Spring 2017 | Volume 10 | Issue 1

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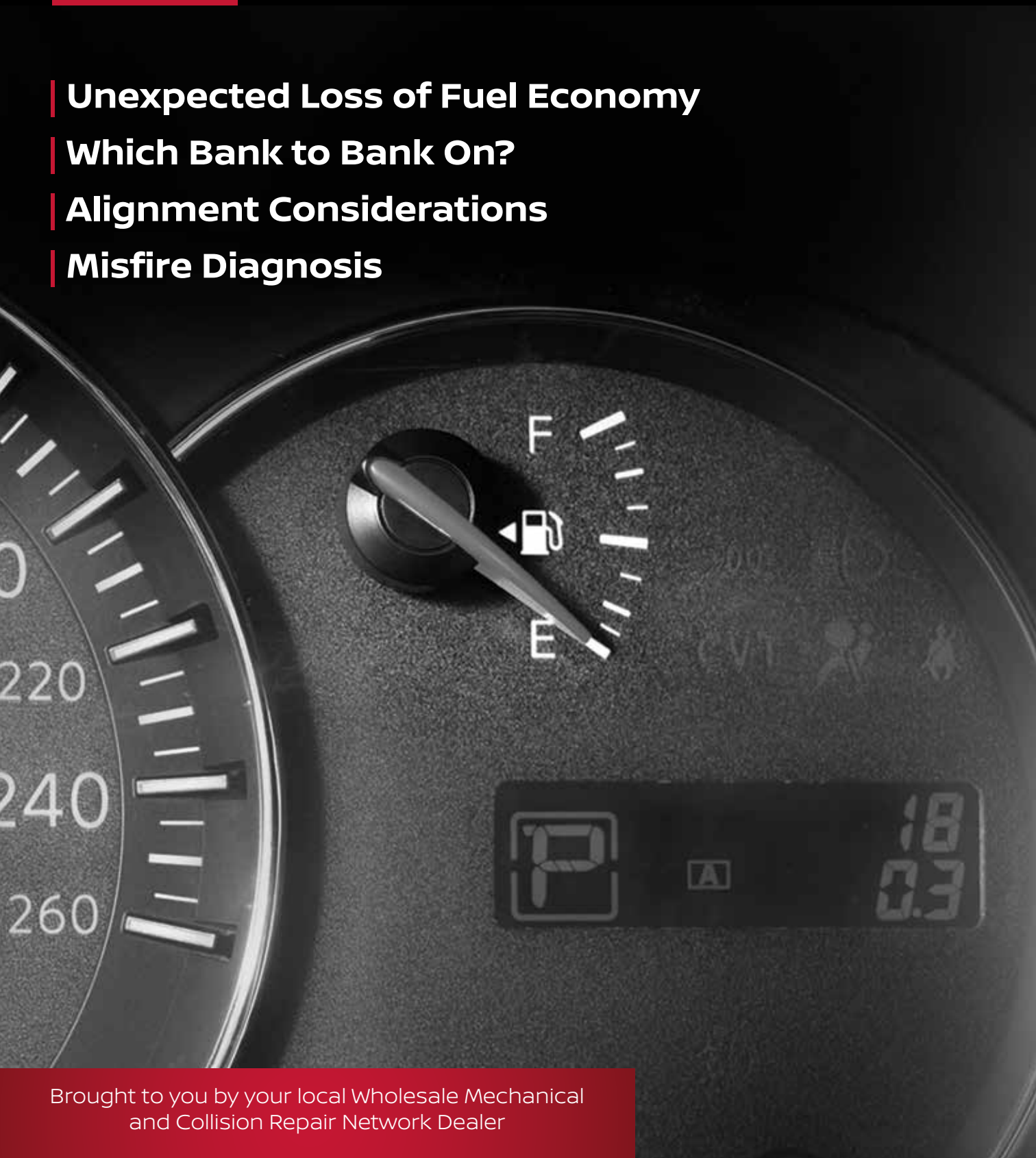
Unexpected Loss of Fuel Economy

Which Bank to Bank On?

Alignment Considerations

Misfire Diagnosis



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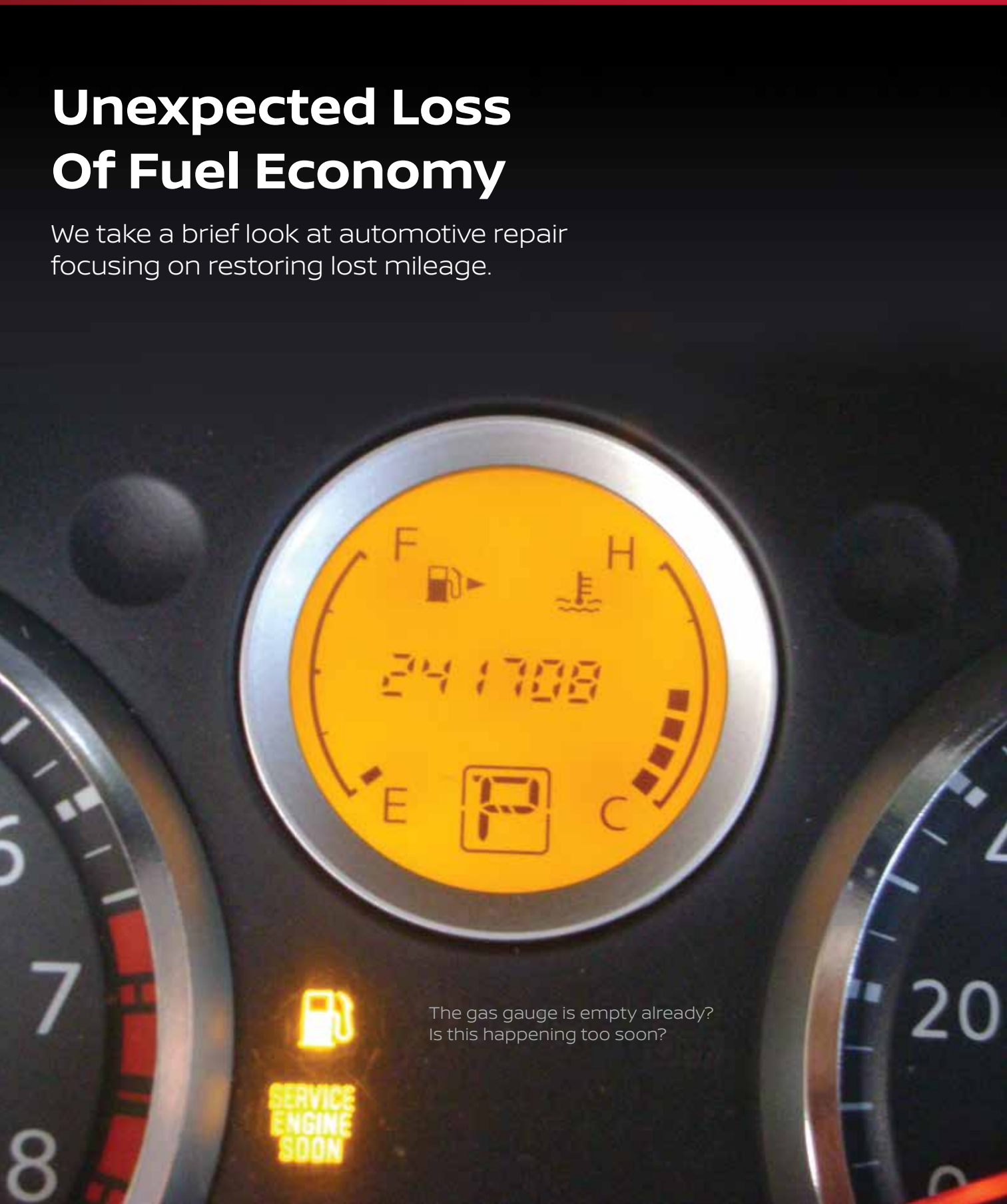
Contents

Features

Unexpected Loss Of Fuel Economy

We take a brief look at automotive repair focusing on restoring lost mileage.



The gas gauge is empty already? Is this happening too soon?

Your customer has been diligently tracking miles driven, and how much gas was put in their tank. He's even gotten himself a note pad with his favorite sports car on the cover to write it down and keep track of his economy. Then it happens, out of the blue, his calculator tells him that he has lost 5 miles to the gallon since his last fill up. What happened? Where did the gas go?

In today's environmentally aware culture we understand that loss of fuel mileage means more pollution in the air, and more cost at the gas station. What may be missed is that it also means something may be, at least to some degree, failing with the vehicle. Much the same as a person who develops excessive thirst may see a doctor, excessive fuel consumption will likely need the help of a diagnostic technician. The difficulty of these diagnostics can range from simple things the driver should be checking to the advanced internal workings of the transmission. To top things off, there may often be more than one issue causing the problem.

When diagnosing poor fuel economy there is a very large gap in the diagnostic chain. An experienced diagnostic technician knows you should first verify the customer complaint. Unless you plan on running a couple of tanks of fuel through the car during your testing, that's going to be difficult to do. Without verification you are going to have to rely heavily on your customer's observation of the problem. The nice thing is that people that will complain about a fuel mileage change are also the ones keeping track of their fuel mileage.

Start by listening carefully to your customer. Sudden changes in mileage are often attributed to changes in driving situations. Don't assume your customer is aware that vehicles get different mileage on the freeway as opposed to city or rush hour traffic. According to fuelmileage.gov as much as a 33 percent mileage reduction can be simply explained by driver attitude. Careful and tactful interrogation is important to make sure you are looking for a problem under the hood and not just a loose nut in the driver's seat. With any luck your customer can help keep you from looking for a problem that simply isn't there.

As an example, a grandmother is giving her Sentra to her grandson for a graduation present. Mysteriously the car loses 20 percent of its fuel economy and the tires and brakes are worn out after a few thousand miles. She brings the car in on his behalf and wants you to find out what's wrong with the car. Common sense tells us we don't need to spend a ton of time on this one, but don't just dismiss it either. Although poor alignment and sticky brake calipers can cause a significant drop in mileage, youth and testosterone most certainly will cause a drop in mileage.

Considering how the vehicle is being used can also be a direction to investigate. An extreme case might be someone that just got a new job delivering anvils, or just got a shiny new roof rack to hold their mountain bikes. The effects of these changes will vary greatly between vehicles. What might make a significant difference in a Sentra might make less of a difference in an Altima and almost no difference in a bigger vehicle like a Quest.

Assuming you have considered all the external causes and you are convinced there is something wrong with the vehicle, it's time to start narrowing down the possible causes. Test driving on surface streets as well as the highway is a good idea to cover as many angles as possible. A rough idle at a stop light might indicate poor spark plug condition or poor compression, whereas poor power on the freeway may indicate a weak coil or a variable valve timing malfunction. Poor yet smooth acceleration may indicate a slipping transmission or even a faulty torque converter.

This is also a good time to take stock of the warning indicators on the dash.

When an engine is brand new it will have less mileage as it breaks in. The mileage will get better and better, possibly for even tens of thousands of miles. At some point it will reach its perfect break-in point. After this point it will very slowly decrease in efficiency as the engine slowly wears down and loses volumetric efficiency. Just as the many other parts of the vehicle can wear out, once an engine reaches 2 or 3 hundred thousand miles it will start to wear out, no matter how well it is maintained. A leak-down test can identify if the mileage has taken its toll on the engine's performance.

Engine and transmission trouble codes will often lead to fuel robbing malfunctions. Something as simple as a P0442 EVAP small leak code can lead you to a leak in the fuel system. Gas dripping on the ground does not help your mileage. Sometimes codes can still lead you to fuel waste even if they don't seem, on the surface, to be related.

Take for example a P0420 code, catalytic converter below efficiency. Seldom does a catalytic converter cause any noticeable driveability issue, but it can still be an indication of a fuel/air mixture problem. Although converters do fail from old age they are much more likely to fail from an overly rich condition or even excessive hydrocarbons in the exhaust from a partial misfire. Although this would be a great time to hook up your scanner and take a look at the fuel trims, it may not give you the entire picture. Since the ECM gets its fuel trim data by reading the oxygen sensors, keep an open mind about the readings you get.

Oxygen sensors can send false readings to the ECM for various reasons. A leak in the exhaust upstream of the pre-cat oxygen sensor can make it seem that the exhaust is leaner than it actually is, or a failing sensor may read lower than it should. Since the computer has no other way to tell, it assumes the engine is lean and needs more

An impressive display and the car still drives smoothly, but the mileage is suffering.

At 300K miles this engine isn't going to get the mileage it once did. With air hissing in the crankcase it's going to need a rebuild to get its former glory back.

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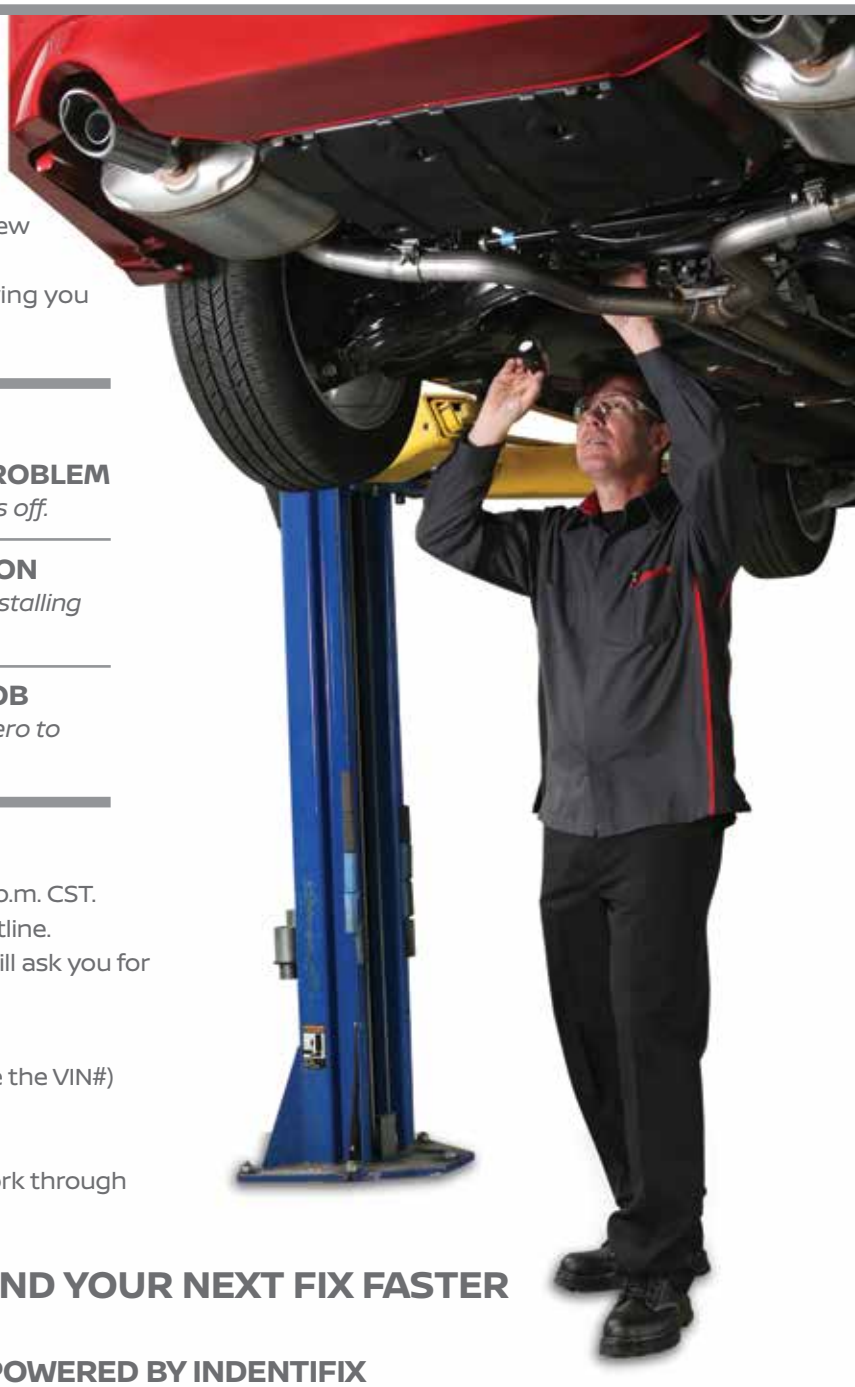

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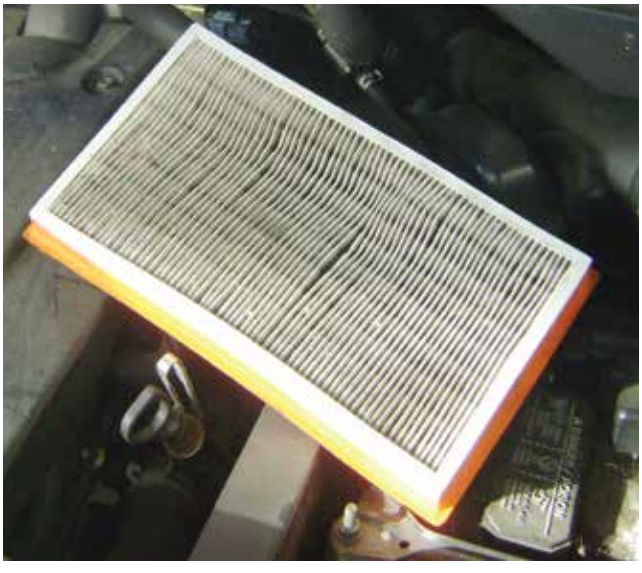
fuel, thus causing an excessively rich condition and a significant loss of fuel economy. A solid way to verify a condition like this is to use a 5 gas analyzer or even just take a look at a spark plug. Black soot on the plug indicates too much fuel. Often you can even smell richness in the exhaust. If the fuel trims don't agree it's time to investigate the oxygen sensors.

These plugs are clearly getting too much fuel, yet the fuel trims on this 1997 Maxima still showed a lean condition.

Another common cause of fuel mileage woes rests in the transmission. Scanning for codes in the transmission may reveal the culprit. Codes for the torque converter clutch like P0744 or P0740 indicate that the torque converter is still slipping when you should have direct power transfer through the converter. In city or stop and go traffic you may not see any difference in mileage. At higher speeds it can really start to add up since a torque converter typically slips about ten percent at highway cruising speed without the torque converter clutch locking up properly. Other systems can also prevent lockup as well. A low coolant temperature sensor, inaccurate input or output speed sensors, or even a faulty TPS signal can also prevent the TCC from locking up.

Unfortunately not all issues will have a bright light on the dash to point you in the right direction. Often a simple lack of maintenance is at fault. 20,000 miles overdue for replacing spark plugs can result in reduced efficiency. 5,000 miles overdue on an oil change can result in a loss of the friction-reducing properties of the oil and a reduction in mileage, not to mention engine life. Failing to change a dirty air filter is a very common oversight that can add up to inefficiency. Any of these items may not be enough to raise any eyebrows, but together they can easily add up to a loss of as much as 5-10 mpg. Getting the maintenance up to date should at least help if not solve the fuel mileage problem.



As the air filter gets dirty the air pressure builds and starts to deform the filter material. It's time to replace this filter.

Engine performance issues are not always the root cause of mileage loss. Brakes, alignment, and tires also play a role. According to fueleconomy.gov you can expect about 0.2 percent mpg loss per 1 psi average pressure drop across all four tires. Using the tire pressure recommendations on the driver's door jamb is your best bet for setting the correct pressure. Lower than recommended pressure will decrease efficiency, but don't assume the opposite is true. Inflating the tires to maximum pressure won't necessarily add the same fuel mileage that a low tire takes away. More importantly, over inflated tires decrease traction and stability.

Very intelligent engineers from Nissan, the tire manufacturers, and several organizations like the Tire and Rim Association (TRA), have already done the leg work and figured out the perfect compromise between safety, performance and fuel mileage. Taking their recommendation is the right call and you can find that recommendation in the driver's door jamb on almost any modern vehicle.

Alignment can have surprisingly strong effects on mileage. For every 1/8th inch of toe there is the same force as dragging the tire sideways 28 feet for every mile driven. As you can imagine, the action of removing rubber from the tires as it's dragged sideways takes a lot of energy that ultimately comes from the gas tank.

Checking the tire pressure is quick and easy. Low tire pressure means a loss of fuel economy.

Getting the front toe as close as possible to zero would seem to be the easy answer, but it's not. The specifications for setting toe are designed to be used when the vehicle is sitting still on the alignment rack, not as it's driving down the road. Drag on the front tires and pull from acceleration can change the actual toe under various driving conditions. Same as tire pressure, following the set specifications is the best bet. To a lesser degree, caster and camber can have an effect as well. If there's enough energy to pull the vehicle off its straight path, that force has to come from somewhere.

When a customer has a problem with the brakes they will most likely notice some other symptom before they notice any change in fuel mileage. For the sake of thoroughness, though, we should consider a couple of issues that may present a problem in the braking system.

A really good practice, whenever you are doing any kind of brake work, is to check the temperature of the brakes at each wheel with an infrared temperature sensor. Each axle should have a relatively minor temperature difference side to side. More than a 20 percent difference indicates that one side is working too hard or the other side isn't working hard enough.

Tire pressure recommendations are often found in the driver's door jamb on a placard like this.

There should be a difference between the axles, with the rear being cooler than the front to varying degrees depending on the weight of the vehicle and the weight balance. Patterns that may warrant a closer look as a culprit

for a mileage decrease might be warmer rear brakes or warmer diagonal brakes. Either of these patterns may not cause a noticeable pull to either side while driving and yet still cause enough drag to kill fuel economy. Simply raise the vehicle off the ground and spin each tire by hand. Any excessive drag will be obvious.

Keep in mind when looking for a fuel mileage complaint, as with any complaint; verify the customer's concern. Sometimes people have unrealistic expectations of what kind of mileage they should get. Take for example a customer who comes in with a 2004 Maxima and he is just distraught that he is only getting 27.7 mpg. If he's doing any city driving you might have some difficulty improving on that since the rating for this car is 20 mpg city and 29 mpg highway.

People get the impression that a V-6 Maxima and 4 cylinder Sentra are about the same size and made by the same manufacturer so they must get similar fuel efficiency, when the reality is as much as a 40 percent difference in these two 2004 models. It wouldn't be a bad idea to start any service regarding fuel mileage expectations with a quick search of the manufacturer's estimated city and highway mpg rating.

Cars are engineered very well these days. If all the systems are functioning properly, it is unlikely they will suffer poor fuel economy. Of course, if the vehicle is not configured as it was designed to be run, all bets are off. Aftermarket performance ECMs, cold air intakes, oil filled air filters, and other performance parts can make a big mess of things. Many performance parts can ruin the fuel mileage only to gain very small horsepower improvements.

At nearly 28 mpg this Maxima is getting great gas mileage. The driver reports a lot of highway driving.

One example is a system that connects inline with the coolant temperature sensor. The device sends erroneously low temperature readings to the ECM, tricking it to run richer at full temperature. The increased fuel may slightly increase power but will dramatically reduce mileage. Should you find these kind of devices installed, they are a good place to look for the lost mileage.

One last very notable fuel economy problem is the type of fuel going into the tank. E85 fuel is available in most states now and most manufacturers including Nissan have flex fuel vehicles available. Unfortunately mileage while using E85 fuel will suffer a lot. Some estimates are as much as 30 percent less fuel economy.

To add to that news, the lower price of E85 will often tempt people to use it even if they don't have a flex fuel vehicle. This can manifest itself in a Check Engine light with codes for a lean condition. Some have claimed that the high ethanol content makes it more corrosive and may damage rubber and aluminum parts in the fuel system. The important thing for this conversation is that if your customer is using E85 they will have a loss of fuel economy.

Although finding fuel mileage problems can cover a broad range of systems, they don't have to be scary problems to diagnose. If there is truly one problem causing the mileage loss it will not be hiding. It is more likely you will find several smaller issues working together. If your test drive doesn't reveal a problem and your inspection doesn't turn up anything obvious, think outside of the box a little. Significant weather changes and seasonal fuel blends can have an effect on mileage. Construction in the area may cause more stop and go traffic. A cold turn in the weather combined with a remote start system could be other things to consider.

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Keeping it Straightforward: Alignment Considerations

Winter rains and snow always wreak havoc on roads. Pothole season can bring more than average traffic into your shop for alignments. This article will explore the adjustments you should expect to see on Nissan vehicles, how and when to perform steering angle sensor calibrations, as well as some extra information about the often-overlooked alignment diagnostic angles.

If there's anything in the automotive world that goes together like peanut butter and jelly, it has to be "tires and alignment." But how often should a vehicle have its alignment checked? Once we know it needs an alignment, what must we mechanics be prepared to see and adjust on Nissan vehicles?

With modern Nissan vehicles, some alignments aren't finished until a scan tool is used to set sensor data. Likewise, why are so many customers being told "not to worry about" certain suspension angles that are out of specification? This article should prepare you to identify when alignment should be recommended, how to make needed adjustments on various types of suspensions, when the CONSULT scan tool is required following adjustments, and some tips about useful information hidden in diagnostic angles like steering axis inclination.

I Think I Need an Alignment

Good communication is key for any shop. If the customer simply asks for an alignment, but the office staff never asks them what symptom they're experiencing, you may get caught in the middle as the mechanic. It's always a good idea to understand exactly what the reason is for doing an alignment on request. Based on the description of the problem, your intuition and experience may save time and effort by avoiding a needless suspension alignment.

Inspect the tires first. Many customer complaints originate with neglected tire inflation or rotation. If you discover evidence of premature edge wear, feathering tread patterns, or a recently bent rim, you can make an appropriate recommendation for alignment. Unless the tires are replaced, you can also advise the customer that the symptoms they're experiencing may not be corrected with the alignment. Expectation management is primarily an office staffer's job, but you can protect yourself from repeatedly re-aligning the same vehicle to no effect!

Nissan does not publish an official interval for preventive alignment. However, one should be performed whenever a suspension component is replaced or disturbed. The service manual for any repair will identify whether alignment is required. Even for repairs where you don't think the alignment is affected significantly, it is best practice to verify the angles are within specification.

Identifying the Suspension Design

Most Nissan vehicles fall into four categories of suspension design, each with different considerations for how to perform the alignment adjustments. As you know, not all suspension angles are necessarily adjustable. Knowing what is possible to adjust is critical for knowing whether something is bent. Each model mentioned below is from MY 2012:

Category 1

Small economy cars like the Versa, Sentra, LEAF, and Juke utilize MacPherson struts in the front, and a solid rear axle beam. Only the front toe is adjustable, all other angles are set rigidly from the factory.

Category 2

Full-sized coupes or sedans like the Altima and Maxima utilize MacPherson struts in the front, but they have independent multiple links in the rear. The front toe is adjustable, and so are the rear camber and toe.

SUVs like the Rogue and Murano have suspension designs similar to the Altima or Maxima but with different link engineering.

Category 3

Heavy duty trucks like the Frontier, Xterra, and Titan have complicated independent

double wishbone front-end suspensions, but a solid rear axle. Front caster, camber, and toe are adjustable, but nothing is adjustable in the rear.

Category 4

Sport performance vehicles like the 370Z and GT-R are designed with independent double wishbone suspension in the front, and independent multiple link suspension in the rear. Front toe is adjustable, and both camber and toe are adjustable in the rear.

Let's discuss what it would take to do an alignment on these designs.

Considerations Before You Begin Any Alignment

First of all, Nissan always recommends performing a four-wheel thrust alignment on all its vehicles, regardless of whether the rear end is adjustable. The phrase "thrust" refers traditionally to the direction in which the rear-wheel drive tires are pointed. Therefore, a thrust alignment ensures that the vehicle is aligned in relationship to itself, even if the thrust cannot be set. Otherwise, a front-end only alignment could result with the front wheels toed to the right, and the rear wheels toed to the left.

Second, Nissan always recommends verifying proper wheel size and inflation, as well as confirming that there is no suspension play in wheel bearings, ball joints, tie rod ends, strut mount points, or control arms. The service manual for any vehicle includes specifications for measuring unacceptable suspension play in relevant components.

Last, following any alignment adjustments performed on vehicles equipped with a steering angle sensor, the CONSULT scan tool is required. We will dedicate a section to this step below.

Considerations for Alignments in General

Suspension angles should always be adjusted in the following order, starting in the rear before moving to the front: ride height, caster, camber, toe. Each angle affects the next in that order. No modern Nissan has adjustable ride height. If needed, the correct height measurement is published for reference in the service manual.

While stationary with wheels pointed straight, caster does not have a direct effect on any other angle. However, caster is usually adjusted by physically moving the same components that create the steering axis pivot points, which will necessarily affect the other angles.

Likewise, when adjusting camber, one often must physically shift the same components that determine toe. On vehicles with a bent component that has changed camber, it may be impossible to correct excessive toe without repairs.

Double check to be sure that the steering wheel is secured and hasn't shifted before making final front end toe adjustments. If you end up using excessive elbow grease to free up rusty or stiff components, recheck your steering wheel position. It will probably frustrate you more than the customer if they come back with an off-center steering wheel after your alignment.

Considerations for Category 1 Alignments

If you've only ever done one alignment in your life, it was likely on a car equipped with a MacPherson strut front end, and solid beam rear end! This ubiquitous design can be found on nearly every FWD car.

The front toe can be adjusted by lengthening or shortening the tie rod end links. Loosen the lock nut, use an appropriate wrench to hold the outer rod link by the flattened portion, and twist the inner rod as needed for the adjustment. The left and right rod links should be adjusted proportionally; in other words, you should not ever hyper-extend one link to complete the adjustment. Alternate between left and right sides to shift the toe to as close to the center of the specification as possible. Torquing down the lock nut is likely to move the adjustment slightly, so verify the number before moving on.

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If needed, loosening the lower strut mounting bolts and manipulating the strut can sometimes slightly affect the camber. Bear in mind that the strut and/or knuckle are likely bent if camber is excessively out of specification.

Since the solid beam in the rear has no adjustments, the official Nissan way to correct alignment is with complete replacement. If the rear angles are only slightly out of specification, it may make the most sense to recommend that the customer perform more frequent tire rotations. However, it is also possible to install alignment shims between the rear spindle and beam mounting points. Do not compromise safety for alignment; there is no official Nissan recommendation for performing rear beam alignment adjustments.

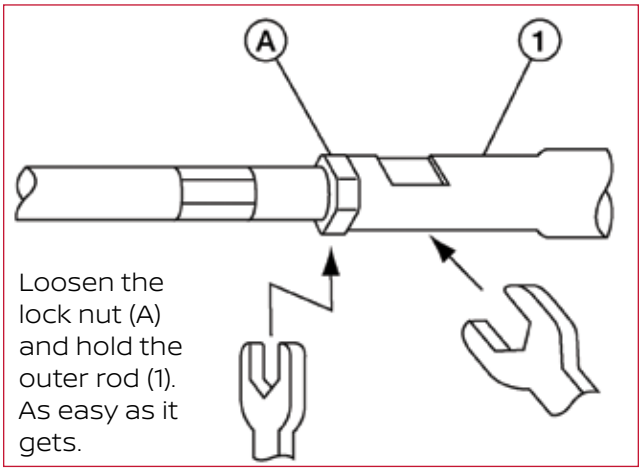
Category 2 Alignments

Many Nissan vehicles utilize independent multiple links for their rear suspension designs, and have adjustments for camber and toe. While the actual engineering of each independent link may vary by model, the general concepts are the same. Adjustments are performed by rotating one or both of the eccentric alignment bolts located on two different lower links of either side. Each bolt has tick marks that correspond to approximately 0.08 degrees of adjustment. If you're curious, the exact amount is published in each model's service manual.

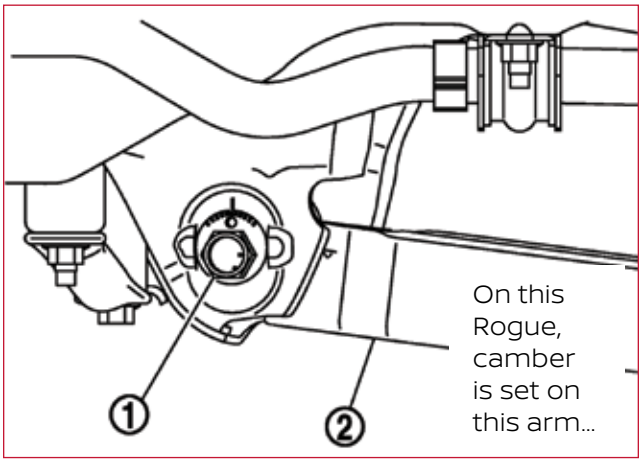
Start with the forward-most lower link's bolt. It should primarily affect camber. The rear-most lower link's bolt should primarily affect toe. Sometimes, it is unavoidable that either bolt affects both camber and toe at the same time. Rotating both bolts in the same direction should adjust camber; and rotating both bolts in opposite directions should adjust toe.

Category 3 Alignments

Nissan trucks have fully adjustable front-end suspension. It is important to note that some trucks come equipped with straight bolts installed. This means that before any adjustment can be performed, the existing hardware must be replaced with the appropriate Nissan alignment bolts and cam washers. All alignments should be performed when the vehicle is unladen – that is, with nothing in the truck bed and no one in the cabin.

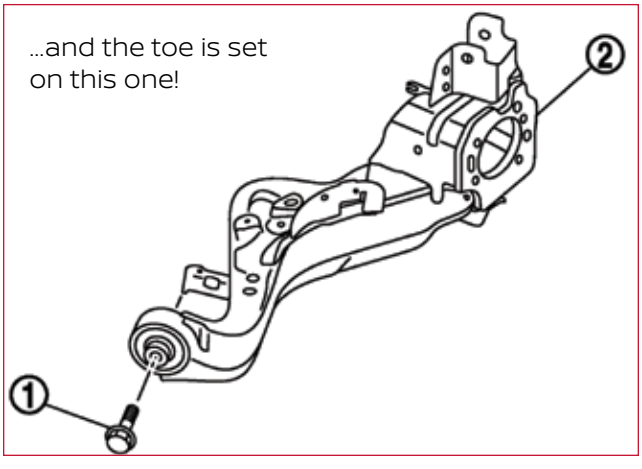


Loosen the lock nut (A) and hold the outer rod (1). As easy as it gets.

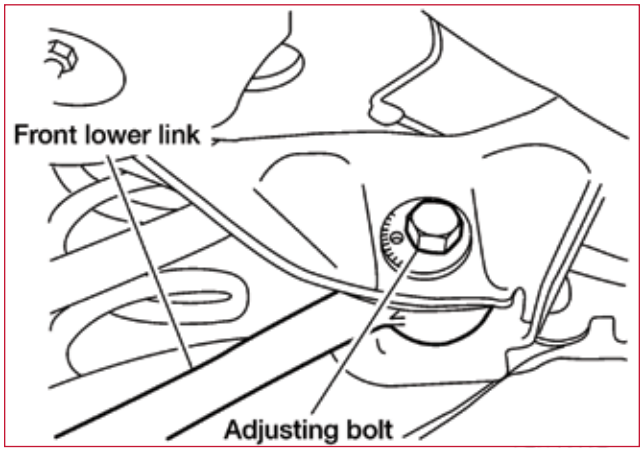


On this Rogue, camber is set on this arm...

...and the toe is set on this one!



Making adjustments on this design can become quite confusing since you're moving things in 3D space, compared with 2D planes when working on just toe or camber separately. Thankfully, Nissan includes a relationship table in the service manual that should eliminate the guesswork that often happens when working with this suspension design. That's right: get a service manual out for this one!



This Maxima's design will likely require a bit of trial and error to dial in.

Replacing ball joints on a truck is a common procedure that requires an alignment. It's worth pointing out that there is an official special service tool for this application that can save time and effort. Look on Nissan TechMate website for J-24319-01 "Gear Arm Puller."

Category 4 Alignments

Alignments on sports cars like the 370Z are not inherently more challenging than any other designs already mentioned. Despite double wishbones, the front toe is adjusted with tie rod ends as described above. We have also discussed how to adjust multiple independent rear links as well.

Finishing the Alignment Properly With the CONSULT

Due to federal safety regulations, all vehicles MY 2012 and newer are standard-equipped with Vehicle Dynamic Control (VDC) or some variant in the name. This also means that for many alignments on a 2012 and newer Nissan vehicle (or as needed on older cars) there is one final step when finishing an alignment: telling the car's computer you just did one. Let's discuss setting the neutral position of the steering angle sensor.

Skipping this step can result in uneven brake wear, erratic handling, or the illumination of dash board warning indicators.

For any Nissan, the steering angle sensor re-learn procedure is located in the service manual under the Brake Control section (BRC). Furthermore, the re-learn procedure always requires the CONSULT; there is no alternative method for reinitialization.

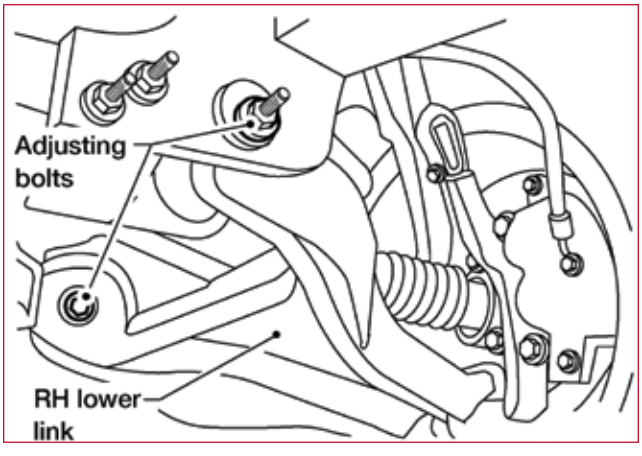
Using the CONSULT to perform the procedure and verify success is easy. Connect the scan tool, and navigate to WORK SUPPORT. One of the options is "ST ANG SEN ADJUSTMENT." Follow the prompts within the tool to finish the procedure; it will require that the vehicle be parked on level ground. To verify the neutral position, navigate to the DATA MONITOR section, choose "ST ANG SIG" for a PID, and drive. The PID should read between +/- 2.5 degrees when going straight ahead.

Beyond "Toe and Go" – Looking at Diagnostic Angles More Critically

Some alignment equipment will give printouts that include a number of measurements we haven't yet discussed: SAI, included angle, turning angle differential, cross caster/camber, total toe, and maybe more! Sometimes one of these angles may print out in red ink, and the customer will ask "what's wrong with this?" We're all guilty of suggesting "not to worry about that" because it doesn't result in tire wear, but what is the point of measuring this information if we don't use it for anything?

Excessive Cross-Camber May Cause Drift

Cross-camber is the difference between the two camber angles. If the two camber angles are independently within specification, but at the opposite limits of their spec, excessive cross-camber can occur. All other things being equal, the vehicle will have a tendency to pull toward the side with more positive camber.



On this 2013 Frontier, each tick mark corresponds to about 0.05 degrees of adjustment.

Rear adjusting bolt	1 In	1 Out	1 In	1 Out	0	0	1 In	1 Out
Front adjusting bolt	1 Out	1 In	1 In	1 Out	1 In	1 Out	0	0
Camber Degree minute (Decimal degree)	0' (0°)	0' (0°)	7' (0.12°)	- 7' (-0.12°)	3' (0.05°)	- 3' (-0.05°)	3' (0.05°)	- 3' (-0.05°)
Caster Degree minute (Decimal degree)	- 12' (-0.20°)	12' (0.20°)	0' (0°)	0' (0°)	6' (0.10°)	- 6' (-0.10°)	- 6' (-0.10°)	6' (0.10°)

This table can quickly show you which bolt to hold and which to rotate in order to move the suspension toward the green.

Typically, a cross-camber measurement should be no greater than 0.5 degrees, but this specification is published in the repair manual.

Excessive Cross-Caster May Cause Drift

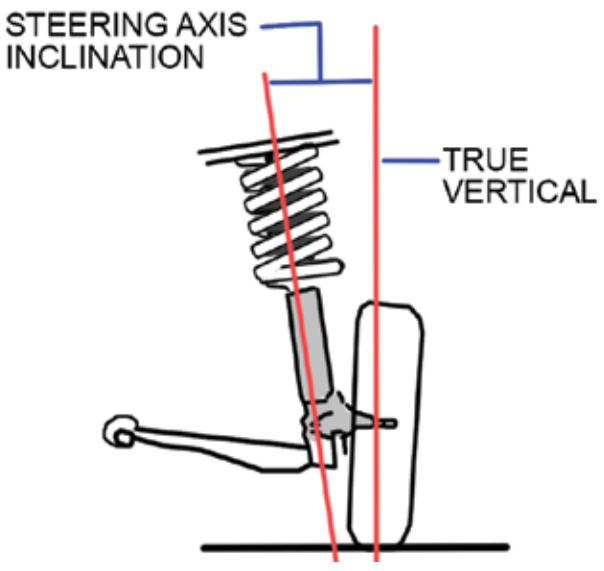
Cross-caster is the difference between the two front caster angles. Since most vehicles do not have adjustable caster, one of the front wheels may be set back by comparison due to collision. All other things being equal, the vehicle will

Refer to the table below to determine if adjustment of steering angle sensor neutral position is required. (X: Required –: Not Required)	
Situation	Adjustment of steering angle sensor neutral position
Removing/Installing ABS actuator and electric unit (control unit)	-
Replacing ABS actuator and electric unit (control unit)	x
Removing/Installing steering angle sensor	x
Replacing steering angle sensor	x
Removing/Installing steering components	x
Replacing steering components	x
Removing/Installing suspension components	x
Replacing suspension components	x
Change tires to new ones	-
Tire rotation	-
Adjusting wheel alignment	x
Battery disconnection	x
If you're not sure whether the car actually needs this step after a repair, the service manual will tell you.	

have a pull to the side whose caster is the least positive (that is, whichever is closer to negative), and often corresponds to the wheel that is set back.

Total Toe is What Matters Most for Tire Wear

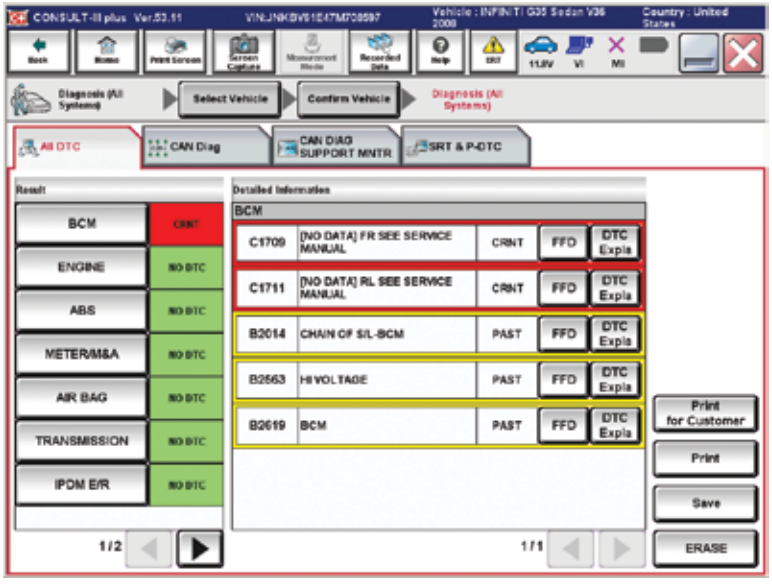
At the end of the day, total toe should be set to the specification to prevent uneven tire wear. When one side of the suspension is toed out/in, the opposite side will toe out/in to compensate. It is the compensation that creates an off-center steering wheel, or for feathering patterns to develop on the tires. Run your hand across the tread, perpendicular to the tread grooves. If the tread blocks have steep edges in one direction compared with the other, we can quickly identify toe-related wear by feel. If the edges catch your hand as you rub toward the inner edge, this is excessively negative (toe-in); if the edges catch as you rub toward the outer edge, this is excessively positive (toe-out).



Visualizing the SAI.

Steering Axis Inclination

SAI is important for two reasons: engineering and diagnostics. From the engineer's perspective, correct SAI ensures that the vehicle has proper steering return-to-center, resistance to bump-steer, tire scrub radius, and stability at higher speeds. From the mechanic's perspective, incorrect SAI often tells us which suspension component is bent.



Perform a scan on either ALL SYSTEMS or just ABS. Once the scan is completed, choose the WORK SUPPORT tab of the ABS computer.

Double Wishbone design (370Z, Frontier, Titan, Pathfinder, Xterra)			
SAI	Camber	Included Angle	Probable cause
OK	LESS	LESS	Bent knuckle
OK	GREATER	GREATER	Bent knuckle
LESS	GREATER	OK	Bent lower control arm / frame mount point, or camber adjustment needed
GREATER	LESS	OK	Bent upper control arm / frame mount point, or camber adjustment required
LESS	GREATER	GREATER	Bent lower control arm / frame mount point / knuckle

SAI lies on the same plane as camber, but what exactly is it?

SAI is an imaginary line drawn through the upper and lower pivot points of the steering. The angle is measured between this line and a 90 degree vertical upward line through the center of the wheel. It would follow the line of the MacPherson strut tube, or would connect the upper and lower ball joints on a double-wishbone design. SAI can perhaps be conceptualized as a "door hinge" that is rigidly attached to the body of the vehicle on one side, and on the other the wheel swings in an arc.

Take the door hinge analogy. Imagine we had a suspension design with zero SAI; the wheel would rotate around the straight up-and-down hinge, just like a door in real life. Problems appear when the wheel encounters any type of resistance force like a bump: it's super easy to swing the door open or closed. When we add SAI by tilting the hinge inward, the spindle must now travel up and down as the hinge "opens and closes" through its arc. Because there is a portion of the arc where the wheel would go into the ground, steering into this range will actually have to hoist the suspension and compress the springs. Once the steering or road forces have stopped, the springs will also push the wheel back toward its resting center.

Likewise, the SAI has a relationship with wheel width and rim off-set to create a scrub radius. Follow the imaginary lines of both SAI and the 90 degree upright through the center of the wheel into the ground. They will not likely intersect at exactly the ground (this would be zero scrub radius). If they intersect above the ground, this is positive; intersecting below the ground would be negative.

The more excessive the scrub radius – either positive or negative – the greater the steering wheel effort required. This is worth mentioning in case the customer has just changed the wheels to something different than stock; changing the wheels is more likely to affect scrub radius than the suspension.

Since SAI is not adjustable, whenever it is out of specification, there must be something bent or broken in the suspension. Diagnostic charts like the ones below can help you interpret which component is bent. Take note that the "included angle" is simply the SAI plus the camber. Compare your angles against their specification, and then compare with the chart for a logical first location to inspect.

The Future of Alignment Work

The automotive industry will be forever performing alignments until cars start to fly! The biggest changes we must face are the relationship between suspension angles and the computers that depend on their measurements. Learn about the diagnostic angles to help track down drift and pull complaints, as well as identify which parts are bent. Just because an angle doesn't wear tires, it doesn't mean it should be ignored. Nissan engineering ensures safety and drive quality, so you might be improving the ride by fixing the alignment right the first time.

MacPherson strut design (Most vehicles)			
SAI	Camber	Included Angle	Probable cause
OK	LESS	LESS	Bent knuckle and/or strut
OK	GREATER	GREATER	Bent knuckle and/or strut
LESS	GREATER	OK	Bent control arm / strut out at top mount point
GREATER	LESS	OK	Strut in at top mount point / damaged cradle
GREATER	GREATER	GREATER	Strut in at top + bent knuckle and/or strut
LESS	GREATER	GREATER	Strut out at top + bent knuckle and/or strut
LESS	LESS	LESS	Strut out at top OR bent control arm + bent knuckle and/or strut
LESS	GREATER	LESS	Strut out at top OR bent control arm + bent knuckle and/or strut

Misfire Diagnosis

There are multiple components necessary to attain proper combustion within the modern engine. Oxygen, fuel, compression, ignition, not to mention everything coming together at just the right moment in order to have a successful event. Since the very beginnings of the internal combustion engine, there have been misfires. It could be argued that during development, the misfire actually precluded actual combustion! As much as things have remained the same, things have also changed dramatically. Technology has taken over much of the role of mechanical workings as far as spark and fuel are concerned. Add to

that variable valve lift and timing and we have now opened up a wide range of potential failures. Nissan engineering has stood up very well over the years, but at some point something is bound to act up and a misfire may develop.

The tools available to technicians today dramatically improve the speed at which the root cause of the misfire can be found. The key to a successful diagnosis is utilizing this tooling, the service information available, and methodically working through the steps to ensure no system or component is overlooked. Nissan service information found at Nissan-techinfo.com will be the most valuable resource for any diagnosis one may have.

When it comes to a misfiring engine, proper identification of the offending cylinder(s) is an obvious first step, and utilizing the CONSULT III Plus will allow you access to corresponding diagnostic trouble codes (DTCs). Nissan engine management systems do a great job at making sure they set a misfire code for the correct cylinder. As unlikely as it is that the incorrect cylinder would be flagged for a DTC, you may benefit from keeping an open mind until the offending cylinder is verified. Fortunately, you have the ability to utilize a power balance feature within the CONSULT III Plus software. It is a great way to ensure that the P030X code you retrieved previously actually shows up as a low contribution for that cylinder. Furthermore, in cases where a misfire can be felt but doesn't set a code, the power balance feature will help guide you to the correct location.

So now you know which cylinder(s) should get your attention, next is determining which component is responsible for the poorly-performing engine. In this day and age, regardless of how straightforward the problem appears to be, a check of your technical service bulletins is a good idea. You may not find any reason for the misfire you are dealing with. However, updated parts information or service procedures may be found in your search. An example would be bulletin number NTB06-075, affecting 2004-2006 Altima, Maxima, and Quest models with the 3.5L engine, as well as the 2007 Quest with the same 3.5L engine. Failed ignition coils that have a blistered appearance, may simply be replaced without a second thought. Had TSB information been checked, a closer look at the negative battery cable would be performed and the root cause actually found.

A balancing act of system and component testing is at the doorstep, but before going elbows deep into scan data or swapping parts around, remember that some of your best tools aren't in the tool box. Sights, sounds, smells are all important inputs to steer you towards the end goal. Only a minute or two of poking around under the hood while pondering the possibilities may garner some valuable clues. What condition is the rest of the vehicle in? Does it appear to have been properly maintained per Nissan recommendations? How many miles are on the odometer? Has any major or even minor work been done recently?

OK, it's time to do some actual work. What test would you expect to be able to perform in the least amount of time, that may actually give you the most information? No really, take a second and answer that question in your own mind. There are no wrong answers, and every vehicle has its own diagnostic process. Keep in mind though, that when dealing with misfires, clear flood mode is your best friend. The new technicians may not be thinking about it, and the seasoned ones may have forgotten about it at times, but the reality is that it's a tremendous tool in your arsenal. Nissan for the most part has incorporated this feature for quite

some time. Turning the key on, then depressing the accelerator pedal to beyond 80 percent, then turning the key to the Start position should result in an engine that simply cranks but does not start. The cadence of the engine can be listened to, and any possible compression issue can subsequently be heard as an out of rhythm frequency.

Imagine the time savings when you suspect right off the bat that there is a compression issue. While the cause still needs to be determined, this information will help keep you from making assumptions with scan data or secondary ignition patterns. Also, all the spark plug ignition coils and injectors in the world aren't going to remedy a compression fault misfire. That said, if ever a compression issue is determined to be the fault, you will be wise to make sure that the ignition and injection systems are functioning properly. Replacing a cylinder head only to have to sell an ignition coil or injector after the fact will most certainly affect customer confidence.

Just imagine a scenario where the compression has been decreasing in a particular cylinder for a while, without the customer actually noticing much of a difference. If most driving occurs under light load conditions, this is a very possible scenario. Now the ignition coil or injector fails, and the misfire is much more severe. The quick relative compression check is always a good thing, but it may not be the only factor. Take the Murano 3.5L engine pictured in the right-hand column.

It came into the shop running very poorly. A single cylinder was found to be the culprit from the code retrieval using the CONSULT III Plus. A clear flood mode relative compression test was performed, and as you can see from the screen capture, there is a low cylinder.

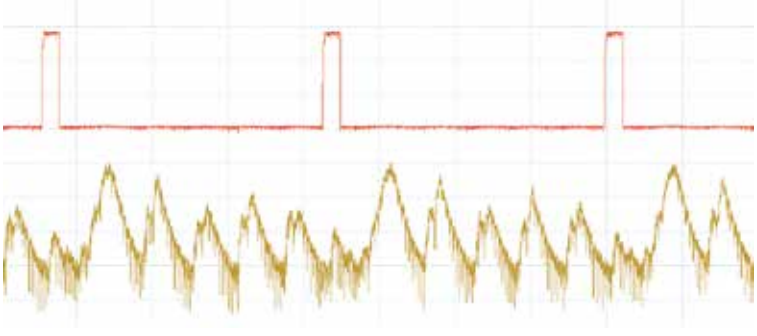
Fortunately on this particular V type engine, the cylinder in question is easily accessible, and so the ignition coil and spark plug were removed for inspection and further testing to determine the source of the low compression. Upon removing the spark plug, it was evident the electrode gap was missing.

This should solidify the reason behind making sure that all systems related to proper combustion are verified.

The fuel delivery and injection systems on Nissan vehicles have proven to be robust and for the most part trouble free. It is easy to overlook these areas when a problem vehicle arrives, but it would be wise to verify their operation under any driveability concern scenario.

Without the proper fuel volume delivered to the engine management system everything will be off, so starting with the fuel delivery system may be advantageous in both the short and long run. Have you gone looking for a fuel pressure test port lately? Fuel pressure testing isn't quite as straightforward on Nissan vehicles as some others. However,

This spark plug is certainly not gapped to specifications!

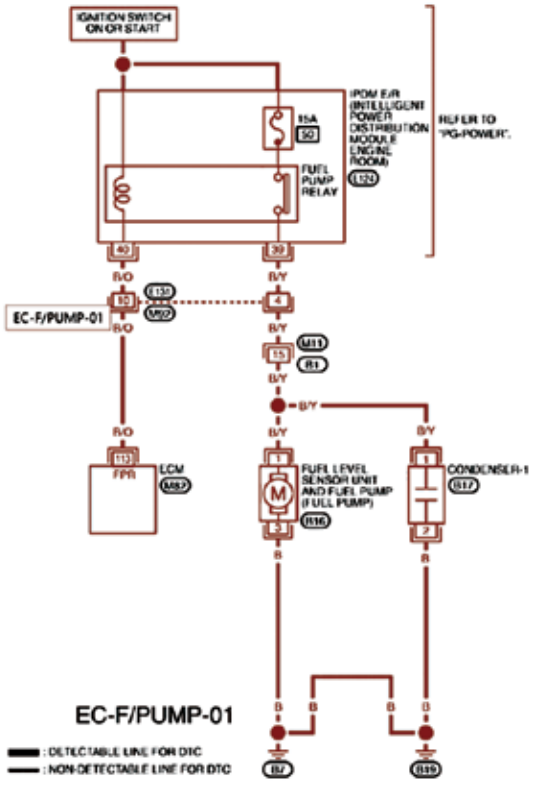


As you can see here an uneven cylinder compression test suggests an issue.

it is still possible to attain the reading, albeit intrusive and potentially messy. Keep in mind the particular misfire concern being dealt with before diving right in on fuel pressure. Are there other ways to establish whether this system is healthy or not?

The CONSULT III Plus is a perfect way to get some bearing. First it will already be deployed for interrogation of the modules for codes. While it's in use, and as a test drive should likely be performed, graphing fuel trims and air/fuel ratio or oxygen sensors could rule out the possibility of fuel pump issues. Some experience on known good vehicles will be handy when analyzing fuel trim data on a misfiring vehicle. It is said that a fuel misfire causes higher fuel trim readings than an ignition misfire. However, if an injector is shut down due to a misfire, the ECM has now created a fuel misfire and the potential for fuel trims that can lead you astray.

Another source of valuable fuel pump performance information lies in the circuit's amperage and voltage signatures. Typically the fuel pump is on a circuit along with a dedicated fuse and relay.



This allows quick and easy access to insert a fused jumper either at the fuse or the relay terminals. Reference Nissan-techinfo.com for the proper wiring diagrams to aid in setup. Some practice with evaluating fuel pump waveforms will go a long way in this area. Once familiar however, you'll be able to quickly narrow down specific fuel delivery issues.

Take for example an amperage waveform that shows low current and low pump speed. This is typical of high resistance in the circuit. The resistance lowers the ability for current to flow which in turn results in a slow spinning pump. How about high current draw but slow pump speed? This isn't going to result from high electrical resistance, but possibly high mechanical resistance. You may also have a restriction to fuel flow causing high current but low pump speed. Coupling current testing with the results obtained on a road test with the CONSULT III Plus should allow fuel supply to be ruled in or out alone, without the need for messy fuel pressure testing.

On the other end of the fuel supply system is the fuel delivery system, namely the fuel injectors and rail connecting them. Again, Nissan has been solid for years in regards to injector reliability. However, they must not be overlooked. As spark plugs have been becoming difficult to access in recent years, then you are well aware of the hidden nature of the fuel injectors. It is still possible most of the time to get your stethoscope into hard to reach areas, and using the CONSULT III Plus to control the injectors while listening to an audible click is an extremely time saving go/no go test.

Wiring diagrams. Wiring diagrams. Wiring diagrams. There, that was three times, hopefully it will stick. This road map of testing will give you a jump start in your quest for flushing out any injector problem. Right off the bat you will be able to ascertain where your best test points are. Many times injector supply voltages are linked together. Even better, many times they share the same fuse without any other loads also on that fuse. This is another great place for an amp clamp

to be put to use. Hey, remember that ignition misfire that caused the ECM to shut down an injector, that in turn drove fuel trims on that bank high? Guess what, watching to see if you have a missing injector event with your amp clamp could point you in that direction.

Would it also be advantageous to see if the testing would much more effectively be done at the control module instead of at the component? The ability to check the complete circuit beginning to end may provide you the information you need to rule the injector complete out of being at fault. If the injectors are buried under the intake, yet the module is clearly accessible right there under the hood, it may be a good idea to just go right there. Plus, the entire circuit is being tested first. If there is an issue present, then acquire additional facts in order to dig deeper, you now have a reason to do so.

The digital storage oscilloscope is fired up, the amp clamp is deployed around a fused jumper loop at the IPDM, and leads are carefully attached at the ECM in order to check the voltage of the circuit while still intact and operating. By now pintle hump may be something you have heard about. It is the usually noticeable dip in the rise of the current when the injector has been turned on.

The reason for this dip, is because now as the pintle moves off its seat and within the windings of the unit, by laws of electricity it creates an opposing flow of current. Albeit only very momentarily, but it's definitely there. Let's say that dip is missing, the cylinder in question is the same as the injector current we are viewing, and the fuel trims are heavily in the positive on that bank. It's now hard evidence of why an additional test is required to verify lack of fuel flow through the injector.

Say you see no current rise at all for a given injector. Look to the voltage readings. If the ECM is pulling the control side all the way to ground, yet there is no, or very little current flow, then high resistance in the circuit is to blame. No really, that's it, it can't be anything else. Now where that resistance is will be something that has to be narrowed down, but just check the wiring diagram you have pulled up on Nissan-techinfo.com. Where is the next place to check that circuit that will yield the most information?

Be aware that Nissan vehicles in particular have some interesting injector voltage signatures. Some vehicles have voltage traces you will not find on other car lines. Testing and practicing on known good vehicles really is the best was to create a foundation of knowledge for yourself.

It is entirely possible, however, that the injector screen is gummed up and dirty, causing a lack of actual fuel flow. This may not show up very easily in any of the voltage and current traces. Here is a scenario where it may actually be necessary to hook up that fuel pressure gauge mentioned before. Once installed, priming the fuel system through the bi-directional controls of the CONSULT III Plus will establish your baseline pressure. Next, using a suitable tool calibrated to pulse the injector for a specific, and repeatable, period of time, will allow the injectors to be flow tested while still installed on the vehicle. A word of caution here would be to make sure the same injector is not energized too many times before actually running the engine a bit. Excessive fuel sitting in a cylinder is not the best thing for the engine.

Up to this point the focus has been on engine cylinder misfires that are present at all times. Of course, that's the only way

In some instances, there won't be a pintle hump reflected in Nissan injector control waveforms.

misfiring occurs right? The real world technicians live in is not so easy. Many of the misfire complaints that come into your bay are not always occurring. It may take a considerable amount of effort to even duplicate the issue. There are some tips you can use to attempt to make those misfires show up much more easily.

Lean conditions really stress ignition system components. Back when throttle cables were still around, a very quick snap of the throttle to wide open would create a momentary lean and high compression condition that would reveal most misfires. Not as easy to do these days with electronic throttle control, but other methods can be used. Why not just drive the engine lean purposefully? Vacuum brake boosters are still quite common, and also generally have large vacuum hoses for them. Pulling off this hose and controlling the bleed rate can possibly achieve the lean conditions necessary to recreate the misfire in the bay, instead of on the road. Using the CONSULT III Plus, there are times when you will have the ability to drive fuel trims. Usually this test is to aid in diagnosing oxygen sensors, but why not use what they give you?

Water helps create "new paths" to ground for secondary ignition parts. A light spray over the secondary wires, or even ignition coils themselves may create the conditions needed for that spark to start taking the path of least resistance. It's quite likely that spray bottle is already close at hand, so use it. Always take care when coaxing secondary ignition to stray. These days you really can hurt yourself, or one of the many electronic parts on the vehicle. Creating the conditions where the misfire can happen long enough to either set a code, or register during power balance testing is the goal here.

Misfires can be easy to find on Nissan vehicles if the tools available are utilized to their fullest potential. Creating a standardized and comprehensive testing strategy will yield continued success for years to come.

Which Bank to Bank On?

Air/fuel mixture data from your scan tool can go a long way towards narrowing the diagnostic path when you are faced with a no-code driveability or engine performance problem.

With the introduction of variable valve timing, Nissan was among the first to incorporate a mixture ratio feedback system that maintains the air/fuel mixture as close as possible to the ideal stoichiometric ratio to provide complete combustion of the fuel in the cylinder, under normal conditions. Complete combustion helps achieve not only the best engine performance, but also good fuel economy.

Mixture control also allows rapid cycling of the air/fuel mixture from slightly rich to slightly lean and back. This helps the three-way catalyst (exhaust manifold) to better reduce emissions of harmful carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides (NO_x).

A slightly lean mixture ensures that enough oxygen enters the converter to help the oxidation stage of the catalyst burn any unburned HC and CO.

But too much oxygen in the converter makes it easier for nitrogen atoms that have been ripped from NO_x molecules by the catalyst to find and re-bond with the oxygen into new NO_x before exiting the exhaust. The mixture ratio feedback system prevents this by temporarily increasing the amount of fuel in the exhaust through adjustment of the air/fuel mixture. This creates the rapid cycling of the A/F and O_2 sensor signals from lean to rich and back when the system is functioning properly.

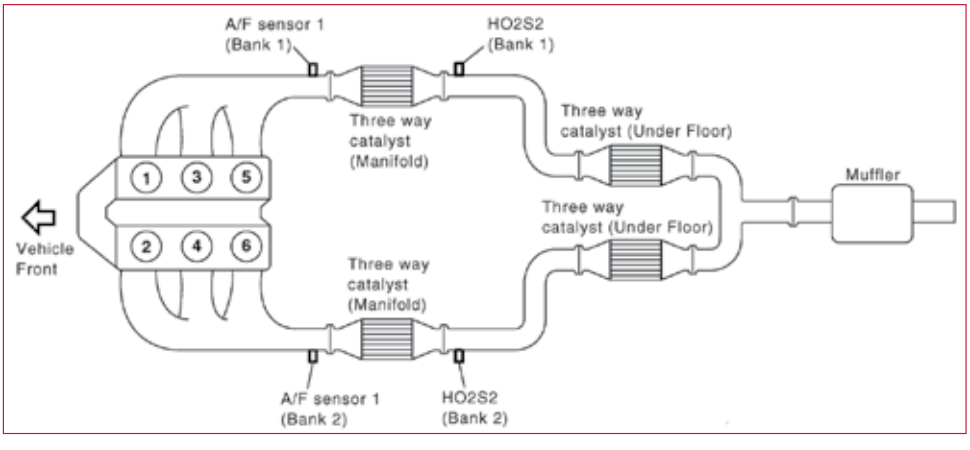
Closed Loop Operation

Nissan's engine control module (ECM) monitors the signal from the oxygen sensor 1, located in the exhaust manifold, to see whether the engine is operating rich or lean. The ECM adjusts fuel injector pulse width accordingly.

The cycle then repeats. The oxygen sensor tells the ECM what amount of oxygen is entering the converter, the ECM tells the fuel injectors how much to increase or decrease fuel flow into the engine, and the ECM then monitors the oxygen sensor 1 to see if it achieved the commanded air/fuel mixture. This cycle is called closed loop operation.

The ECM also uses the signal from a heated oxygen sensor (HO2S2) located downstream of the three way catalytic converter to check the function of the oxygen sensor 1. Under normal conditions the HO2S2 is not used for engine control. If the switching characteristics of the oxygen sensor 1 deteriorate, the air/fuel ratio is still controlled to stoichiometric by the ECM, using the signal from the HO2S2.

The oxygen sensor 1 does not provide accurate readings at temperatures below approximately 800 degrees C (1,472 degrees F). Similarly, an HO2S2 needs to reach approximately 398 degrees C (750 degrees F) before it can give accurate voltage readings. Closed loop operation cannot begin



The 2011 Pathfinder 4.0L V-6 engine control system includes heated oxygen sensors, three way catalytic converters, and other sensors (not shown) on both engine banks.

until the oxygen sensor 1 and HO2S2 reach the required operating temperatures aided by built-in heater elements to accelerate their warm up on cold start engine operation.

Open Loop Operation

The ECM controls operation of the HO2S2 heater element in conjunction with engine speed, the amount of intake air (engine load) and engine coolant temperature. The ECM commands the HO2S2 heater element ON when engine speed is below 3,600 rpm after the engine has begun warming up, and has been idling for at least one minute under no load. Above 3,600 rpm, the ECM shuts the HO2S2 heater element OFF.

Until the engine has warmed up, and the oxygen sensor 1 and HO2S2 have reached their required operating temperatures, A/F mixture control is in open loop operation. The ECM regulates fuel injector pulse width so that the air/fuel mixture matches a stored base value that is in the ECM prior to any learned on-board corrections. Nissan calls this "base fuel schedule," and labels it "B/FUEL SCHDL" in its CONSULT series scan tools.

The base fuel schedule maintains a stabilized fuel combustion while the engine is in open loop control. Until it switches to closed loop operation, the ECM does not alter the base air/fuel mixture command.

Open loop operation occurs when the ECM detects any of the following conditions:

- Deceleration and acceleration
- High-load, high-speed operation
- Malfunction of the oxygen sensor 1 or its circuit, including insufficient activation of the oxygen sensor 1 at low engine coolant temperature
- High engine coolant temperature
- During engine start-up, warm-up, or immediately after shifting from N to D

Fuel Trim

Once the engine has warmed up and is in closed loop operation, engine conditions are monitored and continuously modified by the ECM to provide the best combination of engine performance, fuel economy, and emissions control. Fuel trim refers to the fuel injector pulse width adjustments made to the base fuel schedule by the ECM. It includes short-term and long-term adjustments.

Short-term fuel trim (STFT) is an immediate, rapid adjustment to maintain the mixture ratio at its stoichiometric value. The voltage signal from the oxygen sensor 1 indicates whether the mixture is rich or lean compared to that ideal value. The ECM reduces injector pulse width if the mixture is rich, and increases fuel volume if it is lean.

Long-term fuel trim (LTFT) is an adjustment that occurs when the ECM sees frequent, increased deviations in the STFT from the stoichiometric air/fuel ratio. These deviations may occur more over time as cylinders fail to seal as well as they once did, the engine evap system loses capacity, the fuel delivery system becomes less efficient, and other signs of normal wear begin to appear.

Within five to twenty seconds of noticing a consistent larger up or down deviation than before, the ECM calculates a new adjustment percentage to compensate for a significant portion of the changes. That new number is the LTFT.

By absorbing a large portion of the consistent deviation, LTFT leaves a much smaller adjustment task to the STFT factor. This allows STFT to make faster, more precise responses to rapid changes in engine operating conditions such as acceleration, intake air flow and other real-time load condition indicators.

High Fuel Trim? Ask Why.

Fuel trim numbers are displayed in OBD-II readouts as a percentage of fuel added to or subtracted from the base air/fuel ratio. A general guideline is to investigate further whenever the total of STFT and LTFT is greater than 10 percent. This is true whether the difference is higher (trending rich), or lower (lean).

For example, if STFT is +3 percent and LTFT is +5, the total of +8 percent may be acceptable.

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However, a 3 percent increase in STFT may look acceptable, until you see a +12 percent LTFT. The 12 percent LTFT increase (and +15 percent total) is covering for a problem.

The +15 percent total fuel trim may not be high enough that the ECM sets a trouble code. A problem affecting fuel trim could originate anywhere between the intake air filter and the exhaust manifold. On an overhead cam V-type engine where there are two each of timing, air/fuel mixture control, and sometimes even catalyst system and other components, you have a lot of diagnostic ground to cover.

Unbalanced Fuel Trim Narrows the Search

"A/F ALPHA" is Nissan's term for the percentage of air/fuel ratio correction commanded by the ECM per engine cycle in closed loop operation. On some V-type engines, it can be looked up separately for each bank. In this example on a 2011 Pathfinder with a 4.0L V-6, you can use Nissan's CONSULT series or your scan tool to get a quick indicator of whether fuel trims differ by engine bank.

First, warm the engine up to normal operating temperature, and check that the "FLUID TEMP SE" (A/T fluid temperature sensor signal) indicates more than 60 degrees C (140 degrees F). Make sure that the rear window defogger, air conditioner, and lighting switches are OFF, and the steering wheel is straight ahead.

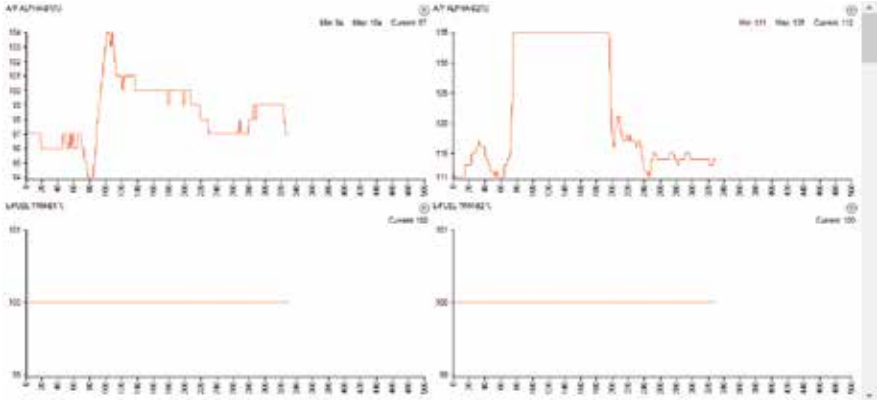
Look up A/F ALPHA-B1 and A/F ALPHA-B2. The value should average between 95 and 105 (plus or minus 5 percent of the base fuel schedule) for each engine bank. If the deviation is outside of the specified 95 to 105 percent adjustment range, and either bank is significantly different from the other, focus your next investigative steps on the bank with the highest deviation from the base fuel schedule.

Intake Valve Timing

Dual overhead camshaft (DOHC) designs advance or retard timing of the intake camshaft under different engine operating conditions to improve low or high speed torque. When lower engine speeds result in less intake air entering the engine, the intake valve should ideally close early, to prevent the rising piston from forcing some of the combustion chamber's just-received air back up the intake port.

As speed increases and more intake air enters the engine, the intake valve should remain open longer, to allow more air into the combustion chamber. The minor timing overlap this creates between intake and exhaust valves is desirable at higher engine speeds. It allows the slight negative pressure created by gases being pushed out of the exhaust port to help draw more intake air into the combustion chamber, a process we know as "scavenging."

Too much valve overlap at lower speeds can be a problem. A high amount of exhaust gas forcing its way back into the intake manifold will make the vehicle feel as if it cannot make up its mind at what rpm level to operate. This hunting or inconsistent rpm also reduces cylinder compression.



We unplugged a single fuel injector on bank 2 on a 2005 Pathfinder 4.0L V-6, causing A/F ALPHA B2 (short term fuel trim) to add fuel at a consistently higher rate (Minimum 111 vs. Minimum 94 for B1), and to add a significantly larger amount of fuel than bank 1 in the approximately 120 data points between the 80 and 200 mark.

Nissan's intake management system uses computer-operated intake valve timing (IVT) control solenoids to precisely meter the valve opening and closing cycle. In response to ON/OFF pulse duty signals from the ECM, this IVT control solenoid valve, or cam phaser, changes the amount and direction of flow of oil through a hydraulic valve that mechanically alters cam timing. Longer pulse width advances intake timing, and shorter retards it.

If the IVT control solenoid valve's oil passages become clogged, the valve could become stuck and cause drivability problems. Alternately, if an incorrect voltage signal is sent to the ECM from the IVT control solenoid valve, it could cause a mismatch between the actual phase control angle degree, and the degree expected by the ECM.

Intake Timing by Engine Bank

On our 2011 Pathfinder V-6, with the engine warmed up, shift lever in P or N, A/C OFF, and no engine load, we can check the INT/V TIM (B1) and INT/V TIM (B2) readings in CONSULT III or on a generic scan tool.

At idle, crankshaft advance should be -5 degrees to +5 degrees CA. At 2,000 rpm, you should see approximately 0 degrees to 30 degrees CA (Crankshaft Angle). If either bank shows a reading that is out of the specification range, it should set a P0011 (B1) or P0021 (B2) trouble code.

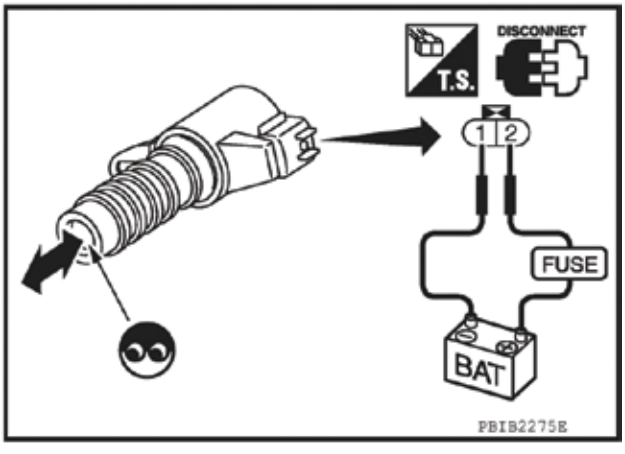
If no DTC is set, look for differences in the reported numbers between B1 and B2. Then look further for issues on whichever side of the engine appears more out of range of the specification.

IVT Control Solenoid Valve Circuit Function by Bank

You can check whether the IVT control solenoid valve circuit is functioning properly by looking up, under the same engine operating conditions, INT/V SOL (B1) and INT/V SOL (B2) on your scan tool. At idle, the reading should be between 0 to 2 percent. At 2,000 rpm, it should show between 0 to 50 percent.

If there is an open or short in the intake valve timing control solenoid valve circuit, it should set a P0075 (B1) or P0081 (B2) DTC. If no code is set, check resistance of the IVT solenoid valve on whichever side appears nearest to exceeding the specified value.

Checking the IVT control solenoid valve between terminals 1 and 2, resistance should be 7.0 – 7.7 Ω (ohms) at 20 degrees C (68 degrees F). Checking between terminal 1 and ground, you should see zero continuity. If one side or the other fails, replace the IVT control solenoid valve on that side.



The plunger in the IVT Control Solenoid Valve should move out and back into the valve body when you apply battery voltage between terminals 1 and 2. If it does not, the valve's oil passages may be clogged.

The intake valve timing (IVT) control solenoid valves are located on either side of the front of the engine block. The bank 1 IVT control solenoid valve is on the passenger side.

If neither side fails, but you suspect the INT/V SOL reading, you can check to make sure the solenoid valve plunger is not stuck. Provide 12V DC between the IVT control solenoid valve terminals, and then interrupt it. The plunger should move out and back into the valve body as you apply and remove voltage. CAUTION: Never apply 12V DC continuously for 5 seconds or more. Doing so may damage the coil in the valve.

Oxygen Sensor Function by Bank

Heated oxygen sensors are located after the catalytic converter and generate a voltage that is close to 1 when the exhaust gas mixture is RICH, and nearer to 0 when it is LEAN. Our 2011 Pathfinder V-6 engine contains post-catalytic converter heated oxygen sensor locations on both engine banks. We can look up HO2S2 (B1) and HO2S2 (B2) using CONSULT III or a generic scan tool.

The ECM groups the errors it detects into three categories. The sensor does not reach the specified high voltage level when the exhaust mixture is RICH, does not fall to the expected low when the mixture is LEAN, or the switching cycle time is too slow.

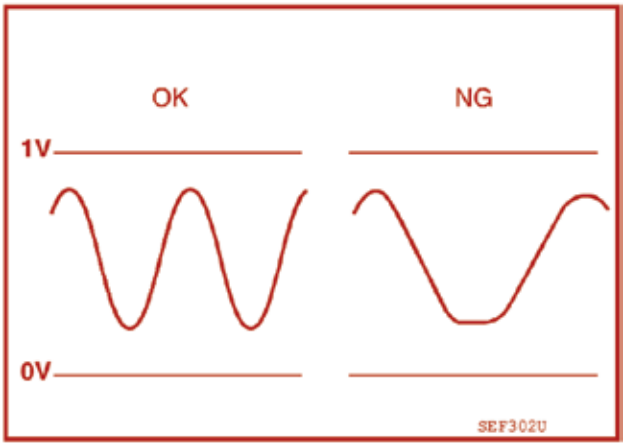
The voltage signal should reach above 0.68 volts at least once during its switching cycle. If it does not, the circuit may be open or shorted, the sensor may be dying, there may be intake air leaks, or there may be a fuel delivery problem. Either way, the ECM should set a code P0137 (B1) or P0157 (B2).

If the HO2S2 readout is above 1.2V, or does not reach below 0.18V at least once during its switching cycle, either the sensor circuit is sending a false high reading, or there may be a problem in the fuel delivery system. The ECM should set a P0138 (B1) or P0158 (B2) DTC.

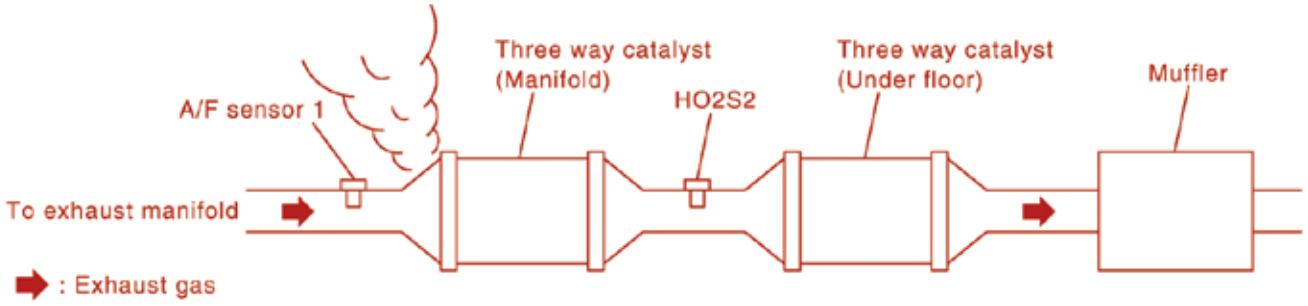
The ECM knows how long a post-catalytic converter heated oxygen sensor should take to switch from rich to lean and back. If the switching time is longer than specified, there may be an open or short in the circuit, the sensor could be failing, or there may be a problem in the fuel, EVAP, or intake air system. The ECM should set a P0139 (B1) or P0159 (B2) DTC.

Oxygen Sensor Function by Bank

An oxygen sensor outputs a continuous signal that varies with oxygen content in the engine exhaust. Because it indicates exactly how much oxygen is in the exhaust, oxygen sensor feedback allows the ECM to more precisely adjust the air/fuel ratio. Using CONSULT III Plus or a generic scan tool, we can



If it takes longer than specified for an 0_2 sensor to switch from RICH to LEAN and back, the ECM will set a trouble code.



Repair of a simple exhaust gas leak before the three way catalyst (manifold) on either bank could clear up a few errant engine control sensor readouts.

look up oxygen sensor 1 data for both bank 1 and bank 2 on our 2011 Pathfinder V-6.

When the ECM adjusts STFT or LTFT, it expects the voltage reading from oxygen sensor 1 to quickly reflect a changed mixture. If it does not, the ECM thinks there is something wrong with the sensor or its wiring circuit, and sets a trouble code.

If the oxygen sensor 1 output is consistently showing 0V, the ECM considers it too low for the base fuel schedule, and sets a P0131 (B1) or P0151 (B2) DTC. If it consistently shows approximately 5V, the ECM thinks it is too high, and sets a P0132 (B1) or P0152 (B2) DTC.

If it consistently shows any other voltage amount despite the fact that STFT or LTFT is changing, the ECM sets a P0130 (B1) or P0150 (B2) DTC.

If the oxygen sensor 1 shows a switching cycle time that is slower than specified in Nissan's algorithm, the ECM sets a P0133 (B1) or P0153 (B2) DTC.

Check Other Sensors by Bank

There are other sensor readouts that can easily be checked by bank 1 or bank 2 using CONSULT III Plus or a generic scan tool. These include:

- FUEL SYS-LEAN-B1 and FUEL SYS-RICH-B1 (for fuel injector function, both also available for B2)
- TW CATALYST SYS-B1 and TW CATALYST SYS-B2 (three way catalyst)
- KNOCK SEN/CIRC-B1 and KNOCK SEN/CIRC-B2
- CMP SEN/CIRC-B1 and CMP SEN/CIRC-B2 (camshaft)
- Codes for the built-in heaters for the oxygen sensors
- Misfire codes for each individual cylinder

Most of these sensors that have bank 1 and bank 2 locations on a V-type engine can be checked from the OBD-II port (diagnostic data link) under the dash. You won't even have to pop the hood to get started narrowing your diagnostic path to one side of the engine or the other.

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