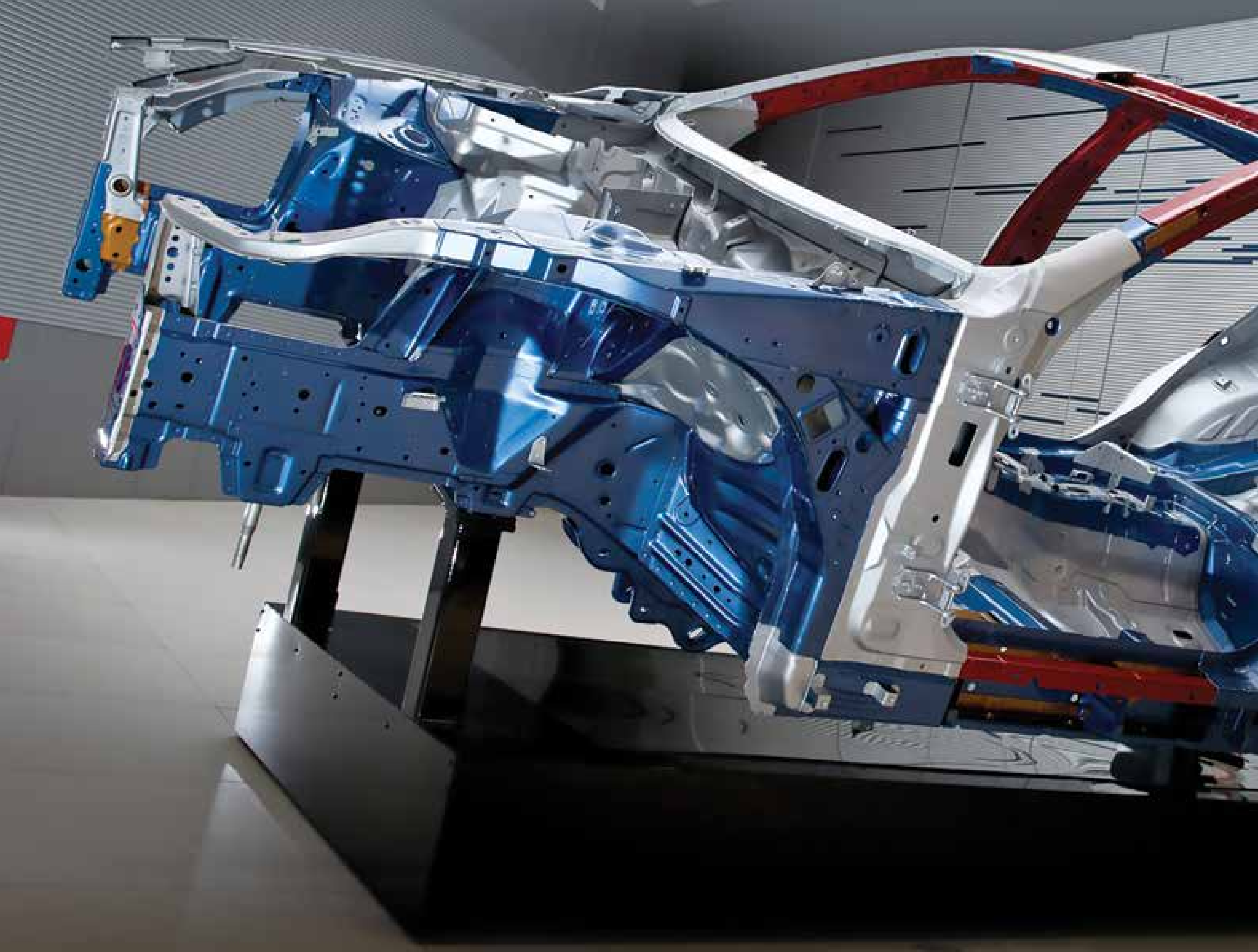
Repairing High Strength Steels

As automotive designers seek to lighten the vehicle weight to attain safety and higher mileage levels, stronger steels are being employed for body structure. Here's an update on those steels, how they are used in Nissan vehicles and what every collision facility should know about the latest advances in body materials and how to repair them.



Safety and crash worthiness are important factors in automotive design for several reasons. Obviously, occupant safety is of supreme importance, along with meeting regulatory and insurance standards. But, structural integrity for durability and fuel economy are high on the list of desirability. These factors become a valuable marketing tool for auto manufacturers such as Nissan that promote safety, durability and therefore, confidence in the vehicle.

The term for designing these evolving vehicles toward lighter, but stronger structure is called “lightweighting.” If you haven’t heard the term by now, you will shortly as vehicle design and construction material producers and automobile manufacturers work together to create vehicles for the future. The use of new, stronger “Super Steels” is one area where automobile manufacturers are implementing lightweighting.

The Steel Marketing Development Institute (SMDI) works with automakers, government agencies, universities and industry entities to share information in an effort to develop new materials and promote the use of advanced technology. In 2011, SMDI formed FutureSteelVehicle (FSV), a program to developed fully-engineered, steel-intensive designs aimed at reducing mass by more than 29 percent over a benchmark vehicle and reducing total life cycle emissions by nearly 70 percent. This design effort can meet a broad list of global crash and durability requirements and enable five-star safety ratings, while avoiding high-cost penalties for mass reduction. Nissan has participated in this consortium to stay on the cutting edge of the latest and best technologies.

We’ve outlined some of the development of these super steels over the last few years in the November, 2011 issue of Nissan TechNews, so we’ll focus on the two types most commonly found in the design of Nissan vehicles. You can read the previous article: “Paradigm Shift: Coming to Grips with Super Steels” on the Nissan TechNews website at NissanTechNews.com.

HSS & UHSS

High Strength Steel (HSS) is steel with a yield strength value of 440 MPa – 979 MPa. Yield strength, or yield point, denotes the level of stress at which the collision-damaged material will not return to its original configuration when the stress is removed. It’s measured in millipascals (MPa). A steel panel with a yield point value of 965 MPa is equal to about 140,000 psi, so you can see that the term “High Strength Steel” is quite accurate.

Ultra High Strength Steel (UHSS) has a yield strength value of 980 MPa or greater. These materials provide superior strength, rigidity and integrity while lowering the weight of the overall vehicle. Nissan designs vehicles with both steels, as well as other materials.

The Nissan Body Repair Manual Fundamentals

Earlier this year, Nissan launched an updated version of its Body Service Manual Fundamentals for 2015. It can be accessed on the Nissan TechInfo website at nissan-techinfo.com. You must be a member subscriber or purchase a short or long-term subscription to access the information. On the site you will also find body service manuals for certain specific Nissan models over the past twenty five years.

The 276-page 2015 Nissan Body Repair Manual Fundamentals covers all aspects of body service for Nissan vehicles. If you are in the body service business, this manual can be of great value to you in servicing Nissan vehicles.

Among the vast variety of topics covered are the procedures for newer structural components and metallurgy, including High Strength Steel (HSS) Ultra High Strength Steel (UHSS) and aluminum. As a matter of updating, the BSM points out cautions for servicing HSS and UHSS components.

Cautions for Working with HSS

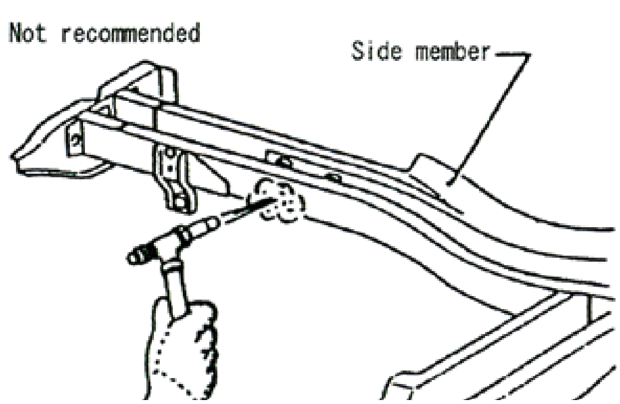
When replacing an HSS welded panel, it is not recommended to heat components such as reinforcing side members as this may weaken the component. When heating is unavoidable, do not heat above 550°C (1,022°F). Verify the temperature with a thermometer; Crayon-type or other similar types of thermometers are appropriate.

When straightening body panels, use caution in pulling any HSS panels. Because HSS is very strong, pulling may cause deformation in adjacent portions of the body. In this case, increase the number of measuring points and carefully pull the HSS panel.

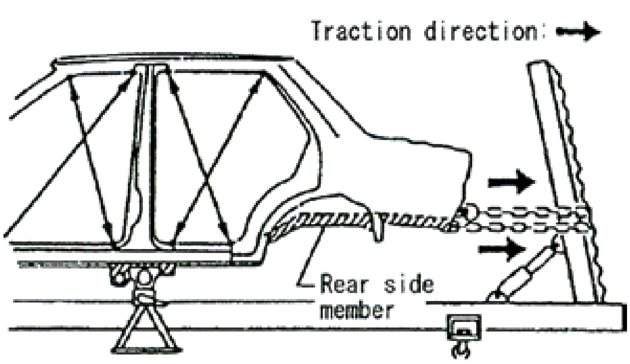
When cutting HSS components, avoid gas (torch) cutting if possible. Instead, use a saw to avoid weakening surrounding areas due to heat. If gas cutting is unavoidable, allow a minimum margin of 50mm (1.97 in.) from other components.

When welding HSS panels, use spot welding whenever possible in order to minimize weakening surrounding areas due to heat. If spot welding is impossible, use gas shielded arc (GSA) welding. Do not use acetylene gas (torch) welding because it is inferior in welding strength.

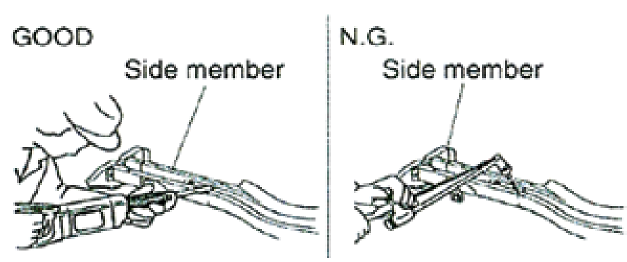
The spot weld on HSS panels is harder than that of an ordinary steel panel. Therefore, when cutting spot welds, on an HSS panel, use a low-speed



Heating HSS side members is not recommended as it may weaken the components.



Pulling HSS panels may cause deformation of adjacent panels.



Cutting with a saw is recommended over the use of a torch to avoid weakening surrounding materials.

The Genuine Nissan Original Equipment Collision Replacement Parts Advantage

A customer who has experienced a collision is very likely to be under stress from the accident. They may incur unplanned expenses; they may have been injured; their means of transportation has been damaged; they are going to be without the vehicle for a specified time; they will have to make alternate plans - perhaps renting or borrowing a vehicle and their family life is likely to be disrupted until the vehicle is back. These factors can lead to an overwhelming state of confusion and stress. As a collision and body service professional, you are an important part of the process of returning the customer's vehicle – and life – to normal.

Most collision customers are not sure whether they can request the use of OEM parts. They are not aware that they have the right to demand OEM replacement parts on their vehicle even if they must pay a little more.

They rely on you to explain all their options and let them make the decisions as to the types of materials used in the repair. Inform them of all the factors involved in returning their vehicle to as original condition as possible. And, you want a satisfied customer who will return if needed in the future and will suggest your services to friends and family members.

The best way to satisfy a customer and ensure a smooth, profitable job for your shop is to use OEM parts. The use of Genuine Nissan Original Equipment collision replacement parts hold value for both the customer and your shop.

Benefits to the Customer

Using Genuine Nissan Original Equipment collision replacement parts holds benefits for the customer in the following ways:

- **Better Repair Appearance.** Genuine Nissan parts are manufactured to the same specifications as a new vehicle, the parts will have the same contours, gaps and fit as the original.
- **Faster Repair Time.** Aftermarket, salvaged or reconditioned parts may take more time to install or modify to achieve proper fit; all of which may increase labor costs.
- **Improved Structural Integrity.** Genuine Nissan Original Equipment collision replacement parts will deliver the same performance characteristics as the original. This is especially true when it comes to the involvement of HSS or UHSS components.
- **Maintained Vehicle Resale Value.** Using Genuine Nissan Original Equipment replacement parts can assure you of high quality, fit, finish and appearance, which can help support resale value of the vehicle.
- **Original Manufacturer's Limited Warranty.** Genuine Nissan Original Equipment collision replacement parts are the only service replacement parts warranted by Nissan.

Benefits to Your Shop

Your shop also benefits by using Genuine Nissan Original Equipment collision replacement parts:

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- **Rapid Delivery of Parts.** Nissan will get the parts to you as soon as possible so you can get the vehicle repaired and back to the customer quickly.
- **You'll be Using Quality Parts.** Removes the potential of using damaged parts that may come from other sources. You know you'll be getting the best parts available.
- **Less Labor Time.** Brand new Genuine Nissan Original Equipment collision replacement parts are easier to install and don't require extra preparation time to get them to fit or ready for finishing. Time spent preparing salvaged or used parts for finishing is a drain of your end profit.
- **Higher Profit.** The correct, high-quality ready-to-fit parts, faster delivery times and lower labor times all add up to higher profit.
- **Customer Satisfaction.** Returning the vehicle quickly in the best possible original condition will result in customer satisfaction. Happy customers are your best advertisement.

Considering all the facts, shouldn't you be urging your customers to demand the use of Genuine Nissan Original Equipment collision replacement parts for the repair of their Nissan vehicle? |

high-torque drill at 1000-1200 rpm to increase drill bit durability and facilitate the operation.

Caution for Working with UHSS

Never cut and join the panel, plate and reinforcement made of Ultra High Strength Steel (UHSS). If such a part is damaged, replacement is required.

Descriptions, yield strength and diagrams of where HSS and UHSS components are located in the BRM section of the service manual. Before attempting body repairs, it is advisable to check this section and familiarize yourself with the material requirements. Model specific details can be found in the BRM section of the service manual.

Training

I-CAR, the Inter-Industry Conference on Auto Collision Repair, is an international not-for-profit organization dedicated to providing the information, knowledge and skills required to perform complete, safe and quality repairs. I-CAR offers online training and live classes, including sessions on HSS and UHSS, at certain industry events throughout the year. I-CAR also offers training for qualifying independent body shops to become officially certified as Nissan Certified Collision Repair Network facilities. For more information, visit i-car.com.

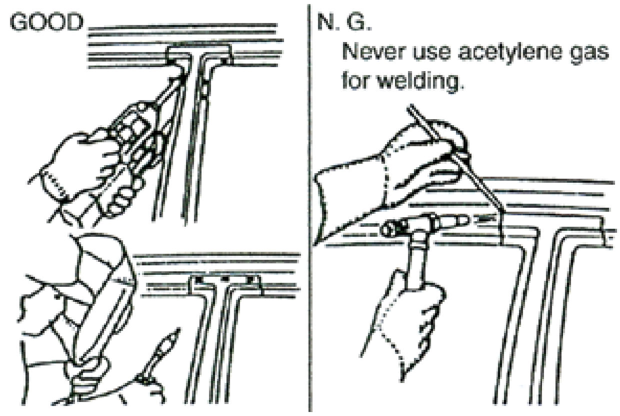
For more information or questions regarding becoming a Nissan Certified Collision Repair Facility contact NNACollisionRepairNetwork@Nissan-usa.com or visit getnissancertified.com to begin the shop application process.

Tools and Equipment

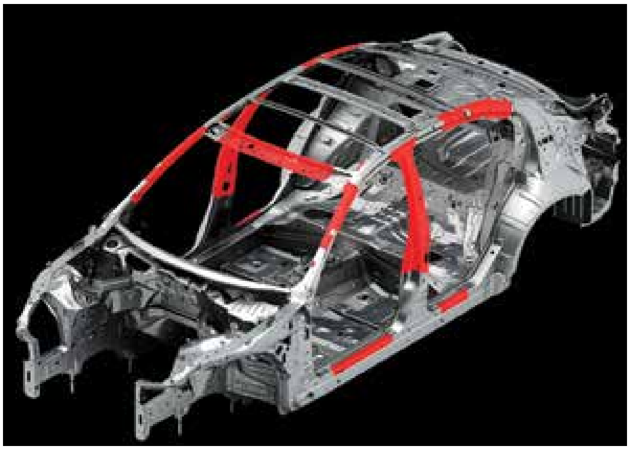
Working on and with HSS and UHSS may require dedicated specialty tools and equipment. The Sheet Metal Work section of the BRM has a list of suggested and required hand tools, along with tool usage methods and techniques.

The Tool and Equipment section at the end of the BRM describes specialty tools and equipment. All Nissan-specific tools and equipment is available on the Nissan Tech-Mate website at nissantechmate.com.

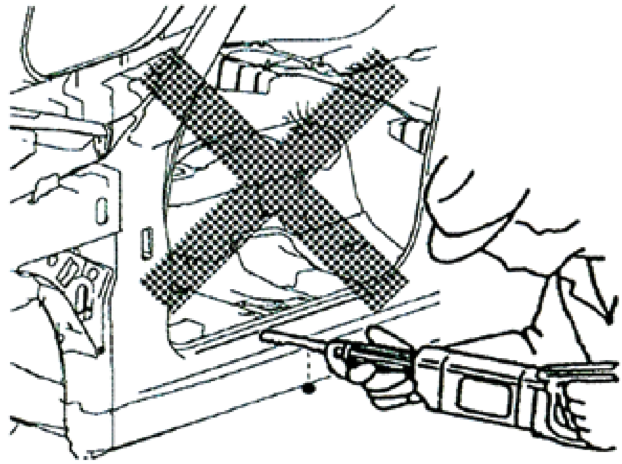
For further reading regarding body service, you can check out the *Body Basics: Equipment and Tools* article in the August, 2011 issue of Nissan TechNews. You can also read that article on the Nissan TechNews website at NissanTechNews.com.



Spot welding is the recommended method for joining HSS components.

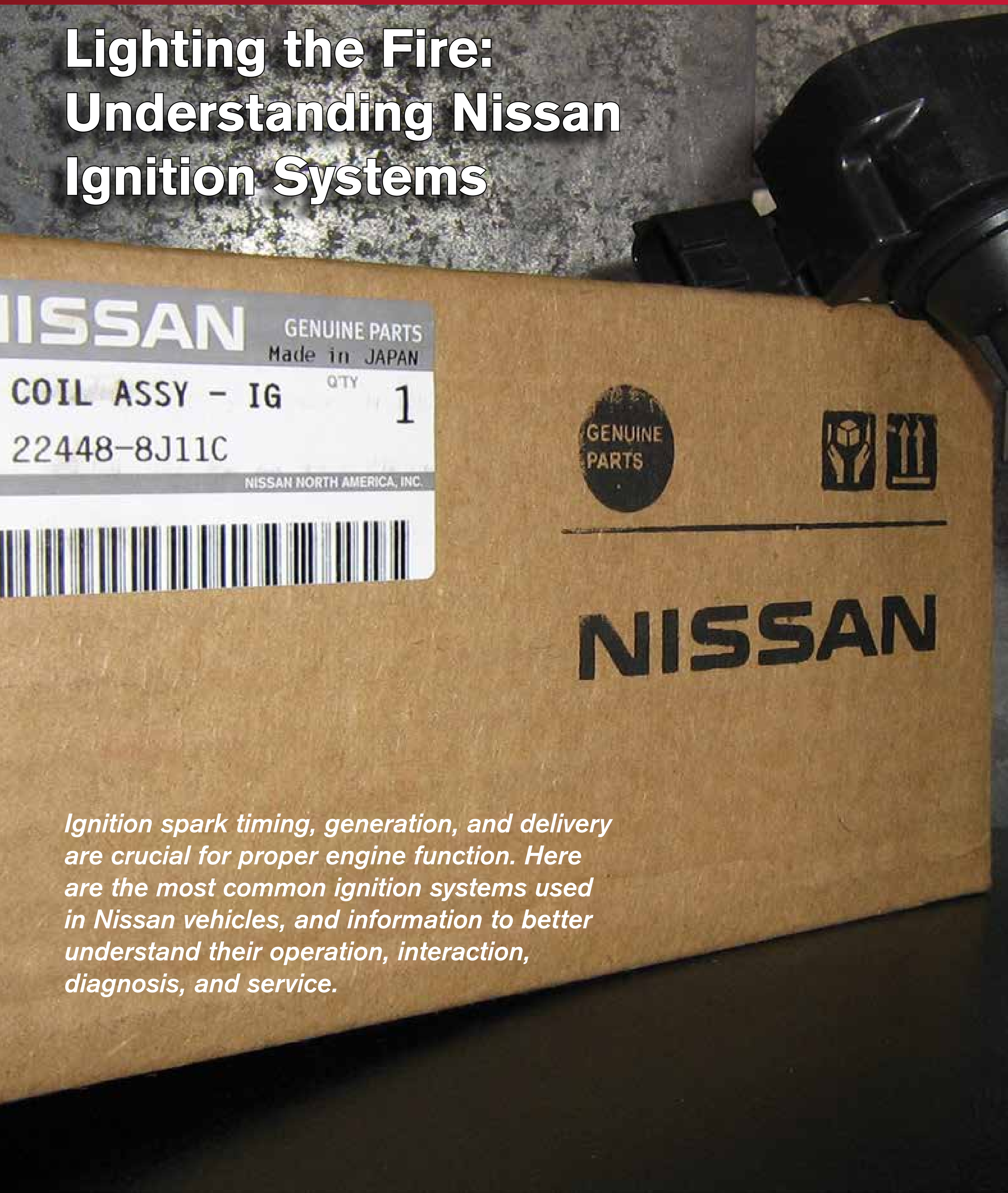


Ultra high Strength Steel (UHSS) is used in the areas of vehicle construction for maximum strength as shown here in red.



Never cut and join UHSS components. Replacement is required.

Lighting the Fire: Understanding Nissan Ignition Systems



Ignition spark timing, generation, and delivery are crucial for proper engine function. Here are the most common ignition systems used in Nissan vehicles, and information to better understand their operation, interaction, diagnosis, and service.

Ask the average person about what an engine needs to run and you're likely to get "spark plugs" as one of the responses. The ignition spark is fundamental in both concept and function to the workings of a combustion engine. Nissan has developed and changed ignition spark management over the years in order to meet their rigorous demands for increased efficiency and reliability.

Let's take a look at the most common design called coil-over-plug, or a direct ignition system (DIS). We will cover how a coil-over-plug system is implemented, who the players are and how they work together. Our goal is not to analyze the nitty-gritty of oscilloscope outputs, but rather to know when and why such tools are necessary in figuring out problems with modern spark management.

Where to Begin

We should start by acknowledging that there are multiple ignition designs that Nissan has historically implemented in their vehicles. Centralized coil packs, distributors, and waste-spark methods are all fading out, giving way to the coil-over-plug implementation. Today, the wide availability of cost-effective micro-controllers permits Nissan to scale down the ignition system, removing components like separate igniters, vacuum-based timing controllers, or ignition cables from the list of possible breakages. Likewise, network-shared data obsoletes the distributor assembly that once housed a redundant cam sensor and igniter for its control feedback loop.

The key is simplicity. Technicians may have once had to check points and verify dwell on a misfiring vehicle, but now "it's probably just a bad coil." Yet, how did we get to this point where failures are often conveniently compartmentalized? Plus, how do we technicians evaluate a digital system that can seem to be working during testing? Let's start by knowing what we're working with.

The Brains of the Operation

Any Nissan vehicle's electronic control module (ECM) manages its ignition. This seems self-evident, as it should, but we must discuss what exactly is being managed. First, the ECM determines both when and for how long an ignition event should be timed. Then, the ECM prepares these two points of data into a package that is referred to as a singular "ignition timing signal." Lastly, the ECM transmits the timing signal to the power transistor, a portion of the ignition coil assembly.

Sensor	Input Signal to ECM
Crankshaft position sensor (POS)	Engine speed[*3] Piston position
Camshaft position sensor (PHASE)	
Mass air flow sensor	Amount of intake air
Engine coolant temperature sensor	Engine coolant temperature
Throttle position sensor	Throttle position
Accelerator pedal position sensor	Accelerator pedal position
Turbocharger boost sensor	Turbocharger boost
Intake air temperature sensor 2	Intake air temperature
Transmission range switch[*1]	Gear position
Park/neutral position (PNP) switch[*2]	
Battery	Battery voltage[*]

Sensor inputs.

The ECM creates different spark durations by controlling the pulse width length of its timing signal to the power transistor. A longer signal pulse width ensures that the duration of the spark remains sufficient to ignite the air-fuel mixture. Once ignited, the burn time of the air-fuel mixture is constant. Therefore, to ensure complete burn as rpm increases, the ECM must determine when to generate an ignition event. An ignition coil requires some milliseconds to charge, and a flame front requires more milliseconds to propagate; therefore, the command for the coil to begin the process must occur in advance. Otherwise, the ignition event will occur at the incorrect time, resulting in knocking, incomplete burn, or misfire. The purpose of ignition spark timing has not conceptually changed with coil-over-plug systems.

The ignition timing data points live within the software of the ECM in a so-called "map." Just like fuel injection timing, the computer uses calculated load and multiple sensor inputs to determine how to structure the ignition timing signal. Crankshaft and camshaft position sensor operation is critical to ignition timing. The data values retrieved from the map will constantly change based on driver input, as well as passive considerations like fuel economy and emissions.

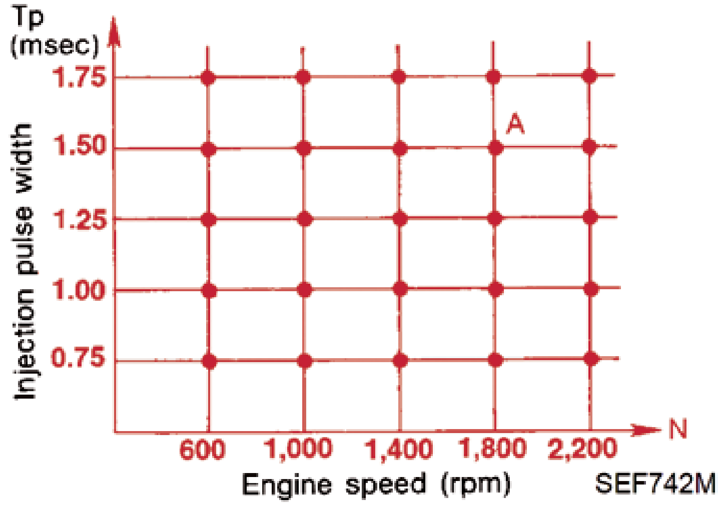
The Inner Workings of an Ignition Coil

Each DIS ignition coil assembly is made up of components that are members of the primary or secondary circuit. Think of the primary side as low voltage control and the secondary side as high voltage action. On the primary team, we have the connector, power transistor, and one half of the internal coil wire windings. On the secondary team, we have the other half of the coil wire windings, the insulator boot, the ground electrode (spark plug), and the condenser, if applicable.

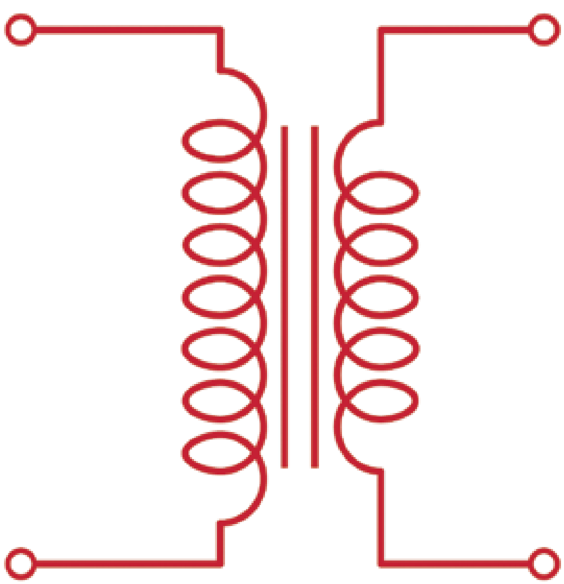
Primary Side's Quarterback

The power transistor is often referred to as the "coil driver" because it controls the rest of the ignition coil assembly. Unlike a relay switch that physically moves, a transistor switches by electrically changing internal state. Furthermore, a transistor can amplify input voltages based on signals from its other contacts. In an automotive ignition coil, the power transistor takes the ECM signal, amplifies it, and switches on a ground for the primary circuit to begin current flow into the primary side coil windings.

The word "coil" refers to the two sets of coiling wires around a magnetic core, and is an electronics device called a transformer. The transformer



This ignition map from a 2000 Maxima shows signal pulse width versus engine rpm. Point A is how far in degrees Before Top Dead Center (BTDC) to begin spark generation.



The transformer circuit diagram shows clearly that the primary and secondary circuits don't actually connect. The solid vertical lines represent the magnetic core and its generated field as the go-between.

components straddle the dividing line between primary and secondary sides. Both sides have a specific number of insulated wire windings that wrap around the core, but the primary circuit is not directly connected to the secondary side.

Both primary and secondary circuits have their own paths to ground. In all automotive applications, the primary side has fewer windings than the secondary side in a manufacturer-proprietary ratio (about 1:100). So, if they aren't connected directly, how does the current flow?

Induction

When the ECM provides a pulse width timing signal to the power transistor, the primary circuit is grounded, causing current to flow through the primary side windings. In a phenomenon called induction, an increasing electric charge builds up on the magnetic core in the form of a magnetic field. Then, when the timing signal stops, the power transistor opens the primary circuit's ground, suddenly stopping current flow. Without flow, the magnetic field collapses. The field collapse induces current to flow through the secondary circuit where the only ground remains. Because the secondary side has more windings, the induced voltage is greater, but the original current is reduced (conservation of energy).

Spark

At this point, our secondary circuit is energized with a huge amount of induced voltage. The spark plug ground electrode is the only ground in town, so the high voltage forces the current to arc across the gap. It sounds easy for this jump to occur, but in reality there is a large amount of resistance at the secondary ground. There is supposed to be more resistance anywhere else, leaving the electricity nowhere to go but across the gap. We will discuss the desire for electricity to seek the path of least resistance more in the diagnostic section.

Aftermath

Coil oscillations occur after field collapse because the power transistor cannot perfectly eliminate the primary circuit ground. There will still remain some potential for energy to flow "back" toward the primary circuit. Modern ignition coil assemblies handle this reflection somewhere within the electrical engineering of the power transistor. If the secondary circuit ground is completely unavailable, after the collapse of the electric field, that energy must go somewhere. It will be absorbed in the primary circuit, resulting in wear. We will further discuss the importance for healthy secondary ignition components in the diagnostic section.

Additional Coil Oscillation Management

In some coil-over-plug implementations, there is a capacitor near the primary coil circuit ground. This capacitor is called the condenser, and it functions like a shock absorber for the coil oscillations. Its purpose is to capture the errant energy that spills over from all ignition coils' secondary discharge reflections.

Diagnosing Ignition-Related Malfunctions

After performing enough evaluation to suspect an ignition-related malfunction, you should first verify that the ignition timing signals are correct. Scan the ECM for faults using CONSULT III plus, then diagnose and repair any camshaft or crankshaft position sensor circuit malfunctions

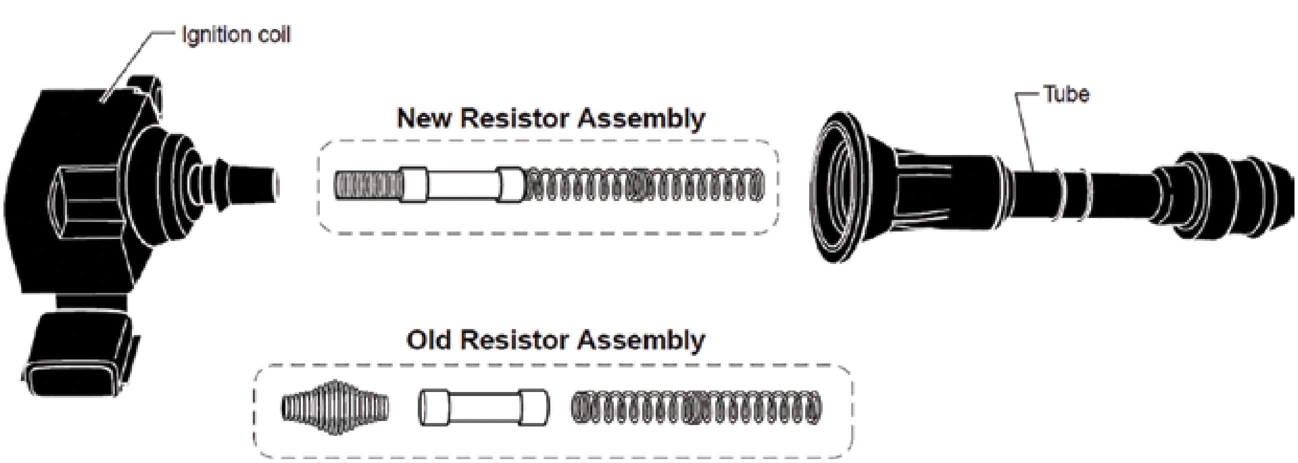
first. It doesn't matter how good the coil output is if the ECM doesn't spark at the correct time.

If there are no faults and the ECM is sending correct timing signals, you must ensure that the wiring between the coils and the computer is good. Check the service manual procedure for your vehicle, and test the harness coil connectors appropriately.

The Path of Least Resistance

It's a natural law that electricity seeks the path of least resistance from power to ground. Because the resistance at the spark plug ground is high, it may not take much for the spark to ground out somewhere else before the plug. You should inspect each ignition coil insulator boot for evidence of oil contamination. Leaking spark tube seals can allow oil to contaminate the boot and deteriorate the insulation. Also, water intrusion can provide enough moisture to serve as a conduit to an easier ground. In some applications, new Genuine Nissan insulator boots can be purchased separately, if needed.

One method to check coil insulation deterioration requires a spark tester and a separate movable ground source. Set up your hand-held ignition coil spark tester as normal. Then attach a grounding wire from body ground to the metal portion of a conductive long screw driver. Use caution to insulate the grip and yourself from a hearty zap! With the engine running, and the ignition coil sparking, touch your ground "wand" across the entire surface of the coil insulator boot. If the spark stops, you have verified a short through the insulator. You can increase conductivity by



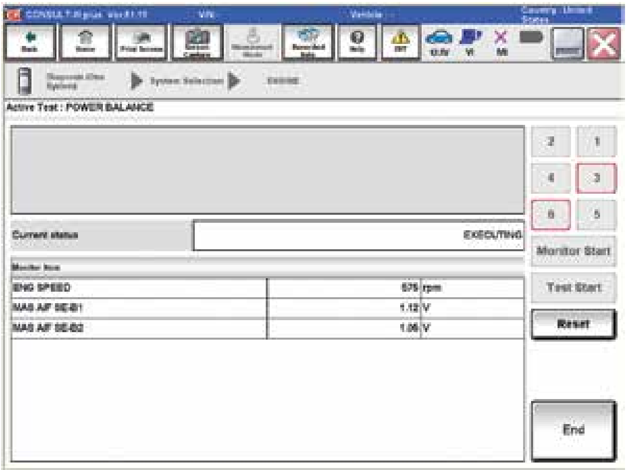
This coil boot design accidentally caused interference with the radio. You can search for helpful Technical Service Bulletins applicable to the specific model you are servicing on the Nissan TechInfo website.

misting the insulator boot with a mixture of baking soda and water. This can sometimes help identify intermittent coil problems related to weather.

Resistivity in the Secondary Circuit

The purpose of a spark tester is to simulate the demand placed on a coil by the combustion chamber environment. Obviously a spark plug gap is much shorter than a hand-held tester's gap, but the test takes place in ambient pressure. Inside a combustion chamber, increased pressure results in increased resistivity. Most molecules that make up "air" are non-conductive, but water or fuel vapors can serve as a path to ground. We know that the air-fuel ratio in a combustion chamber is always more air than fuel, even when rich. However, a lean mixture is best for fuel economy. Thus, the goal is to run as lean as possible without affecting performance or reliability. By the same token, a lean mixture means fewer fuel molecules to create a path to ground. This results in increased voltage demands on the ignition coil to force the jump.

Many ignition misfires occur under load, and may not be caught with a hand-held spark tester. Swapping ignition coils is an excellent diagnostic technique to place a suspected bad coil into an identical environment as the one it came from. Using a CONSULT III plus, perform a power balance test or check for dedicated cylinder misfires. Document the cylinder, move that coil, clear faults, and test drive the vehicle. On the test drive, try to invoke coil failure by snapping the throttle wide open and letting off. By snapping the throttle, the air-fuel mixture instantly becomes lean before the ECM can adjust. An increased combustion chamber pressure (load) coupled with increased air resistivity (lean) can cause a coil not to spark.



Using a CONSULT III plus, you can perform a power balance test or check for dedicated cylinder misfires.

A coil can fail internally so that some of the windings short to one another. This will affect the winding ratio, and will limit the total output capacity of the coil if the short is among secondary windings. This defective coil will then fail to generate a spark under load or too-lean mixture.

Spark Plugs Still Matter

Worn out spark plugs increase the gap and resistance to ground. The coil must work harder to achieve a spark, and excessive work can reduce its lifespan. A missing or severely worn out spark plug electrode could remove the secondary ground as an option all together.

Fouled spark plugs actually make it easier for the spark to find ground. The problem is, the arc is not likely over the spark plug gap. Each incident when the high voltage spark grounds before the gap, a small carbon burn mark develops. This process continues until a carbon track develops along the outside of the plug insulator toward the threads. Engines that consistently run rich or burn oil may have more frequent coil failures.

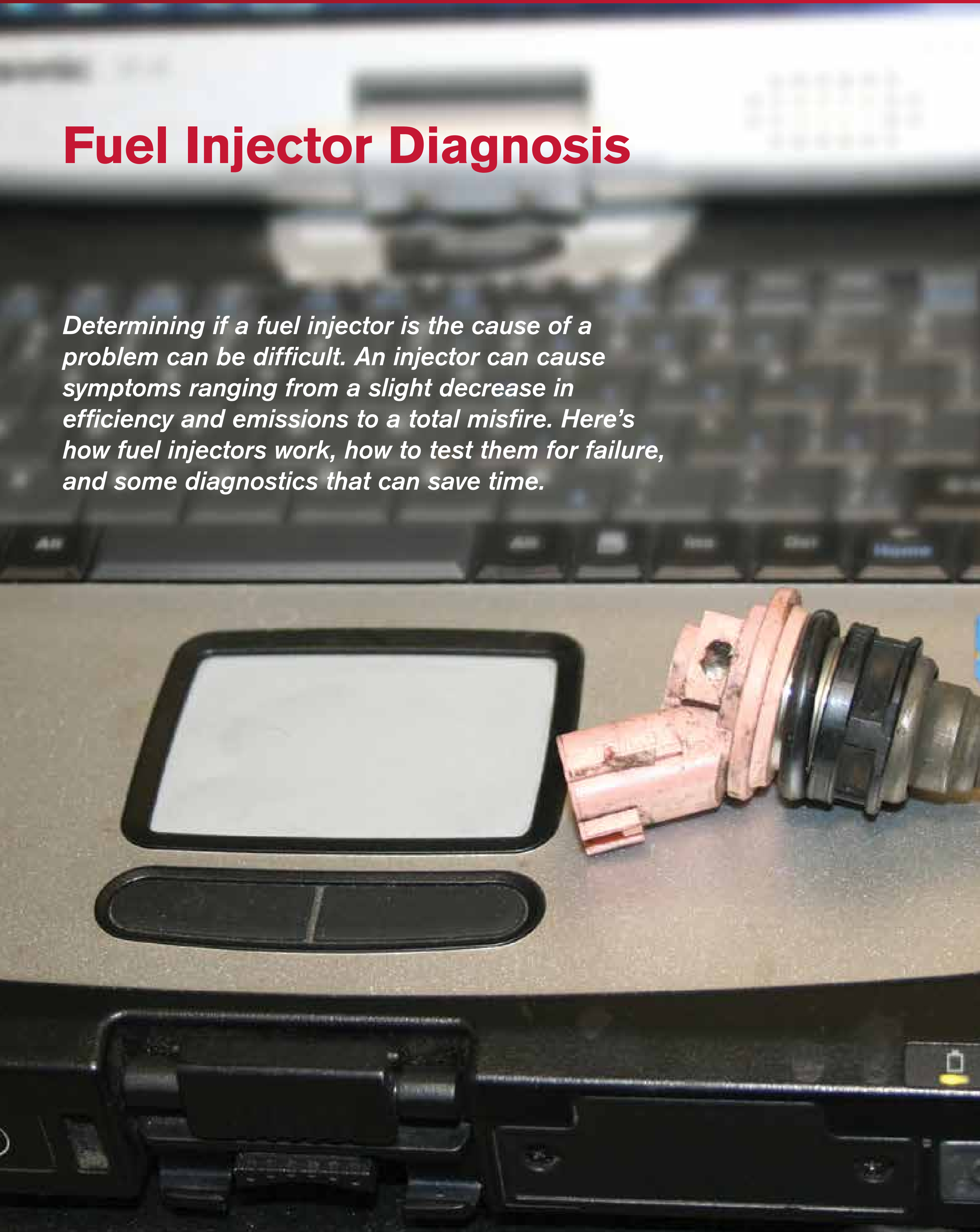
The Right Ignition Coils

For gasoline engines to meet the efficiency requirements of the future, the air/fuel mixture will tend towards lean at the start, and remain lean as much as possible. Forced induction turbochargers increase combustion chamber pressures. Coils must be made well enough to handle these advancements.

Aftermarket coils are prone to short life spans because their manufacturers reduce production costs for their power transistors, transformer quality, and insulator robustness. Do the job right the first time: replace ignition coils with Genuine Nissan products.

Fuel Injector Diagnosis

Determining if a fuel injector is the cause of a problem can be difficult. An injector can cause symptoms ranging from a slight decrease in efficiency and emissions to a total misfire. Here's how fuel injectors work, how to test them for failure, and some diagnostics that can save time.



Fuel injectors are generally problem-free, but when something does go wrong, you need to be able to diagnose them quickly and efficiently. This is not difficult on some engines, but others have little or no easy access to the injectors. In these cases, hours can be spent just to access the injectors. If it turns out that there is an injector problem, the time spent accessing the injectors is just part of the repair. But if there is no injector problem, the hours of time have been wasted, and wasted time is wasted money.

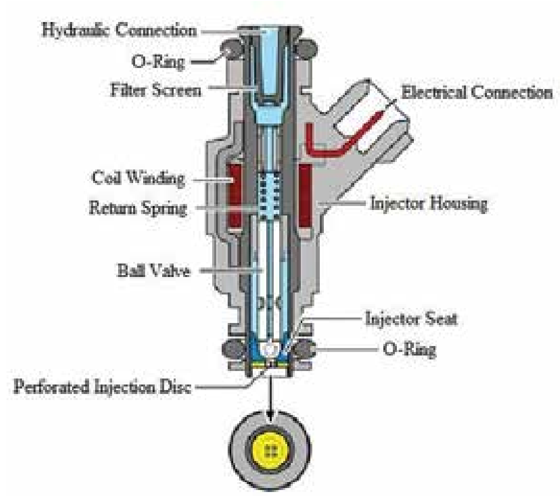
First, let's take a look at how a modern fuel injector works. It's a solenoid valve consisting of a coil and a needle valve (pintle) contained inside a plastic or metal housing. Two wires go to each fuel injector. The first wire will be the same color for all the injectors, and will have battery voltage present any time the key is on. The second wire will be unique to each sensor. This is the ground wire, and is controlled by the ECM. The amount of time the injector is grounded, measured in milliseconds, determines the amount of fuel that passes through the injector. When the injector coil is energized, a magnetic field is generated that pulls the pintle open. This allows fuel to pass through the injector into the intake port and, ultimately, the cylinder. Fuel enters through an orifice on the top of the injector. It passes through a screen filter, the body of the injector, and then through the perforated disc at the bottom of the injector. The screen filter keeps any particles that were too small to be caught in the fuel pump filter out of the fuel injector. The perforated disc determines the spray pattern of the fuel.

Any debris that passes through the screen filter will cause problems in the injector. Either it will hold the injector open, causing fuel to pass through it when closed, or it will clog the injector, causing less fuel to pass through it than desired when open. Both of these issues will confuse the ECM, and it will try to compensate by adjusting the time the injectors are open.

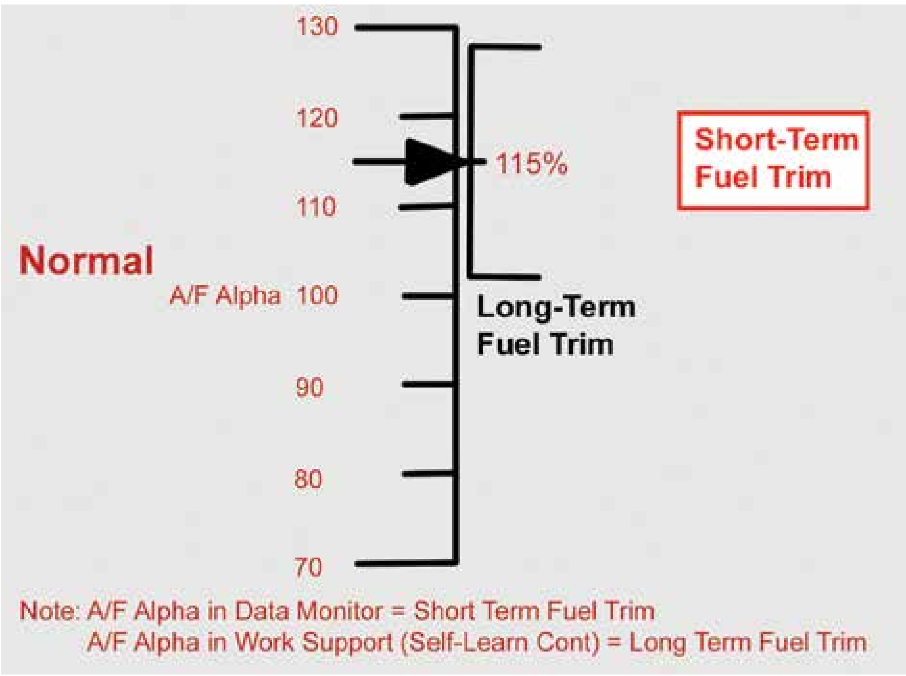
The ECM is programmed with base fuel maps, which determine how much fuel should be delivered for any given engine condition. These base maps are calculated by engineers and are based on computer models of engine requirements. They are a good baseline for fuel delivery, but in the real world, conditions aren't always the same. Changes in things as simple as humidity can affect the combustion process. So the ECM has to be able to adjust fuel injector pulse duration to keep the engine running as efficiently as possible.

These adjustments are called fuel trim. There are two types of fuel trim implemented in modern fuel injection systems: short term fuel trim, and long term fuel trim. Short term fuel trim refers to the constant, small changes the ECM makes in pulse duration. It is based on air/fuel ratio sensor feedback. The ECM tries to keep the fuel to air to fuel ratio as close to 14.7:1 (stoichiometric) as possible. Long term fuel trim refers to more permanent changes in fuel delivery that are based on the patterns of the short term fuel trim, usually due to engine wear. If the ECM sees consistently positive or negative fuel trims, it gradually adjusts the long term fuel trim to compensate. Long term fuel trim sets a new baseline for short term fuel trim.

Nissan's measurement PID when using the CONSULT III plus for both fuel trims is called "A/F Alpha". While in the Data Monitor screen, A/F Alpha represents short term fuel trim. While in the Work Support screen, A/F Alpha represents long term fuel trim. A value of 100 means there is no deviation from base fuel mapping. A value above 100 indicates the engine is running lean, and the ECM must deliver more fuel to maintain the stoichiometric ratio. A value below 100 indicates the engine is running rich, and the ECM must deliver less fuel to maintain the stoichiometric ratio. A/F Alpha can range



This is a cross-section of a typical fuel injector. Designs vary by application, but all port fuel injectors contain these components. Spray pattern is determined by the size, shape, and number of perforations in the perforation disc located at the bottom of the injector.



Here we see an A/F Alpha of 115%. This indicates the A/F Ratio Sensor detects a lean condition, and the PCM is increasing injector pulse duration by 15% to compensate.

from 75-125. Beyond that range, the ECM assumes there is a problem, and sets either a P0171 or a P0172 trouble code.

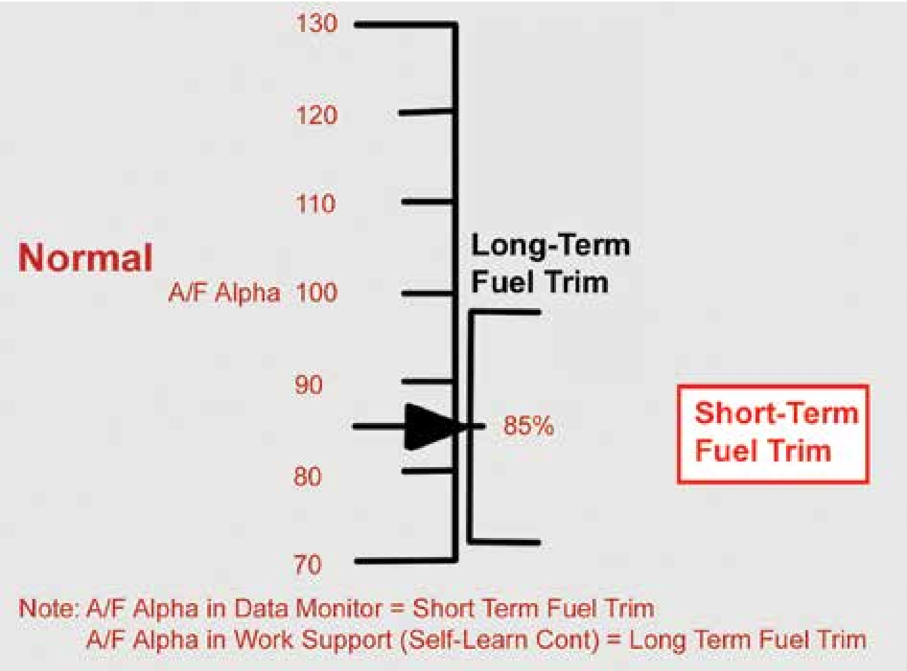
The fuel injection system is one of the most complex systems in any modern vehicle. It analyzes input from just about every sensor in the vehicle when determining the proper amount of fuel to deliver to the cylinder. The amount of fuel delivered to the cylinder is determined by two things: fuel pressure and injector pulse duration. Fuel pressure may vary, depending on engine load, but always in a predetermined value. Therefore, the only way to differ the amount of fuel entering the cylinder is by varying the pulse duration of the injector. A longer pulse duration holds the injector pintle open longer, allowing more fuel to pass through it. A shorter pulse duration allows less fuel to pass through the injector.

The most common problems involving fuel injectors are the engine running rich, the engine running lean, or single cylinder misfire. There are many different factors that can cause these problems, and because fuel injectors are often very difficult to access, they tend to be tested last. The most easily accessible items should always be tested first. Usually these are components like mass airflow sensor, ignition coils, and spark plugs. Once these components have been tested and ruled out as the cause of the failure, the injectors should be addressed.

Testing Fuel Injectors

After you have determined that the injectors are likely the problem, you need to begin testing them. The first test is simple, straightforward, and requires only a stethoscope and a well-trained ear. With the engine idling, use the stethoscope to listen to each fuel injector. If a stethoscope is not available, a long screwdriver will work, but it is not ideal. What you want to hear is the injectors clicking evenly and consistently. The main purpose of this test is to identify an injector that sounds different than the rest, and any discrepancies can indicate failures. If an injector sounds different than the rest, you should focus further testing on that injector. Keep in mind that even if all the injectors click evenly, there may still be a problem. This test is meant to be a quick check for obvious problems, not a definitive indication of injector health.

The next logical step in testing fuel injectors is also quick and easy, but does require a CONSULT III plus. It is called a power balance test, and is invaluable for identifying how much power each individual cylinder is contributing to the overall performance of the engine. With the CONSULT III plus connected to the vehicle, select the Engine option, then Active Test, then Power Balance. As each cylinder is deactivated, you will see a drop in RPM. The service manual simply says that each cylinder should produce a momentary drop in engine RPM. While this



Here we see an A/F Alpha of 85%. This indicated the A/F Ratio Sensor detects a rich condition, and the PCM is decreasing injector pulse duration by 15% to compensate is true, it is not the main benefit from this test. The most useful feature of the power balance test is the measurement of the RPM drop for each deactivated cylinder. Ideally, all cylinders would drop an equal number of RPM when deactivated. In reality, they will never drop the exact same RPM, but they should all be within 10% of each other. Remember that a high RPM drop indicates a strong cylinder, and a low RPM drop indicates a weak cylinder. If a cylinder drops much less RPM than the others, then it should be addressed further. Specifications vary, depending on the engine and application, so be sure to refer to the service manual before condemning any components.

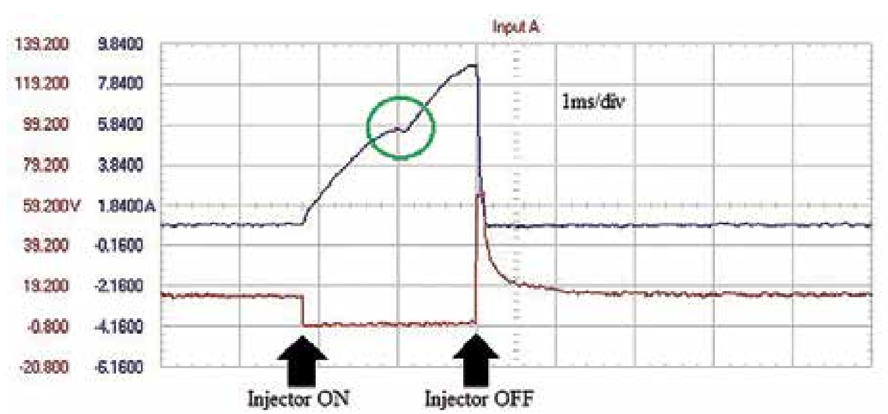
Another very useful, but not definitive, way to test a fuel injector is a resistance check of the injector's coil windings. This check, as with the previously discussed tests, can identify a failed injector, but does not guarantee a good injector. If the fuel injector connector is easily accessible, simply connect an ohmmeter across the terminals to measure the resistance. Specifications vary by application, but generally, the internal resistance should be between 10 and 15 ohms. An injector winding with high resistance, low resistance, or an open will cause the injector to operate improperly, but it is also very common to see internal resistance within specification on a failed injector. This test simply checks the integrity of the coil windings, and has no bearing on the condition of the rest of the injector.

Some engine configurations make accessing the fuel injector connectors very difficult. In these situations, resistance testing should be done from the most accessible connector available. This may be a sub-harness connector for some vehicles, but most Nissan vehicles place the ECM in an easily accessible area of the engine compartment. Take advantage of this, and use a pin diagram in the service manual to locate the appropriate wire to connect to.

All of these tests can identify a failed fuel injector, and they often will. However, sometimes you have to delve deeper into investigating the source of the problem. One of the most useful and informative tests involves looking at the voltage and amperage waveforms of each individual injector. Performing this test requires an oscilloscope. As with the resistance test, connect the oscilloscope leads to the most accessible connection. It may take a few minutes to get the scope set to the proper parameters to be able to see the injector waveform, but once it is set up, you can assess each injector fairly quickly.

What you should see, is steady battery voltage up to the moment the injector is commanded open. At this point, the voltage will drop near zero as current flows through the circuit. Voltage will remain near zero for the duration of the injector pulse, after which there will be a large voltage spike. This voltage spike is caused by the magnetic field collapsing when the ground is terminated.

You should focus on amperage when attempting to identify a stuck injector pintle. The amperage will



This is a fuel injector voltage and amperage trace on an oscilloscope. Voltage is steady around 14V until the injector is commanded ON, at which point it drops near 0V. Voltage spikes when the injector is commanded OFF due to the collapsing magnetic field. Amperage steadily increases as soon as the injector is ON. The slight drop in amperage, circled in green, indicates the injector pintle is opening. If you do not see this "gall", the injector pintle is stuck.

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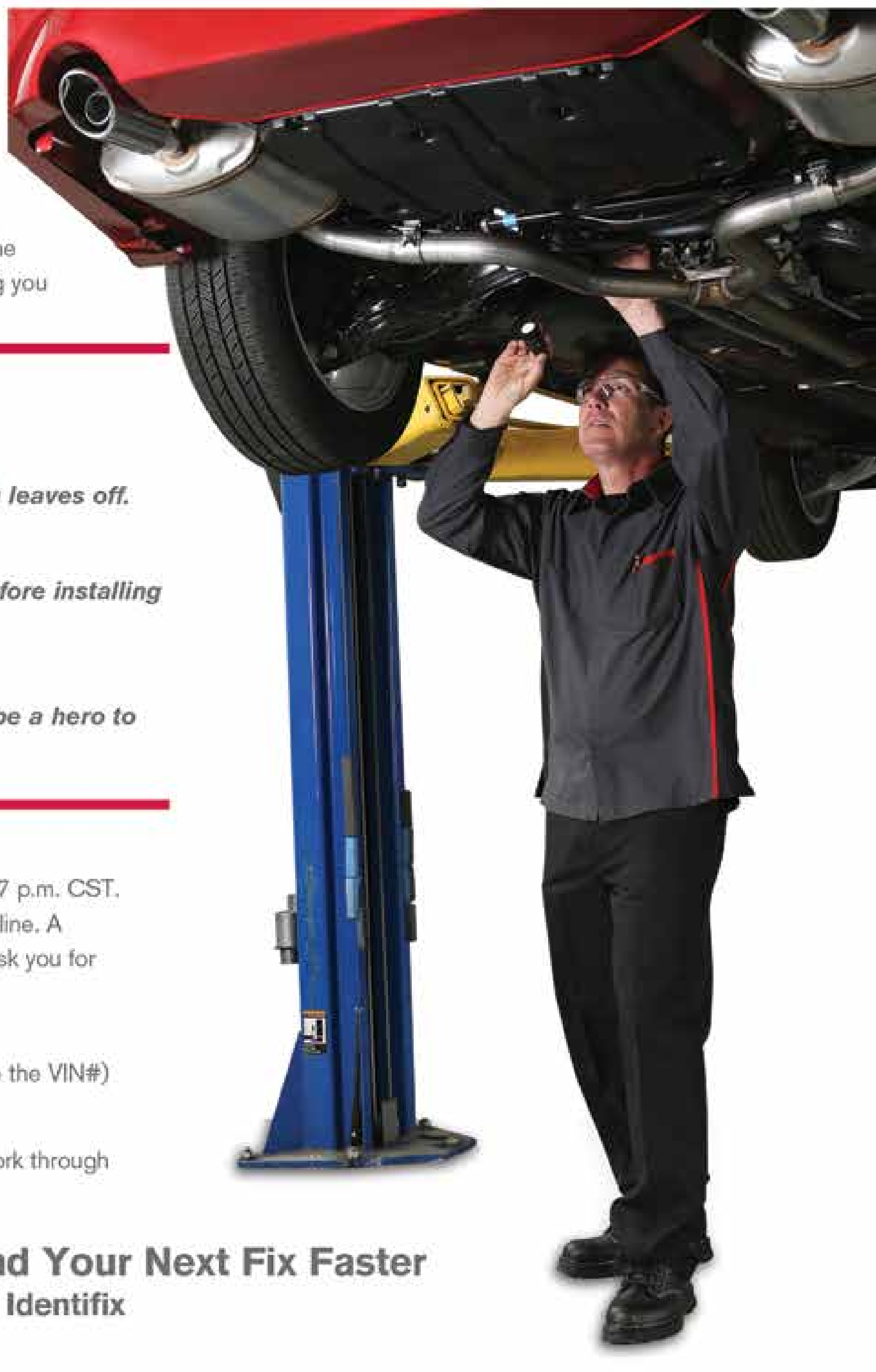

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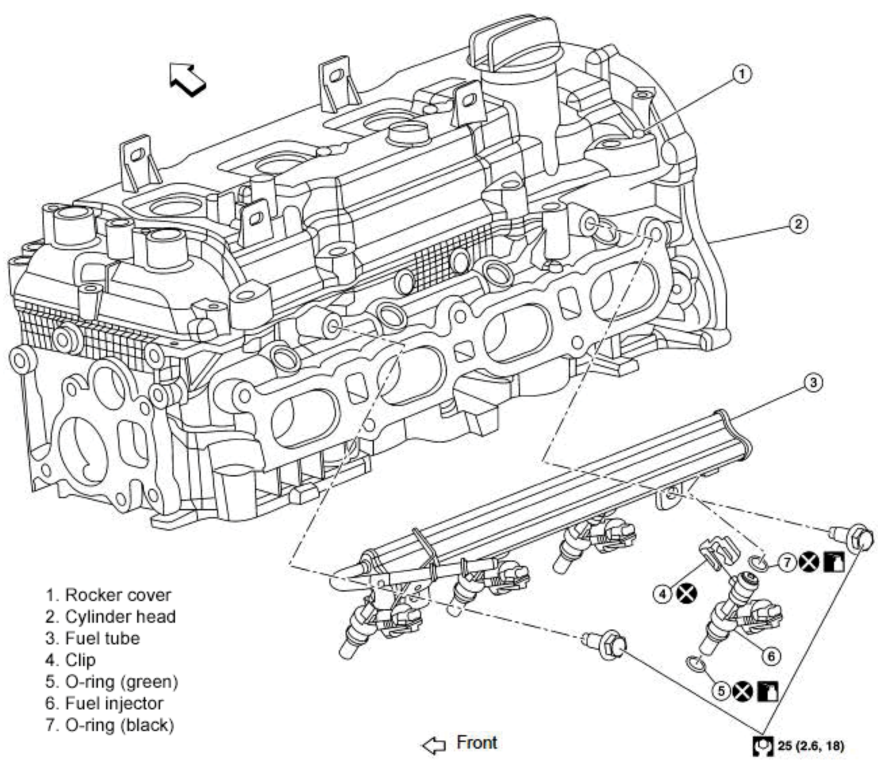
be zero up to the point that the ECM grounds the circuit. It will then steadily climb to the point where the injector pintle begins to move. At this point there will be a subtle dip in amperage due to the movement of the pintle inside the magnetic field. Following the dip, amperage will continue to rise steadily until the ground is terminated, and then drop quickly back to zero. This dip in amperage is what you are looking for, and if you don't see it, the injector pintle is stuck. It takes some practice to identify, so be sure to produce an amperage graph from each injector and compare them carefully. Replace any injector that does not produce this dip in amperage.

If an injector passes all the tests mentioned above, there is a final test that is the most definitive in identifying fuel injector condition. However, it is also the most time consuming. The test is set up by removing the injectors from the intake manifold, but keeping them connected to the fuel rail, and placing each injector in a suitable container like a glass jar. Each fuel injector is secured to the fuel rail by means of a metal clip. This is convenient, as the injectors can be cycled while they are removed from the manifold, but will still stay connected to the fuel rail.

Before the injectors are set up in their containers, the ignition system needs to be disabled. Usually, the easiest way to achieve this is by removing the electrical connectors from each ignition coil. After this is done, crank the engine and observe the spray pattern of each injector. They all should produce an even amount of fuel in an identical spray pattern. Replace any injector that is not flowing a proper amount of fuel, or has an abnormal spray pattern.

As you can see, there are many different tests to determine the condition of fuel injectors. They range from quick and easy tests that can take only minutes, to in depth, time consuming tests that may take hours. Always keep in mind that the fuel injection system is perhaps the most complex system implemented in modern engines, and its operation depends on input from many different sensors. In many cases, the fuel injectors themselves are not the cause of the malfunction. Either the ECM is receiving poor data from one or more sensors, or there is a problem with the fuel injection electrical circuit that results in incorrect voltage being applied to the injectors.

Considering all the work that is often required to access the fuel injectors themselves, be sure you are confident that all supporting systems are in good condition before starting complex, time consuming tests of the fuel injectors. Prioritize repairs based on both time required to test, and by the probability of component failure.



This is an illustration of the fuel injectors and fuel tube (fuel rail) on the QR25DE engine. Notice the clips (#4 in this picture) that hold each injector to the tube. This allows us to cycle the injectors away from the engine without them ejecting from the tube.

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- **B** Quick Order if you know the Part Numbers or VIN.
- **C** See recently searched vehicles.
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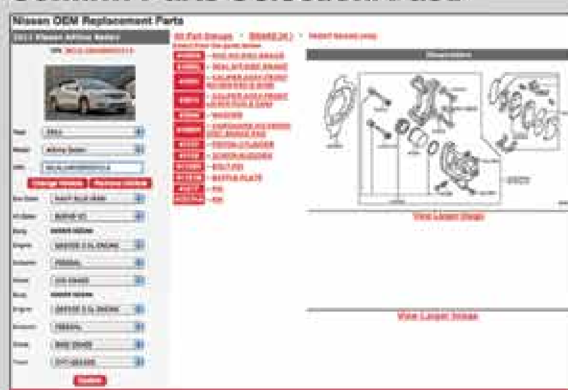
Confirm Parts Selection. Fast.



- Parts diagrams and VIN-verified part numbers for every vehicle system and sub-system.
- Current parts availability shown.

New Streamlined Check Out Process

- Your pricing and discounts are readily visible.
- Purchase and delivery preferences are always saved for your next order.
- Make payments or set up billing quickly and easily.

Nissan Technical Service Bulletins to help make diagnosing and servicing Nissan vehicles a little easier.

Title: ABS Self Check Noise
TSB: NTB10-077a
Applied Vehicles: All Nissan models with ABS or ABS/VDC

If you may identify a clicking, knocking, clunking, buzzing or thumping noise coming from the engine compartment area, and the noise only occurs only once per ignition cycle and does not occur again until the ignition is recycled, and the noise happens briefly for only a few seconds on acceleration, between 5 and 30 mph.

This condition is normal and may be louder if the vehicle has not been operated for a prolonged period of time. The vehicle does not need repair.

Each time the ignition is turned on and the vehicle reaches approximately 5 to 30 mph, the ABS/VDC system performs a "Self-Check" to confirm components of the ABS/VDC system are operating correctly.

This Self-Check function creates the noises described above.

If the brakes are being applied when the Self-Check occurs, a vibration may be felt in the brake pedal and an increased level of noise may be noticed.

Title: DTC P0300 Stored and Ignition Coils Blistered
TSB: NTB06-075
Applied Vehicles: 2004-2006 Maxima, 2004-2007 Quest, 2004-2006 Altima with VQ35 Engine

You may have a customer complain of hesitation on acceleration, a rough running engine or the engine cranks but will not start.

If you confirm a DTC P0300 is stored in the ECM and one or more of the ignition coils is blistered or melted, inspect the negative battery cable at the transmission end (at the battery terminal). Wiggle the end of the cable at the connector to make sure it is tight and not frayed.

1. If you find the cable broken or damaged, replace it with the appropriate Genuine Nissan part.
2. Inspect, test and replace each ignition coils as needed with the appropriate Genuine Nissan part.
3. Erase the DTC and test drive the vehicle to ensure that the engine runs smoothly and no further DTCs are set.

If the problem persists, further diagnostics and repair may be required.

Check the negative battery cable for damage.

Title: 2002 Altima and Sentra: MIL "ON" and DTC P0340 (Camshaft Position Sensor Code) Stored

TSB: NTB01-074a

Applied Vehicles: 2002 Altima with 2.5 Liter Engine (QR25DE) Only, 2002 Sentra with 2.5 Liter Engine (QR25DE) Only

If one of these vehicles exhibits one or more of the following symptoms:

- MIL "ON" with DTC P0340 (Camshaft Position Sensor Code) stored in Self Diagnosis results.
- Engine stumbles momentarily during cruise condition.
- Engine stops running at idle.

The cause of this incident may be the ignition coils. A new resistor assembly (located inside the ignition coil tube) is available to repair the described symptoms, if they should occur.

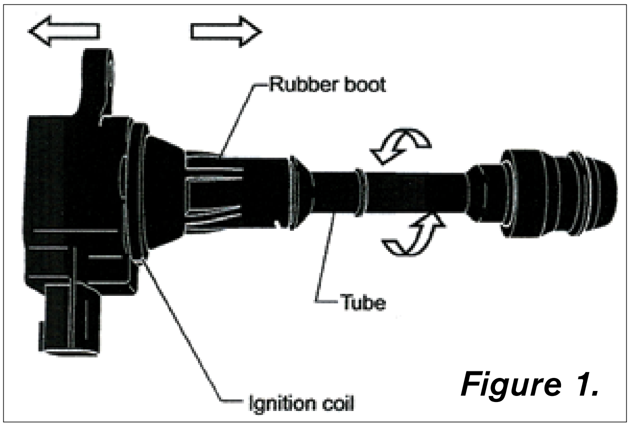


Figure 1.

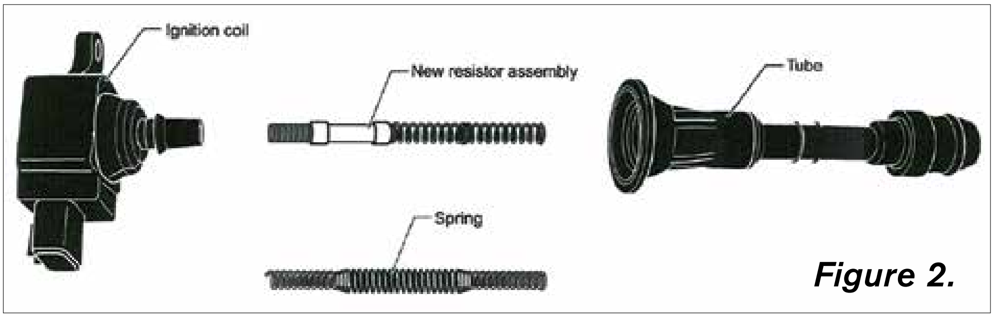


Figure 2.

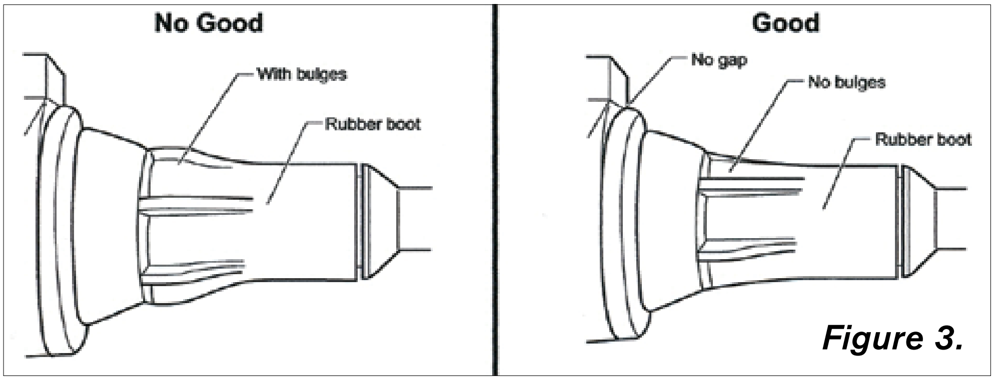


Figure 3.

Service Procedure

1. Verify that the vehicle has one or more of the symptoms listed above.
2. Remove all four ignition coils. Refer to the appropriate 2002 Service Manual for the removal procedure of the ignition coils (page EM-26 for Altima, page EM-106 for Sentra).
3. Install the new resistor assembly in all four ignition coils as follows:
   A. Pull the rubber boot away from the ignition coil. Then, twist and pull the ignition coil tube from the ignition coil to separate them (Fig. 1).
   B. Remove the spring from the ignition coil and discard. Insert the new resistor assembly into the ignition coil tube exactly as shown (Fig. 2).
   C. Assemble the ignition coil tube to the ignition coil.
   - Rotate the ignition coil tube while pressing on to the coil.
   - A "pop" sound will be heard when the rubber boot is seated correctly to the ignition coil.
   - Ensure there are no gaps and bulges between the coil body and the rubber boot (Fig. 3).
4. Re-install the ignition coils with the new resistor

assembly to the engine. Refer to the appropriate 2002 service manual for installation procedure of the ignition coils (page EM-26 for Altima, page EM-106 for Sentra).

5. Erase the DTC from Engine Self Diagnosis.
6. Test drive the vehicle and re-check Self Diagnosis results using CONSULT III plus to confirm the problem has been resolved.

Title: MIL On with P0340/P0345 (CMP Sensor) and/or Engine is Hard to Start When Warm

TSB: NTB04-063

Applied Vehicles: 2002-2005 Altima with VQ35DE Engine Only, 2004 Quest, 2004 Maxima

If you confirm a MIL ON with P0340 (CMP Sensor Bank 1) and/or P0345 (CMP Sensor Bank 2) and/or the engine is hard to start when warm, but starts OK when the engine is cold.

NOTE: "Hard start" is engine crank time that is longer than 3 seconds.

Actions

- If you have DTC P0340, replace only Bank 1 CMP (Camshaft Position) Sensor.
- If you have DTC P0345, replace only Bank 2 CMP (Camshaft Position) Sensor.
- If you have both codes, replace both sensors.
- For a "hard to start warm" incident, replace both sensors, even if you have no codes.

Refer to the correct service manual for sensor replacement information. If replacement of the sensors does not solve the problem, further diagnostics are needed.

Title: Essential Tool: J-41425- NIS Tubing Repair Kit

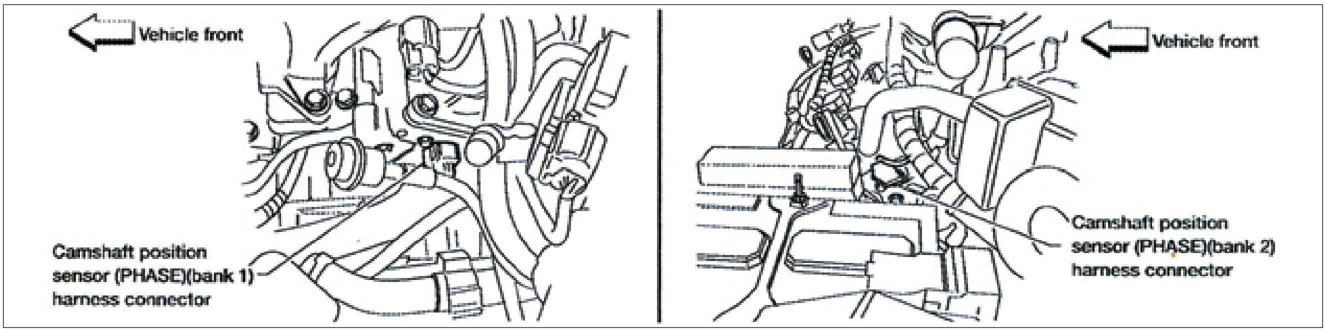
TSB: NTB08-110

Applied Vehicles: All Nissan models

If you find that the aluminum heater coolant or A/C hard tubing needs to be replaced for any reason, this kit will allow you, using the included tubing cutter, to cut out the damaged section and, using the connectors and tools in the kit, splice in a replacement section from the matching service part.

This method of tubing repair, rather than tubing replacement, is more convenient in cases where installing the entire service part would require major disassembly of the vehicle. Complete details and usage can be viewed in the TSB on the Nissan TechInfo website at nissan-techinfo.com.

The J-41425-NIS Tubing Repair Kit can be ordered from Nissan Tech-Mate by logging onto nissantechmate.com or by calling 800-662-2001.



CMP sensor locations.

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