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EVAP

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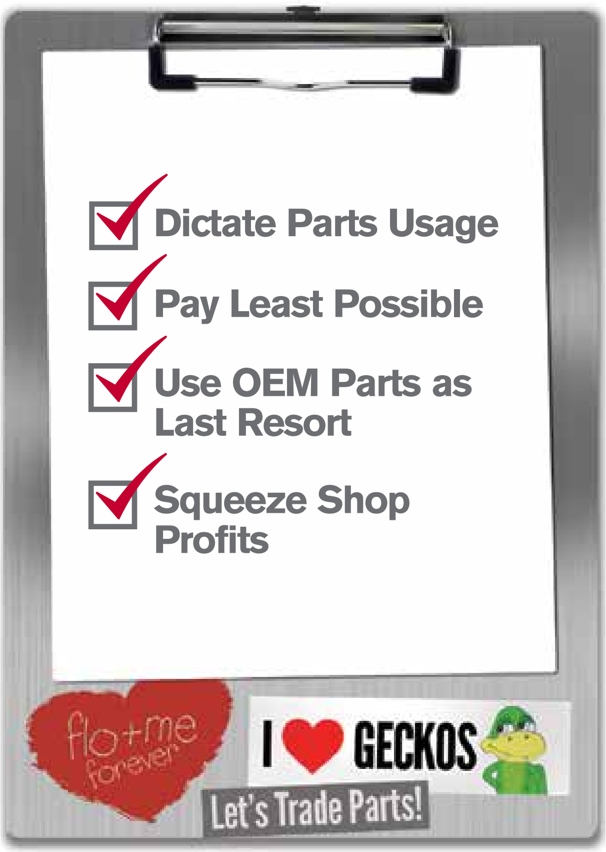
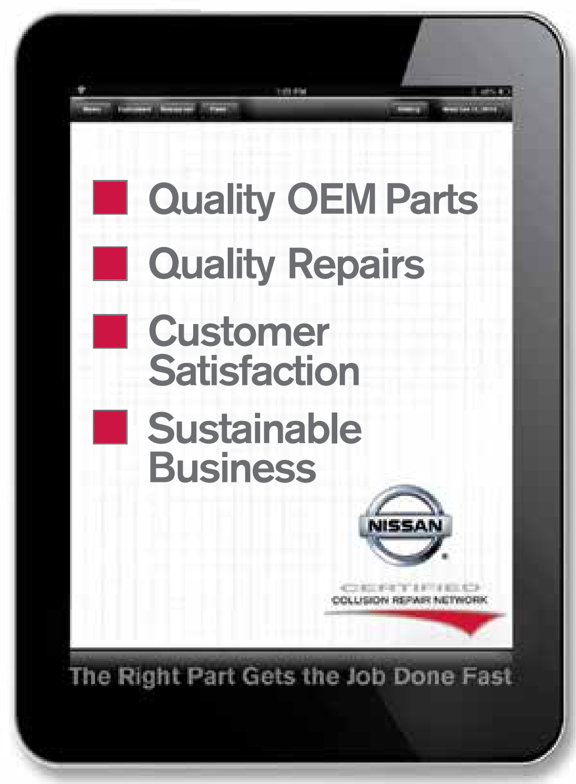


Collision Repair Professional



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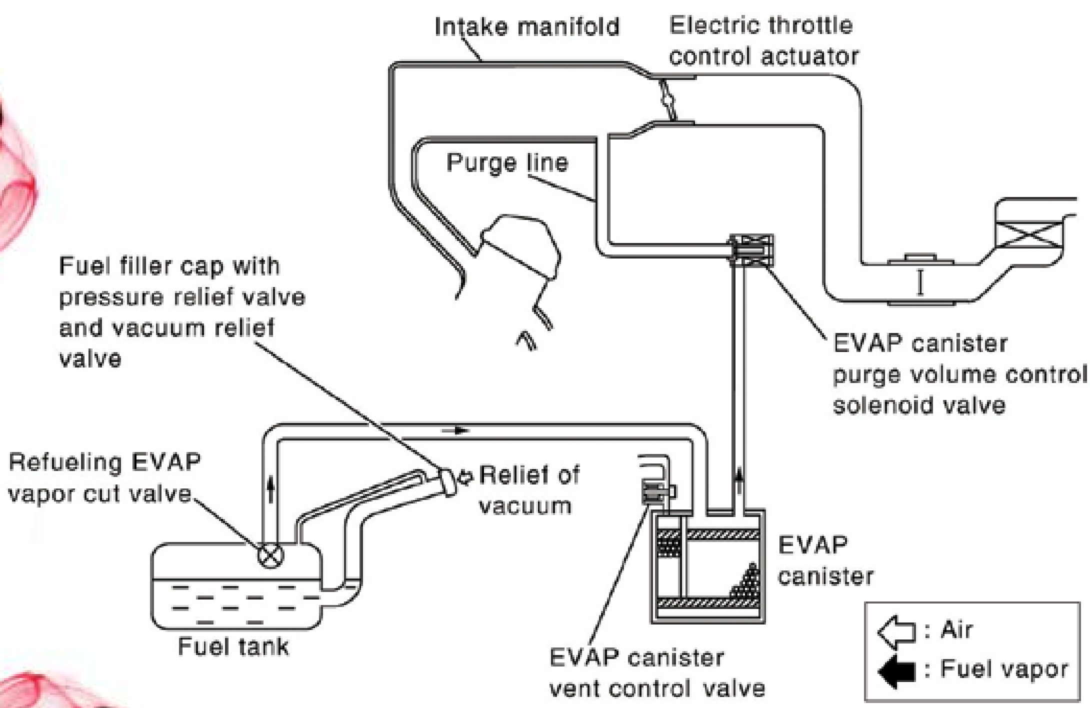
How to deal with EVAP problems without developing indigestion.



On a busy day, a diagnostic tech may find himself wishing for an air-fuel sensor heater code as he stares at the CONSULT screen during the SYSTEM CALL. But sometimes, life doesn't cooperate and we're faced with a P0456 instead of the P0031 we were hoping for. EVAP codes are occasionally "gravy", but more often than not, they're among the more time-consuming reasons behind a glowing check engine light. There's no guarantee that this article will help you fit every EVAP diagnosis into the ubiquitous one-size-fits-all "diagnostic hour", but it may improve your chances.

A Quick Overview of the EVAP System

Gasoline is volatile, that is: it evaporates easily. Gasoline vapors or hydrocarbons (HCs) are bad for the environment because they cause smog and respiratory ailments. If a fuel tank is vented to atmosphere, HCs will escape and pollute the air we all breathe. If a fuel tank is not vented, pressure will build and it will expand and be damaged. The EVAP system allows the fuel tank to vent through a charcoal canister which will strip the HCs from the air and store them for later use as fuel for the engine. The EVAP system is the combination of all the components that make this possible.

The Charcoal Canister

The canister is typically located near the fuel tank. It is a plastic box filled with activated carbon in a filter sock that has pores large enough for the HCs to pass, but small enough to prevent the activated carbon from escaping. Activated carbon is similar to a ground up charcoal briquette. If you've ever squirted lighter fluid (which is a hydrocarbon) onto the charcoal in your barbeque, you'll know that it can soak up a lot of fuel before it is saturated. When the fuel in the tank evaporates, the vapors are routed through the canister where the HCs stay stuck to the carbon while the oxygen and nitrogen pass through to the atmosphere. The most common causes of failure are:

- A torn filter
- Water saturation
- Fuel saturation

A torn filter will be evidenced by black powder escaping from the canister (and often gumming up the purge valve). Fuel and water saturation can be detected by feeling the weight of the canister; it will be substantially heavier than a non-saturated canister. Topping-off the fuel tank can cause oversaturation of the charcoal canister, which can restrict flow through the canister.

Purge Volume Control Solenoid Valve

Let's call the PVCSV "the purge valve". Its full name is wonderfully descriptive of its function, but is a bit of a mouthful. The purge valve is responsible for getting the HCs stored in the canister into the intake manifold so that they can be burned as fuel. The purge valve is a solenoid valve that is open when voltage is applied to its coil, and closed when no power is applied. This means it is a normally closed valve, which is important to know.

The ECM is able to control the volume of flow from the canister by changing its duty cycle. If the valve is ON 50% of the time and OFF 50% of the time, it would flow roughly 50% of its maximum volume. If the ECM changes to 75% ON and 25% OFF, it would flow about 75% of its maximum volume. The purge valve usually operates only when the throttle is open and the engine is warm. The purge valve should always be fully closed during deceleration, otherwise the flow of fuel vapors could cause backfires. The most common causes of failure are:

- Physical sticking due to wear or debris
- Failure of the solenoid winding (if shorted, be sure to test the ECM driver)
- Disconnected or corroded electrical connector
- Disconnected or leaking purge hose

Using the CONSULT's "PURG VOL CONT/V" ACTIVE TEST with the engine running is a great way to check all of the possibilities at once. If the valve is sticking or the solenoid windings are open or shorted, the purge valve will not click and the engine speed will not increase as the valve opens. It also allows multimeter or oscilloscope testing on a working circuit.

Canister Vent Control Valve

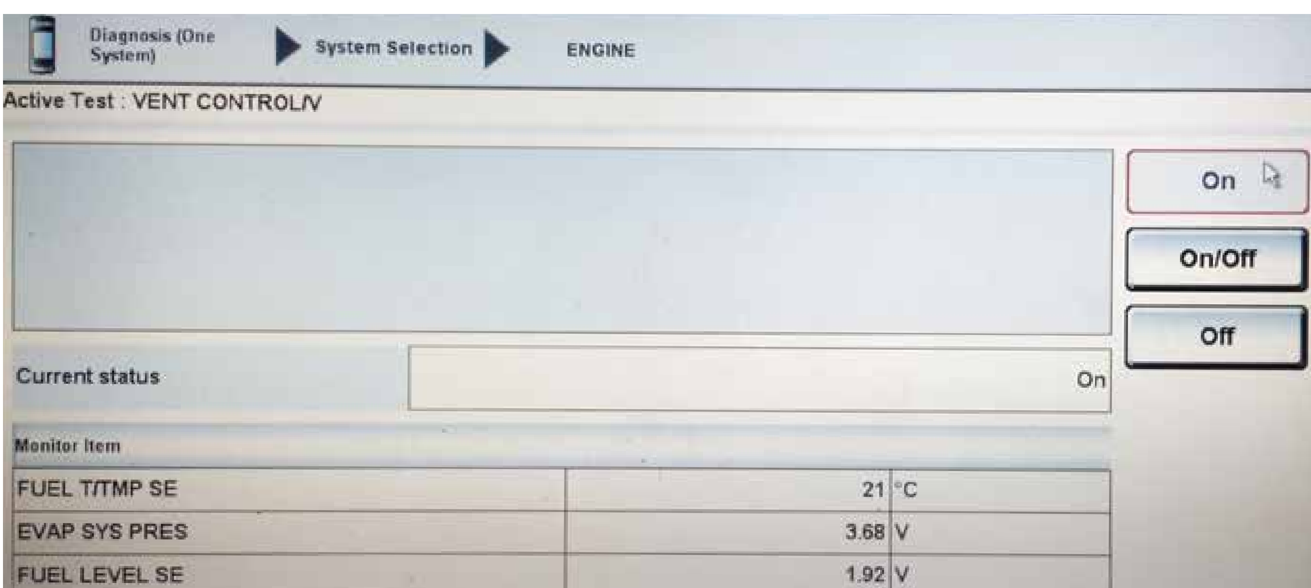
Let's call the CVCV the "vent valve" to save words. The vent valve is a component added for self-diagnostic function only. Its job is to seal the tank from the atmosphere to allow vacuum testing to verify there are no leaks in the system. The vent valve is normally open; the opposite of the purge valve. This allows the tank to vent through the canister while the car is sitting parked in the sun. The only time the vent valve closes is during self-testing; it seals the tank to allow for vacuum decay testing.

The vent valve can fail in all the same ways as the purge valve, plus it's more susceptible to blockage from insect nests and connector corrosion due to its location. It's usually under the rear of the car near the tank and canister. There is a CONSULT ACTIVE TEST "VENT CONTROL/V" which is very useful for manual vacuum or pressure testing.

EVAP Control System Pressure Sensor

The EVAP pressure sensor is a very sensitive pressure transducer with a small operating range of 8.5 – 15.5 psi. Its voltage output increases with pressure. Its purpose is entirely diagnostic; in fact it is the primary sensor for all EVAP self-diagnostic functions. On most systems, the EVAP pressure sensor monitors what Nissan calls "the purge line," which is actually the entire system from the vent valve to the purge valve, including the tank and canister. The EVAP pressure sensor is usually located near the canister and tank.

EVAP pressure sensors are not a very common failure. Its function can be easily checked using the CONSULT's DATA MONITOR. Simply remove the fuel cap and check the pressure reading. It should be equal to atmospheric pressure. Atmospheric



The vent valve is normally open. You'll need to close it with an active test or by manually powering the solenoid before leak testing.

Nissan recommends using an ultrasonic tester and hand-held vacuum pump to find leaks. Vacuum decay (vacuum decreasing over time) indicates that there is a leak. The ultrasonic tester is used to locate the source of the leak.

Pressure decay (pressure decreasing over time) is another way of determining if the EVAP system is leaking.

pressure is going to vary depending on location, so it's a good idea to learn what's normal at your shop. 760 mmHg (14.7 psi) is typical at sea level. If there is not calculated pressure display in the DATA MONITOR, you can use the voltage to pressure chart in the service manual. If you rock the car while monitoring the EVAP SYS PRESS, you'll see that the signal changes as the fuel sloshes. This lets you know that you're looking at a real signal and there is not a blockage between the tank and the sensor.

Fuel Tank Temperature Sensor

The fuel tank temperature sensor is necessary to correct for some unavoidable realities related to gases, temperature, and pressure. Gases will expand when warmed and contract when cooled. Gases in a sealed container (which is precisely what the fuel tank is when the vent valve closes during testing) will also want to expand and contract, but since they are held in a fixed volume container, the pressure inside the container will increase and decrease with temperature. Therefore, the ECM must know about any changes in the temperature of the fuel tank during testing. Remember, the primary sensor for EVAP testing is a pressure sensor, so the ECM must be able to correct for temperature changes, and for that it needs a temperature sensor.

Fuel Level Sensor

The fuel level affects the pressure curve in the tank when a vacuum is applied. This is because liquid is denser than gas so the liquid fuel and the air above it will respond differently when a vacuum is applied. Because of this, the ECM needs to know how much of the space in the tank is occupied by liquid, and how much is occupied by gas.

Diagnosis

So you've found an EVAP code. It's best to start with a visual inspection: eyes only, no touching. Resist the temptation to twist the gas cap! If you tighten it and it seems to move a little, how sure will you be that the car is fixed? It's a good idea to look at the purge line under-hood, and make sure the gas cap is in place, and maybe do a little sniffing for fuel odor, but don't mess with anything until you've confirmed the problem and have a way to confirm the repair.

If you have a CONSULT, start with a DTC confirmation test. This is a very quick way to verify you're chasing a problem that you'll be able to find with testing. If the DTC confirmation runs and passes, it may be in both your customer's and your best interest to cut diagnosis short. Obviously there will be times when "it's not doing it now" won't cut it, and you'll need to pull every trick you have out of the bag. However, the first visit for an EVAP problem that on one hand may be a legitimate intermittent problem, but on the other may have been "repaired" last time the customer filled up may not be the best time to pull out all the stops.

EVAP Leak Check

Nissan service manuals recommend using a hand pump to create a vacuum and an ultrasonic listening device to find the hissing leak. Most of the industry uses pressure/smoke testers regulated at 0.5 psi. Let's talk about the latter, as it is most likely that you'll have a smoke tester and not an ultrasonic tester. Besides that, trying to find a leak with an ultrasonic microphone can be very difficult in a typical loud shop environment. Here are some leak check tips:

- Use the CONSULT to close the vent valve. The valve is normally open, so obviously the system will not hold pressure unless it is closed. Don't pinch off the vent tube unless necessary, otherwise you won't be checking the vent valve sealing during testing.
- Pressure test without smoke before adding smoke to the system. The warm smoke can skew the pressure testing results. Confirm there is a leak with pressure testing first then, find the leak with smoke.
- Before you smoke, tighten the gas cap and see if the leak goes away. Waiting until now allowed you to confirm your repair.
- Fill the system with smoke by opening the vent valve until smoke pours out then, seal it again. Otherwise it can take a very long time to fill a system with a .020 in. leak.
- If you can't find the leak with smoke, mix a batch of tire leak detector and put it in a spray bottle. Mist the EVAP system front to rear and wait 5 minutes. You'll find what looks like a spit bug somewhere along the system. This works really well; give it a try.

What Can Cause This? What Should I Test? What Should My Results Be?

It's really important to understand what can cause a trouble code to set. The code descriptions can be a little misleading at times, and if you're not planning to follow the flow chart blindly and very precisely, you really need to have an idea of what's going on. In Nissan's online service manual you'll find two very valuable sections for each trouble code: Description and DTC Logic. These are valuable resources when trying to find out how the system works and what will cause a trouble code to set. Take time to read and reread this information until you understand the system before testing. Testing is only useful when you know what results are normal. It's common for techs to feel like they

If pressure regulated at 0.5 psi is applied to a sealed EVAP system, the amount of flow in should be equal to the amount of flow lost through the leak. A pressure supply and a flow meter is another way to determine if the EVAP system is leaking.

need to get "working" and begin testing without a good understanding of the system under test. This usually leads to wasted time or misdiagnosis. Research, plan, and then test.

After reading the description and logic sections, try to restate what the service information said in your own words. Restating in your own words is a powerful tool. Obviously, it's a test of your understanding, but it also offers other benefits. It will make you think about the system in a familiar frame. For example, often electron theory is used in information contributed by engineers, but if you think in conventional theory, rewriting will help you think about the system in a way that is more intuitive for you. You'll also find that diagnostic strategies will come to mind as you are restating the information in the manual. The time you spend writing your own description of the code setting criteria will also cause you to read between the lines and discover information that is implied but not directly stated in the manual. Sometimes this is critical information, such as what sensors are responsible for fault detection.

Trouble Code Examples

There's more than one way for an ECM to detect a fault, and trouble codes don't indicate how a fault was detected on a particular vehicle; that's what the DTC Logic section of the manual is for. There are some simplified examples of EVAP codes, their meaning, and their possible causes below. These will be a handy reference for many five to ten year old Nissan cars, but remember that the same code can be detected in different ways on different vehicles, so the service manual is always the best source for information.

P0441:	incorrect purge flow

Meaning: Purge valve is commanded open but EVAP pressure sensor reading does not drop appropriately.

Causes: Anything that would cause no change in FTP reading with valve open. For example:

- Stuck purge valve
- Disconnected purge hose
- A large enough leak that a vacuum cannot be drawn (likely to have a P0455 code too)

P0456*:	very small leak detected
P0442:	small leak detected
P0455:	very large leak detected

Meaning: There is a leak in the EVAP system. The ECM closed the vent valve, opened the purge valve to draw a vacuum, closed the purge valve to seal the system, and then monitored the EVAP pressure sensor. If the pressure sensor voltage increased at a rate equivalent with a .020 in. leak, a P0456 will set. If the pressure sensor voltage increased at a rate equivalent with a .040 in. leak, a P0442 will set. If the pressure sensor voltage barely dropped when vacuum was applied, a P0455 will set.

Causes: Anything that would cause the tank pressure reading to climb too rapidly while the system was sealed in the case of the P0456 and P0442, or anything that would cause the tank pressure reading not to drop in the case of the P0455.

****P0456 Notes: 1.*** The most likely cause is a loose gas cap. Several years ago, Nissan started to adopt EONV (Engine Off Natural Vacuum) testing, which is on almost all newer vehicles. When the self-test is performed, only P0456 is stored regardless of the size of the leak. Nissan is considering issuing a TSB instructing the technician to check the DTC, tighten the gas cap, close the Vent Valve (with CONSULT), and pressurize the EVAP system. If it holds pressure, the most likely cause of the code is that the gas cap was left loose.

2. Nissan adopted Loose Cap Warning for MY2011. P0456 is stored when the customer leaves the cap loose. If he or she does not tighten the cap when the warning come, P0456 will be stored, the MIL will turn ON, and the Loose Cap Warning light will go OFF.

P0443:	purge valve

Meaning: The fuel tank pressure sensor is indicating a vacuum when the purge valve is closed and the vent valve is open.

Causes: Anything that would cause a vacuum to be drawn or retained in the system when not commanded. For example:

- A stuck open purge valve
- A stuck closed vent valve
- A blockage or restriction between the area monitored by the pressure sensor and the atmosphere such as a clogged canister or a restricted hose
- A fuel tank pressure sensor that is indicating a vacuum

P0444:	very small leak detected
P0445:	short in purge valve

Meaning: The ECM is detecting too little current flowing through the purge valve (P0444) or too much current flowing through the purge valve (P0445).

Causes: Anything that would cause low or high current on the purge valve circuit.

P0447:	vent valve

Meaning: The meaning of this code varies a bit car to car. On some vehicles it is a code that indicates open or short in the vent valve control circuit, other vehicles use rational testing to set this code.

Causes: When in doubt, assume that P0447 may be caused by a circuit fault or a functional fault.

P0448:	stuck closed vent valve

Meaning: The fuel tank pressure sensor is indicating that vacuum remains in the system when the vent valve is not being commanded closed.

Causes: Anything that could cause vacuum to be retained or the pressure sensor to incorrectly indicate vacuum. For example:

- A stuck closed vent valve
- A blockage or restriction between the area monitored by the pressure sensor and the atmosphere such as a clogged canister or a restricted hose.
- An inaccurate pressure sensor reading

P0451:	pressure sensor output is abnormal

Meaning: The pressure sensor is a three-wire pressure transducer with a 5V reference, ground, and signal out. If the signal output is erratic beyond what is expected based on conditions, this code will set. For instance, if the vehicle is stationary the ECM would expect very little rapid change in the pressure sensor output.

Causes: Anything that might cause an erratic pressure sensor output. For example:

- A bad pressure sensor
- Fluctuations in the sensor ground circuit
- Fluctuation in the sensor reference circuit
- A poor connection between the sensor & ECM

P0452:	pressure sensor output low

Meaning: The pressure sensor is a three-wire pressure transducer with a 5V reference, ground, and signal out. P0452 indicates the signal voltage is below expected based on conditions.

Causes: Anything that would cause low sensor output. For example:

- A bad sensor
- A short to ground on the signal circuit
- A problem with the reference voltage or the sensor ground

P0453:	pressure sensor output high

Meaning: The pressure sensor is a three-wire pressure transducer with a 5V reference, ground, and signal out. P0453 indicates the signal voltage is above the expected based on conditions.

Causes: Anything that would cause the sensor signal circuit voltage to be high, or anything that might cause the tank pressures to be unexpectedly high. For example:

- A bad sensor
- A short to power
- A problem with the reference voltage or sensor ground
- A problem that prevented tank venting

P0181:	fuel tank temperature sensor rationality check

Meaning: The fuel tank temperature sensor is a thermistor that modifies voltage from the

ECM as the fuel temperature changes. The ECM compares the fuel tank temperature to the intake air temperature sensor and the coolant temperature sensor on a cold start up. If the fuel temperature does not match the other two sensors, a P0181 will set.

Causes: Anything that would cause the sensor circuit voltage to be incorrect.

P0182:	fuel tank temperature sensor circuit voltage low
P0183:	fuel tank temperature sensor circuit voltage high

Meaning: If the fuel tank temperature circuit is too low or high, a P0182 or P0183 will set.

Causes: Anything that would cause the sensor circuit voltage to be incorrect

P0460:	fuel level sensor noise

Meaning: The fuel level signal should be stable when the vehicle is parked. If the fuel level sensor output is changing while parked, this DTC is set.

Causes: Anything that might cause the fuel level sensor output to vary. For example:

- A problem with the fuel level sensor
- Towing the vehicle

P0461:	fuel level sensor stays fixed

Meaning: The fuel level should decrease as the car is driven. If the fuel level stays the same for too many miles, this DTC will set.

Causes: Anything that would cause the fuel level sensor output to stay the same for many miles, or a data problem (if a U-code is present).

P0462:	fuel level sensor output low
P0463:	fuel level sensor output high

Meaning: The voltage from the fuel level sensor is either higher than normal or lower than normal.

Causes: Anything that could cause low or high voltage or a data problem (if a U-code is present).

Drawing a Blank

ECMs are almost never the root cause of EVAP codes, but if an output like a purge or vent solenoid shorts, the excessive current draw may damage the ECM's driver. If you do need to replace an ECM, here's something you'll need to know: many Nissan ECMs are now being shipped blank.

In the past, a replacement ECM may have needed to be updated and/or configured after installation, but a blank ECM is different – it literally has no programming installed. All 2014 and newer ECMs will be shipped blank, and blank ECMs will be phased in for 2009 to 2013 models.

There are two possible procedures for programing a blank ECM. If the old ECM is still communicating, the ECM part number and VIN should be pulled from the old ECM before installing the new unit. To do this, connect the C-III Plus, select:

1. Re/Programing, Configuration
2. Re/Programming
3. Programming
4. Before ECM replacement
5. Save the ECM part number and VIN.

After the new ECM is installed, select:

1. Programming
2. After ECM replacement
3. Program ECM

The ECM part number, VIN, and correct programming will be written to the new blank ECM. Perform the learning procedures for the throttle, accelerator pedal, and idle speed and you should be done.

If the old ECM is not communicating, you'll need the last five digits of the ECM's part number. This can be obtained from the electronic parts catalog. The dealership that supplied the ECM will be able to provide this number to you. For some models there will be two part numbers, one for the blank ECM and one for the programmed ECM. This will not be a problem because the last five digits of both numbers will be the same. Once you have the last five of the part number, visit www.nissan-techinfo.com, select the "Blank" Programming link and use the last five to find the correct program. You'll then need to purchase and download the programming file. Connect the C-III Plus and select:

1. Re/Programing, Configuration
2. Re/Programming
3. Programming
4. After ECM replacement
5. Manually enter the VIN
6. Program ECM

When using manual entry it's very important to double check all manual data entries and read and verify that configuration data matches the car. Perform the learning procedures for the throttle, accelerator pedal, and idle speed and you should be done.

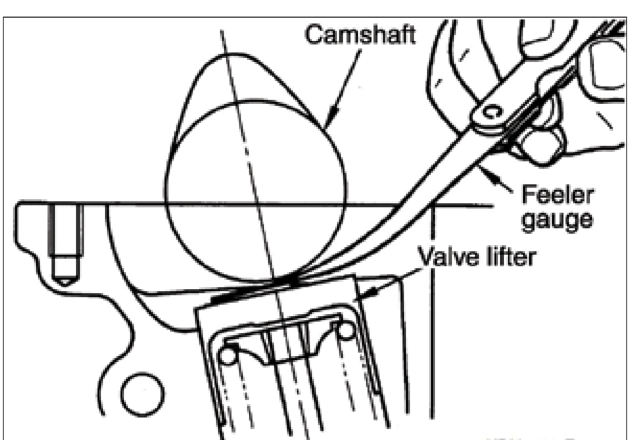
Valve Adjustment: A Touchy Feely Subject

Here's a review of the once-common skill of valve clearance adjustment and how it should be done on modern Nissan vehicles.

Ask any auto shop teacher who was working back in the '80s, and he'll tell you that measuring valve clearance is a skill that is best learned through practice. After enough repetitions, students will develop a "feel" for it. The first attempt at a valve adjustment would usually result in an engine that clatters, misfires, or a combination of both, but after a bit of practice the students would be able to get it perfect every time.

Checking and adjusting valve clearance used to be a very common operation. For example, a 1983 Sentra with an E16 motor would need the valve clearance checked (and likely adjusted) every 15,000 miles. There was ample opportunity for technicians to practice the art of measuring clearance. Fast-forward to 2014 and engines are usually able to hold clearance for 100,000 miles or more, valve covers are buried under intake plenums and other obstructions, and technicians in their 20s and 30s don't remember a time when checking valve clearance was a skill employed daily.

Consider these two facts: technicians don't get much practice checking valve clearance these days, and performing a valve clearance adjustment can take a very long time, often requiring removal of the camshafts. Add to this that checking and adjusting clearance on many modern engines is often a lot trickier than it has been in the past and you have a recipe for a miserable and costly comeback.



Measuring valve clearance with a feeler gauge.

If it were possible to prescribe daily practice until mastered, it would be a far better solution than this article, but since that's not going to happen, let's talk about how to get the job right the first time.

The Basics

First, let's define valve clearance. Valve clearance is distance between the bottom of the cam lobe and the "tappet". A tappet can be a rocker arm or lifter, but you'll find solid lifters on most modern Nissan vehicles. A tappet is defined as any device that intermittently makes contact with a cam or other part so as to give or receive motion. You'll notice that the definition say's intermittently; that's where the clearance comes in. The bottom, or heel, of the cam lobe is circular and is ground concentric with the centerline of the camshaft. This means that there is about 180° of cam lobe rotation where the distance between the cam lobe and the tappet is the same. This gap between the tappet and the cam lobe is called valve clearance and can be measured by finding a feeler gauge of a known thickness that will fit into the gap without too much or too little resistance.

The gap between the cam lobe and lifter is necessary to allow the valve spring to pull the valve head fully against the seat to seal the combustion chamber. But why not make a universal valve clearance specification of .001 in. That would allow the valve to close, right?

There are three reasons for engine-specific clearance specifications. First, we need to have some "fudge factor" built in. Parts wear and clearances change. If valves were adjusted to .001 in. clearance, even the smallest dimensional change might cause the valve to be held open.

Next, we must consider thermal expansion. The aluminum cylinder head and steel alloys used for parts like the valve and seat all have different rates of thermal expansion. Luckily the engineers have calculated what will happen as the engine heats up and provided us a shortcut the right answer in the form of a clearance specification.

Finally there's valve timing. The closer the cam is to the lifter, the sooner the valve will begin to open and the later it will close. On older engine designs you could assume that if there was some clearance, there would not be an engine performance concern. This is no longer the case. If valve clearance is out of specification, but there is still some clearance, do not assume that the engine will still run properly. For example, if the specification is .010 - .014 in. and the measured clearance is .006 in., don't assume it's not causing a problem just because there is some clearance. Tight valves can cause an increase in the duration of valve overlap, low manifold vacuum, and misfires, even when there is sufficient valve clearance for good combustion chamber sealing.

So, tight valves (too little valve clearance) are a bad thing. What about loose valves? If valve clearance is excessive, wear on the cam lobe and tappet will be increased and the valve timing will be a little late. This is preferable to a tight valve, but still isn't good. If faced with a choice, go looser not tighter. For example, if you have a specification of .010 - .014 in., and the available shims would set the clearance at either .010 in. or .014 in., go with the shim that sets clearance at .014 in.

Which brings up worthwhile, albeit subtle, point: whenever setting valve clearance, try to match valves on the same cylinder as closely as possible. Valve clearance does have a small effect on valve timing and if there are two intake valves on a cylinder (and when are there not?) it would be best if they both open at the same time to prevent any weird eddies and maximize cylinder filling. Per the service manual, you might be allowed to set one intake valve at .010 in. and the other at .014 in., but you won't be doing the best job possible for your customer.

Check Valve Clearance When…

Valve clearance inspections used to be preventive maintenance, so looking at the odometer and the maintenance section of the owner's manual was the most common way to know if the valve clearance needed to be checked. Most modern Nissans do not have an interval, so when should you check the valve clearance?

If the valve cover is off, it's a good time to check clearance. If the valve cover gasket is being replaced it makes sense to check the valve clearance while the cover is off.

Abnormal tapping noise is another reason to check clearance. A single loose valve can cause a "click" noise every 720° of crankshaft rotation – the same cadence as an engine misfire, or for that matter, a fuel injector, which also clicks every 720° so be sure not to confuse the two. If several valves are loose, expect a cacophony of clicking with frequency tied to engine speed. However, with modern engines, valve clearance typically doesn't increase over time as a result of normal wear; valves tend to get tighter as the engine wears.

Tight valves are the most harmful and difficult-to-detect reason to perform a valve clearance check. We might call insufficient valve clearance "the silent killer" because a tight valve makes no noise. A tight valve can cause an engine to run rough, but so can a lot of other things, so it takes a bit of knowledge to determine when the next step should be a valve clearance check.

A Go/No-Go gauge has two thicknesses. The primary size should fit with low drag, but the secondary size should not fit at all.

Tracking a Silent Killer

If there is no valve clearance, the valve face will not press firmly against the valve seat and this can quickly damage the valve. Here's why: the valves, especially the exhaust valves, are exposed to combustion gases around 3600°F. A steel-alloy valve will melt around 2400°F. Obviously, the valve will need to be cooled so it does not melt. This cooling takes place when the valve face is closed against the relatively chilly liquid-cooled valve seat. If the valve is being held away from the seat because there is no clearance between the cam and the tappet, the valve will quickly overheat and melt. Obviously, we want to correct a tight valve ASAP, but we also don't want to recommend an expensive investigation without good cause.

The only observable indicator of a tight valve is a misfire. The misfire it causes will typically be erratic; in other words it won't misfire on every cycle. Just in case that doesn't sound sufficiently diagnostically challenging, the misfire is also likely to be intermittent; in other words it won't be present all the time.

You can use a micrometer to help develop a feel for the right amount of drag.

When hunting elusive prey like the tight valve, it's best to know its habits, then lie in wait at the time and place you're most likely to find it. The silent killer prefers the morning, when the engine is cold, because valve clearance decreases when the engine is cold. A misfire caused by a tight valve is also most likely to be found at idle. If you want to catch a tight valve, leave the car to sit overnight then do your testing while the engine is cold and idling.

When a tight valve causes a misfire, it's often because compression pressure leaked out past the partially open valve. A compression gauge might seem like a good tool to check for tight valves, but it's rare that it will uncover problems other than the most severe cases. Every time a valve is cycled, it has an opportunity to seal or leak. A compression tester will display the peak compression achieved while cranking the engine. If the cylinder being tested misses a beat or two due to a tight valve, it won't have much effect on the gauge reading at the end of the test. A vacuum gauge on the other hand is an excellent tool for finding tight valves. A needle pulsation around 1-2 in. Hg at idle provides a solid reason to recommend pulling the valve covers.

Checking Valve Clearance

Earlier in this article we defined valve clearance as the distance between the tappet and the bottom of the cam lobe. So, if we are going to check valve clearance, the cam lobe must be pointed away from the tappet. Old-timers are sure to have their own opinions on the best way to go about setting up engine position for measurement. A common technique has been to rotate the engine to valve overlap on one cylinder, then check the clearance on its companion. Others like to adjust each valve with the lobe 180° away from the lifter. Before deciding to use your own technique instead of using the procedure prescribed in the manual, consider the amount of effort involved with re-adjusting clearance if it doesn't work out.

Once the cam lobes are in the proper position, clearance is measured by inserting a feeler gauge into the gap between the cam lobe and the lifter and sliding back and forth. When the correct amount of drag is felt in the gauge, the clearance is the same as the gauge thickness. But what is the correct amount of drag? That's where the practice used to come in. Here are two shortcuts for developing "the touch." First, set a micrometer to the size of the feeler gauge being used and lock the spindle. Then compare the feel of the feeler gauge in the micrometer to the feel of the gauge between the lobe and lifter. Second, Go/No-Go feeler gauges can be a big help, especially on engines with low-tension valve springs.

Clearance Measuring Pitfalls

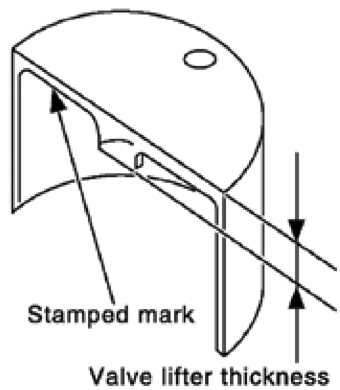
Here are some things to consider when using feeler gauges to measure valve clearance (see images below, and top-right).

There's Stuff in the Way

It is often difficult to insert a feeler gauge between the lobe and lifter because of obstructions. Cam caps, injector rails, even the

Be careful to avoid this. The feeler gauge is touching the spark tube casting and may cause an inaccurate measurement.

You can bend your feeler gauge to avoid obstacles, but avoid bending the area used for measurement.

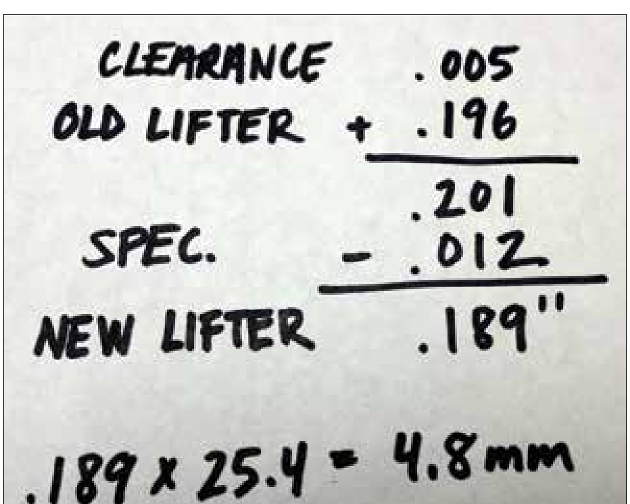


A selection of lifters of different thicknesses can be purchased from Nissan dealers to adjust valve clearance.

Lifter thickness is marked on the underside of the lifter to make it easier to find the size you're looking for. This one is 4.99mm or .196 in.

Measure Clearance

Measure Lifter



Calculated new size.

cylinder head perimeter can get in the way. The ONLY things the feeler gauge should be touching are the cam and the lifter. Anything else can create a false drag and mess up your measurement. You may want to buy one of the many types of custom shaped feeler gauges to avoid obstacles. If necessary, you can bend the feeler gauge so that it does not touch anything else. It's best to bend the gauge in a non-measuring area because a curved gauge can also cause false drag.

Twisted Gauge

The feeler gauge must go into the gap straight. If you put any "English" on the gauge it will cause a false drag. If the feeler gauge is twisting or bending, a very wide gap may feel perfect. Avoid the temptation to tweak the gauge so you can clear obstacles. It's OK to bend the gauge before measuring, but don't twist the gauge while measuring.

Soft Springs

Valve springs are not as stiff as they were in the old days. It's easy to insert a gauge into a gap that does not exist and think that it feels like it's on the "tight side of OK" when in fact you've just opened the valve with the feeler gauge. Shooting for a loose fit with a Go/No-Go gauge is one of the best ways to deal with soft-spring valves.

Adjusting Valve Clearance

Screw and jam nut adjustments are rare these days, and lifters with adjustment shims are fading as well. The most common method of valve clearance adjustment is select fit lifters. The camshafts must be removed to remove the lifter, so measure and document very carefully. Take your time and be very sure before disassembly. Also, be sure to organize and mark lifters so you know where they were located before they were removed. If you somehow lose track, you'll need to reassemble and recalculate before continuing.

Lifter or Shim Selection Formula

Valve clearance measurement + Thickness of lifter removed = Distance between lobe and valve stem tip - Valve clearance specification (from manual) = Lifter thickness to order from Nissan.

Diagnosing Key-Off Drain Problems

Chasing down an elusive key-off drain problem can test the patience of any technician. Here are some tips and hints to make your life a little easier.

Most drivers consider a reliable car a necessity. We must be on time for work, to pick kids up from school, and to a myriad of other destinations. There is very little flexibility in modern life, so a car that does not start reliably is unacceptable for most people.

A battery that goes dead as a car sits can be very frustrating for both drivers and technicians. A shop may only have one chance to diagnose and repair a key-off drain before a customer looks elsewhere, just as a customer may have only one opportunity to meet their obligations using a reliable car. This is why a full effort should be made whenever investigating a key-off drain.

Excessive key-off drains will cause the familiar symptoms of a discharged battery, such as dim lights or no lights, slow cranking or no cranking, etc. However, symptoms of a discharged battery aren't always caused by a key-off drain, so the first step is always to answer these questions: Is a discharged battery the cause of the complaint, and if so, what was the cause of the discharged battery?

A full recharge and evaluation of the battery should be the very first step. If the battery voltage is low, test results may not be valid. Control units do not like to operate on low voltage, so if they don't have an adequate voltage supply, they may not be "thinking" straight. Without good power, control units should not be held responsible for their actions, including sucking juice when they should be asleep. Also, lower supply voltage will push fewer amps through a given load, so the level of key-off drain may look artificially low if the battery isn't fully charged during testing.

A few more possibilities should be eliminated before checking key-off drain. First, a problem with charging system can certainly cause a discharged

Don't begin key-off drain diagnosis before charging and testing the battery.

battery, so it should be tested. Also, a history should be obtained from the customer. All cars use some current while “off”. Control units, clocks, anti-theft, keyless entry, and other systems need to draw power, so some key-off drain is completely normal. Any car that sits unused for long enough will eventually run the battery down. If a car comes in with a layer of dust, spider webs, and mouse droppings, the problem may lie with how the car is being used, not with key-off drain.

So, if key-off power draw is normal, how much is too much? The answer, like so many things in life, is not black and white. Different models have different levels of normal draw. The normal key-off drain in a 1996 Maxima is different than in a 2011 Versa. The only way to know what’s normal for a particular year, model, and trim is to compare it against another identical known good car. In general, older models will draw more than newer models, and fancier models will draw more than simpler models.

Shop teacher A says key-off drain should never exceed 150mA. Shop teacher B says key-off drain should never exceed 60mA. Who’s right? Could be A, could be B, could be both, could be neither. It all depends on the car, the battery, and the driving habits of the owner. Experience and comparison against identical known good cars are your best “specifications”.

You might think that looking at the reserve capacity (RC) of the installed battery, and then comparing it to the key-off drain, could be used to calculate how long the battery is likely to maintain a charge capable of starting the engine. For instance, if a the installed battery has a 100 amp/hour rating, and the key-off drain is 100 mA, we might estimate that the battery should maintain a charge for 1000 hours or 41 days.

There are however, a number of variables that will pummel the accuracy of this crude equation. First, the amp hour rating is based on discharging the battery to 10.5V. Is a 10.5V battery likely to start a car? Then there are other questions. Has the installed battery maintained its original AH rating? When the car is parked, is the battery typically 100% charged? Then there’s Peukert’s Law, which states that changes in the discharge rate will affect the reserve capacity of a battery.

Key off-drain is usually not constant. Control units wake up and go to sleep as needed and self tests can run automatically on a schedule. There will be periods where current draw is too high for good battery life, but periods of high draw are part of normal key-off operation as long as they are not sustained for too long. Often, current draw will be higher after input, such as operating any system on the car or reconnecting the battery. It’s best to test for key-off drain after the car has been sitting for quite some time.

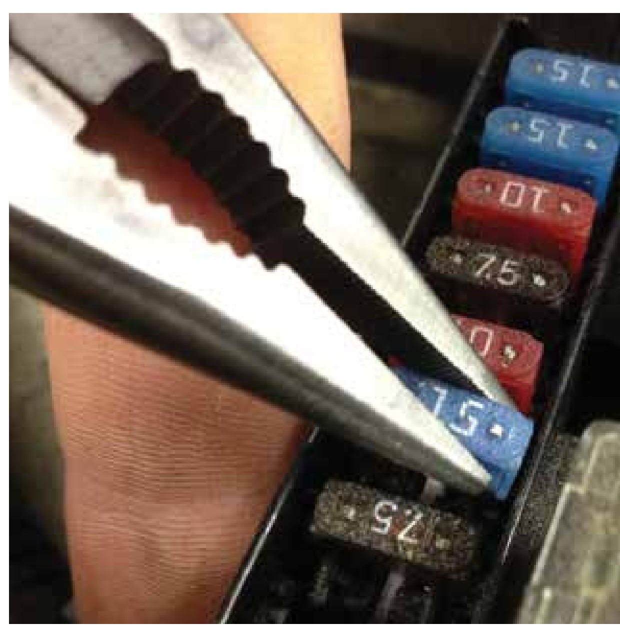
How much is too much? 609mA is certainly too much for continuous draw on any car. 40mA is very unlikely to cause problems, and is normal for this older fully loaded QX4.

How to Test for Key-Off Drain

1. Clean the battery terminals of corrosion, grease, or sealer.
2. Charge and test the battery using the GR8 battery diagnostic station.
3. Remove the keys from the car and close and lock all doors.
4. Connect one lead of the ammeter to a good ground point or the negative battery cable.
5. Loosen the negative terminal clamp and slide it up while continuing to maintain contact with the post. Once the clamp is high enough, slide the other ammeter lead clip onto the post.

Solid test lead connections are essential to accurate diagnosis. A few moments spent on good work habits like removing sealer, grease, or corrosion from the battery terminals will save time in the long run.

An ammeter must be connected in series to measure current draw. If careful, it's possible to connect the ammeter without breaking the circuit to avoid the temporary increase in current that often accompanies electrical systems "waking up."



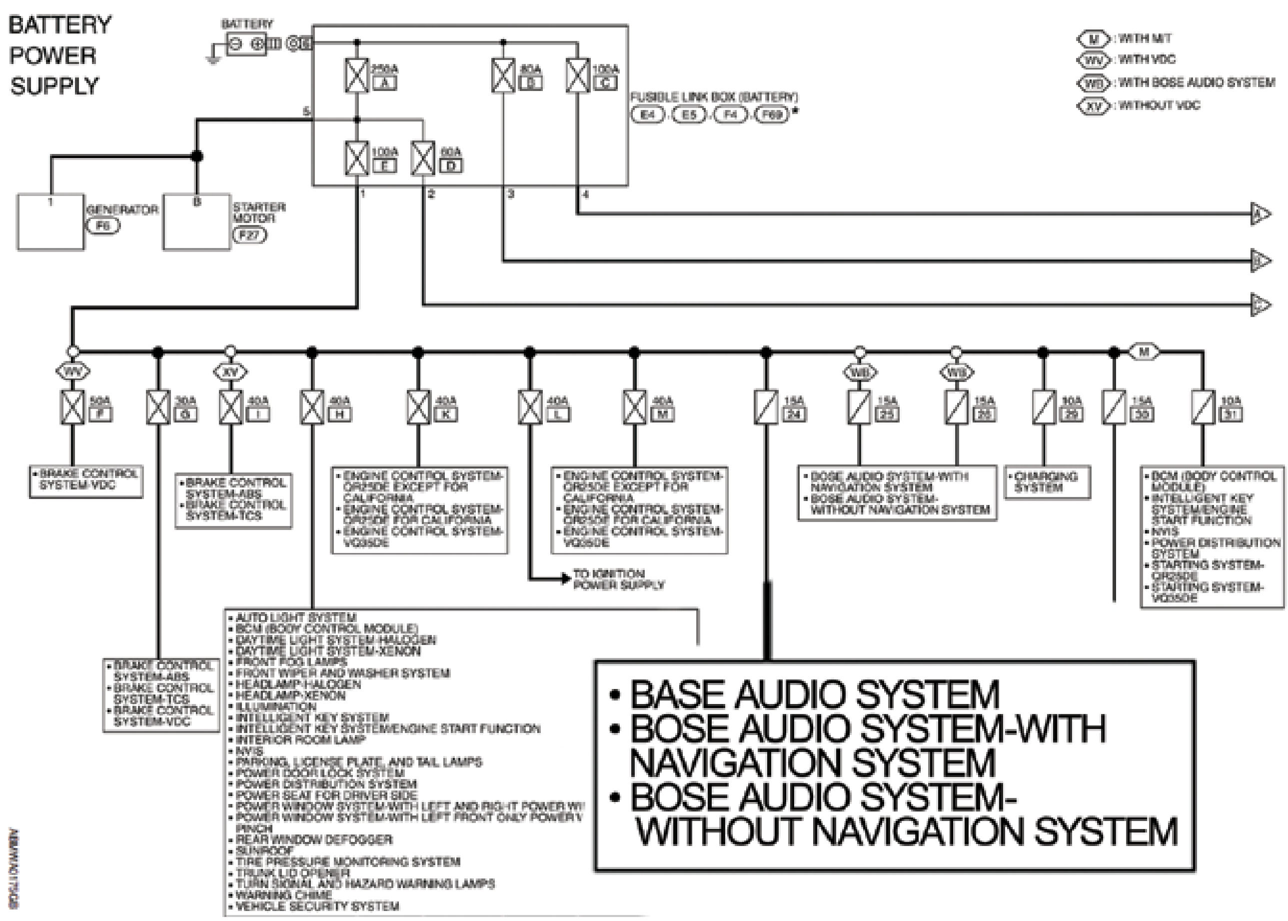
Pull fuses one at a time and take note of the decrease in current consumption (if any). This will allow you to map out the total key-off draw.

6. Remove the negative cable clamp from the terminal and note the reading on the ammeter.
7. If the reading is too high, wait 20 min and check again.

Keeping the negative cable connected until the ammeter completes the circuit is not mandatory. You could simply disconnect the negative cable, and then connect the ammeter between the negative post and the negative cable. However, if the circuit is broken, there is usually a period of increased current draw as control units wake up after the power outage, so you may have to wait longer for the current flow to die down to its normal key-off level. Also, all of the customer's presets will be lost and window, door, and sunroof initializations will need to be performed. Memory savers cannot be used while conducting key-off drain testing because they provide an alternate unmeasured power source and will skew test results.

If excessive current draw is found, the next step is to find the source of the draw. The simplest way to start is by pulling fuses one at a time. Often (but not always) circuits that are provided key off power are fused in the under-hood fuse box, so that is a good place to start. Pull one fuse at a time while checking for a drop in the current flow. It's best to follow a pattern so no fuses are missed. If the current doesn't drop substantially with any of the fuses in the under-hood fuse box, move on to the other fuse boxes and repeat the process, pulling one fuse at a time.

Once the circuit responsible for the bulk of the draw is found, take a look at the Power Supply, Ground, and Circuit Elements section of the service manual. There you'll find a list of circuits powered by



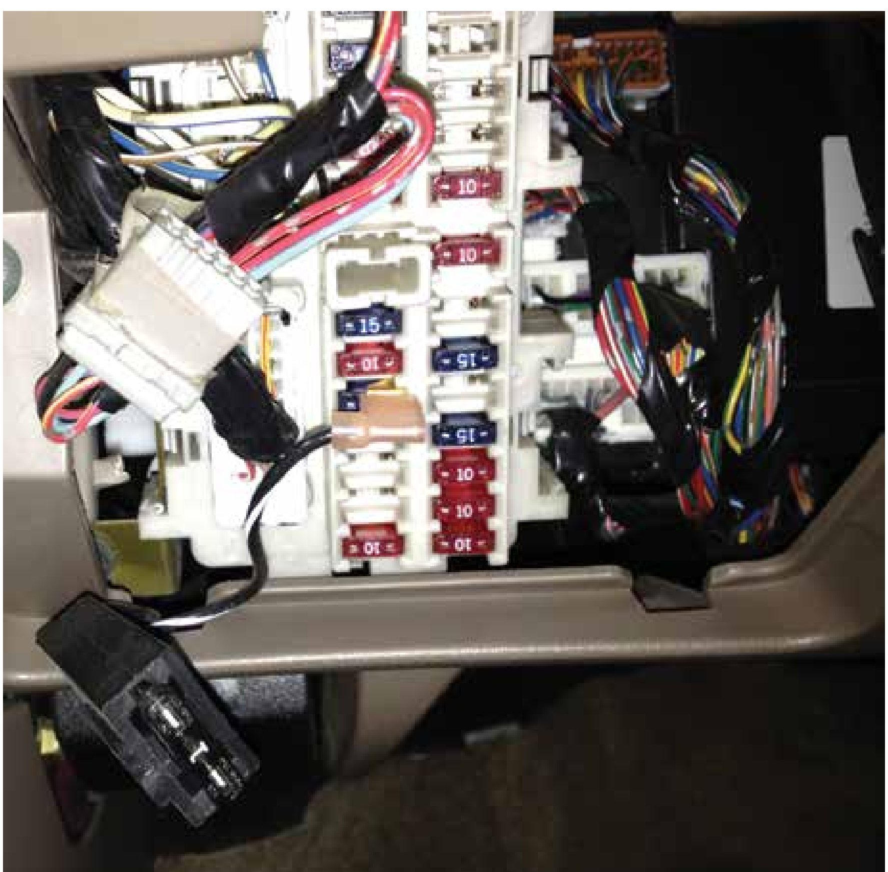
Finding the fuse responsible for the draw is only part of the challenge. The next step is to determine what systems are powered by the fuse.

Don't miss the forest for the trees! Take a moment to step back and stop, look, and listen before getting too fancy with diagnosis.

each fuse. Once you know the circuits powered by the fuse, check the individual wiring diagrams to find out which components and connectors are involved. Once this is known, look up the locations and make a plan of attack based on effective isolation of circuit elements and accessibility of connectors.

For instance, if you found circuit that powered four components is pulling 300mA, you might look for a connector that would depower two of the four branches. Or, depending on location it might be easiest to just disconnect the components one at a time. Time spent learning about the circuit, connectors, and locations will make diagnosis a lot quicker. A plan of attack is invaluable.

Logic is a diagnostician's best tool. That said, it sometimes pays to start with an educated guess. Who knows, you may get lucky with it. There are a few "repeat offenders" when it comes to key-off drains. Before proceeding in purely a logical fashion, it might be a good idea to start by questioning some of the usual suspects.



Guilty until proven innocent! Aftermarket junk causes a lot of key-off drain complaints. Start by assuming the worst and pull its cord.

Audio units always have at least one key-off power source, and they do fail with some regularity. If the CD player decides it needs to eject a stuck CD, it may not give up on its quest until the battery is dead.

Door switches are another common failure. Taking a moment or two to really look at the car can pay off. Just look for any lights that are on inside the car with all of the doors closed. A dome light that's on all the time will certainly drain the battery.

Trunk lights can be a little trickier since the trunk is not visible from the outside of the car. The switch is typically located on the latch or striker, and they usually are obviously broken or loose when they fail, so it's worthwhile to take a quick look. If in doubt, most

Nissan products have a trunk that will comfortably hold a human.

Finally, the glove box light is another place to look. Thanks to GPS, most folks have stopped overstuffing the glovebox with maps, but unfortunately, many have found other stuff to cram into the glovebox to hold the door slightly ajar and keep the light on all night.

Add-on Headaches

Folks love to add stuff to their cars. Nissan knows this and provides quite a few add-on accessories for a variety of needs or wants. Unfortunately for those of us who fix cars, the vast majority of add-on accessories are not Genuine Nissan kits.

Some aftermarket accessory kits are well designed, but so many are not. Poorly designed or installed kits can create some real headaches; often the hardest problems to diagnose are problems that were created by someone else modifying the car. Keep an eye out for anything that is not OE. When in doubt, temporarily disable aftermarket devices to determine if they are the source of the trouble before going too deep with standard diagnosis.

Tough Cases

An intermittent problem with the battery could cause what might at first appear to be key-off drain. An intermittent cell short can bring the static voltage down to 10.5V, which might appear to be a discharged battery. It's possible for a shorted cell to come and go as components or sediment shift inside the battery and this can be very frustrating. The battery may test good after charging, but then drop a cell once your customer drives the car home. If the battery is not sealed, check under the caps for debris floating in the electrolyte. If debris is found, suspect a battery problem.

Very intermittent drains are another tough-to-diagnose problem. A loose detent in the headlight switch might cause the high beams to come on in the middle of the night. A loose or misadjusted striker for the trunk latch might cause the trunk light to stay on sometimes, but of course not while you're testing. A damaged door switch might work nine times out of ten, but you won't know that unless you work the doors enough while testing to induce a failure. Best advice? First, don't ignore seemingly unrelated problems you encounter. If the headlight stalk feels floppy, consider if there is any way it might be related to the customer complaint. Second, operate the car like the customer would. If there is no drain found with the car sitting static, start trying to simulate normal use of the car.

Measuring current draw overnight is sometimes necessary. Using an ammeter in MIN/MAX recording mode can be very helpful. Remember that various tests may be run with the key off, so a 2A draw in the middle of the night may not be a problem. Use the average function to differentiate between normal spikes in current draw and excessive draw.

Involving the Customer

Talking to customers serves two purposes. First, it may lead to some insight about how to induce the drain. Ask customer questions about their driving routines and let them know that you are trying to duplicate the things they do with the car to get it to act up. Second, involving customers gives them a window into the challenges you are facing, and may spur some empathy and feelings of good will, rather than just the frustration of owning a broken car.

Measuring current draw overnight using MIN/MAX.

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How Regenerative Braking Works

The regenerative braking systems on Nissan hybrid vehicles can be confusing and misunderstood. Let's take a look at how these systems really work.

If you've been working in this field for a while, you probably remember being surprised when you pulled the wheels off your first hybrid. Where were the "regenerative brakes?" There was nothing behind the wheel but the familiar disc brake setup, just like a regular car. How does the car capture braking energy using regular brakes?

As I'm sure you know now, the braking is split between the "regular" brakes and a motor/generator, attached to the wheels through the axles. This article will focus on how this division of work is accomplished. We'll explore the components that make up the system, their responsibilities, and how the whole system works together to seamlessly provide the braking the driver wants while capturing the energy normally wasted.

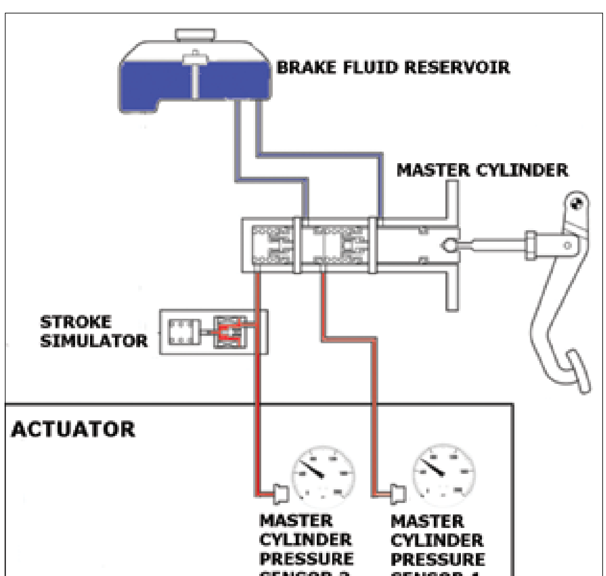
Modern braking systems are complex, but possible to understand in bite size chunks. This article will avoid discussion of ABS, VDC, collision avoidance, and other features that add complexity and might delay understanding of how regen works. Also, systems vary, so this article will not match every Nissan hybrid. However, systems will be similar and what you learn here will speed understanding when encountering new models like the 2014 Pathfinder hybrid.

Making a New System Undetectable from the Driver's Seat

Let's start with the most important thing about the system: "what the driver wants." Brakes are there to slow or stop the car when the driver wants. Everything else is less important. So, how does the driver communicate his or her needs? The braking request could have been designed around almost any input device, but Nissan wisely chose not to "reinvent the wheel" and stuck with the familiar brake pedal. If you know how to drive a car, you know how to drive a Nissan hybrid. Not only is the input method the same, the "feel" of the brake pedal is the same as any other car.

The perception of the braking experience may be the same, but what's happening behind the pedal is very different. The brake pedal is linked to a master cylinder via a push rod. Familiar enough, but then things get different.

The fluid pushed from the master cylinder creates pressure in a "dead end" in the brake actuator where two pressure transducers measure how hard the driver is stepping on the brake pedal. The Master Cylinder Pressure sensors are the primary input for driver braking request.



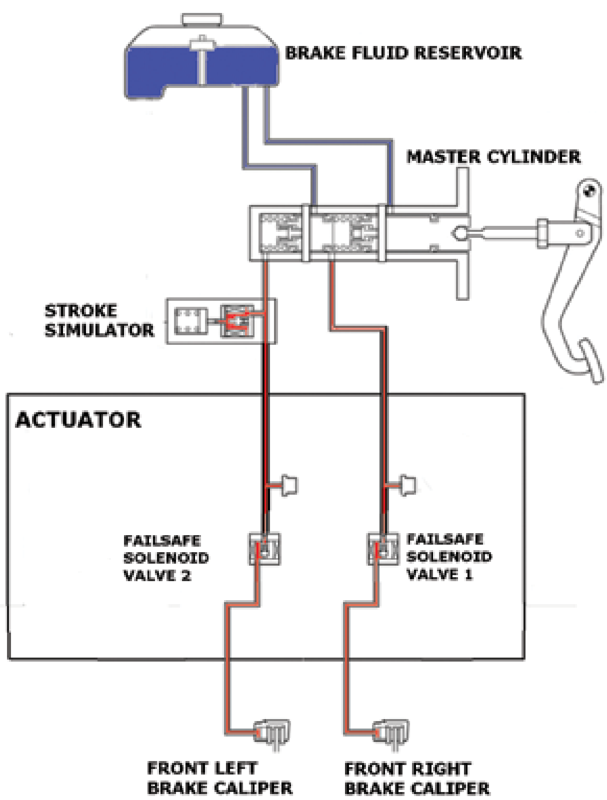
These Master Cylinder Pressure sensors are the primary input for driver braking request.

Because the master cylinder is pushing fluid into a "dead end," the brake pedal would have no give and feel weird to the driver, so a spring-loaded piston is used to simulate the flex of calipers and brake hoses. This gives the driver a "regular" feeling brake pedal.

An added benefit to using a real brake master cylinder is that in the event of a system failure, it can be used to apply the brakes, just like a regular car. Two normally-open solenoid valves connect the master cylinder output lines to the calipers. The solenoid valves only close when the system is operational. When closed, the master cylinder pushes fluid into the pressure sensors for the driver braking request input, but if something goes wrong or the vehicle is simply not powered up, the fluid goes to the calipers and the car brakes normally.

After thinking about the failsafe operation, you might be wondering if the stroke simulator makes the brake pedal feel mushy when the failsafe valves are open. After all, the driver would feel the flex of the lines and calipers on as well as the calibrated mushiness of the stroke simulator, right? The engineers thought of that too, and there is an additional solenoid that prevents the stroke simulator from functioning. If a problem develops, or the vehicle is not READY, the Stroke Simulator Control Solenoid prevents stroke simulator operation and helps maintain a firm pedal in failsafe mode.

In addition to the pressure sensors that monitor master cylinder output, a stroke sensor is also used on some systems. The stroke sensor is a redundant sensor with dual variable voltage outputs similar to a throttle and accelerator position sensors. The stroke sensor allows for fine tuning of brake response to driver input.



In the event of a system failure, the failsafe solenoids will close and direct brake fluid to the calipers to stop the vehicle.

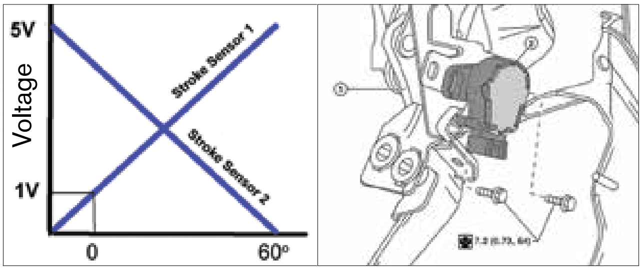
Making the Driver's Request Happen

The primary control for the brake system is the ABS ECU. Ultimately it decides what percentage of the requested braking will be performed by the disc brakes, and what percentage will be provided by the electric motor/generator. However, it must first check with the hybrid control unit to find out how much torque the hybrid system can provide, and it must check with the actuator to get the master cylinder pressure sensor readings.

There are three major players involved in converting the driver's braking request into a combination of regenerative braking and friction braking: the ABS control unit, the hybrid control unit, and the ABS actuator.

The primary control for the brake system is the ABS ECU. Ultimately, it decides what percentage of the requested braking will be performed by the front brakes, and what percentage will be provided by the electric motor/generator. However, it must first check with the hybrid control unit to find out how much torque the hybrid system can provide, and it must check with the actuator to get master cylinder pressure sensor readings.

There are several limits to regenerative braking. First, the motor/generator has a maximum torque output as a motor. This same torque limitation applies when it is being used as a generator. The generator can only develop so much negative torque, and if the braking request



The stroke sensor found on some systems has a dual voltage output.

exceeds the maximum output of the motor/generator, the remainder will need to come from the conventional brakes. Another limitation is the battery. If the battery is fully charged, there is nowhere for any power generated to be used or stored, so regenerative braking cannot be used. Thus, the ABS ECU may issue a request or regenerative braking that cannot be met by the hybrid control unit so they are constantly negotiating back and forth.

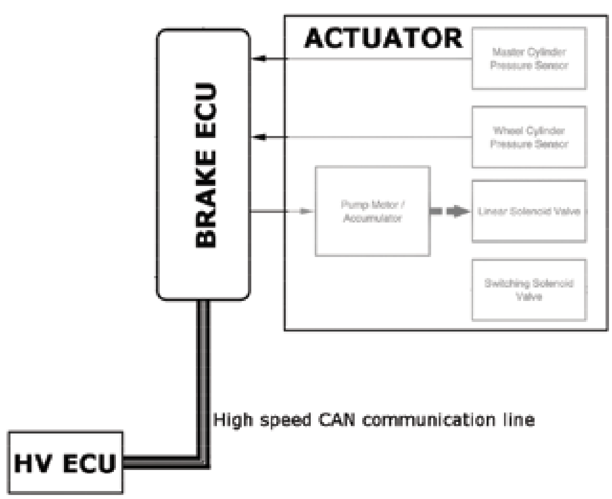
The ABS actuator is a densely packed unit with a lot of different components and functions, so we'll need to break this player into small sections to talk about it. First, let's talk about brake fluid pressure. On a traditional brake system, the line pressure to apply the caliper comes from the brake master cylinder. There is often a brake booster to make the pedal easier for the driver to press, but the pressure is coming from the master cylinder pistons. As you'll remember from the beginning of the article, the brake master cylinder output dead ends into a pressure sensor and does no work in this system; it is simply measured.

The pressure necessary to apply the brakes is generated by an ABS pump. This pump is driven by an electric motor that is powered by two relays. One relay supplies power to the pump through a resistor wired in series with the pump motor. This provides a low (quiet) speed. The other relay provides full power to the pump motor for a high (fast) speed. The pump can run slow and quiet, fast and louder, or shut off entirely. Having two speeds and two relays also provides redundancy. If one relay or circuit fails, the other can power the pump and maintain full brake function until the driver has a chance to have the warning light addressed.

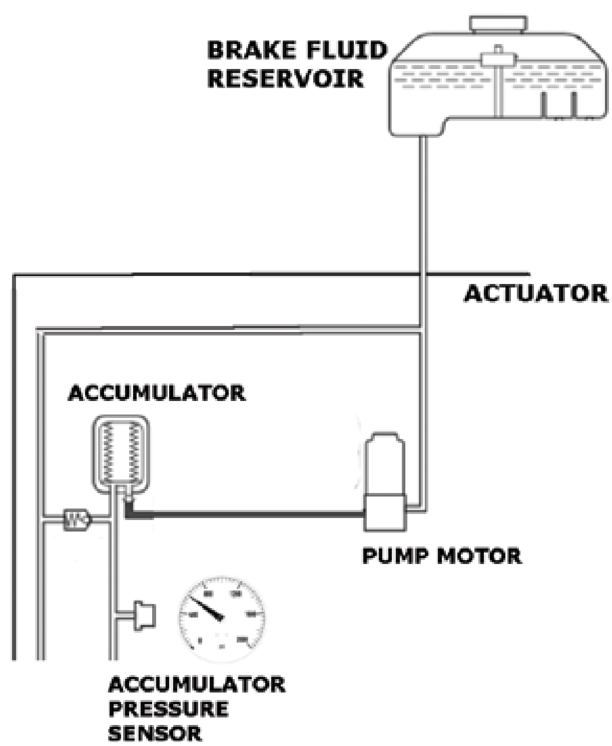
The ABS pump can generate pressure pretty quickly but pressure will dip as the brakes are used and rise as the pump runs. Since the ABS actuator needs to precisely modulate caliper pressure to match driver request, it's helpful to have a stable supply pressure. This is accomplished with an accumulator. This device is sort of like a capacitor for a hydraulic system. It stores pressurized fluid to even out dips and spikes in the pressure supply.

The accumulator is a fluid reservoir backed by a diaphragm and inert pressurized gas. The diaphragm presses against the fluid reservoir and maintains steady chamber volume and pressure as fluid is used and added to the reservoir. Thus, the accumulator prevents rapid pressure drop when the brakes are applied and buffers rapid pressure rise when the pump is running.

We now know how pressure is created and stored, but how does the ABS control unit know when to run the pump and when to shut it off? I suspect you just guessed that there is a pressure sensor in the accumulator, and you were correct. Take a look at the accumulator pressure PID with the CONSULT and furiously pump the



The ABS control unit, the hybrid control unit, and the ABS actuator work together to decide the proportions of regenerative braking and friction braking.



The accumulator stores pressurized fluid to even out dips and spikes in the pressure supply.

brake pedal. You may be surprised at how steady the pressure remains. This system works really well.

So now we know how a steady supply of pressure is created to apply the brakes, but how is the pressure modulated to precisely match the driver's braking request minus available regenerative braking? The four brake caliper pressures are controlled individually. This allows for all sorts of cool things to be done with ABS and VDC, but let's ignore those systems for now.

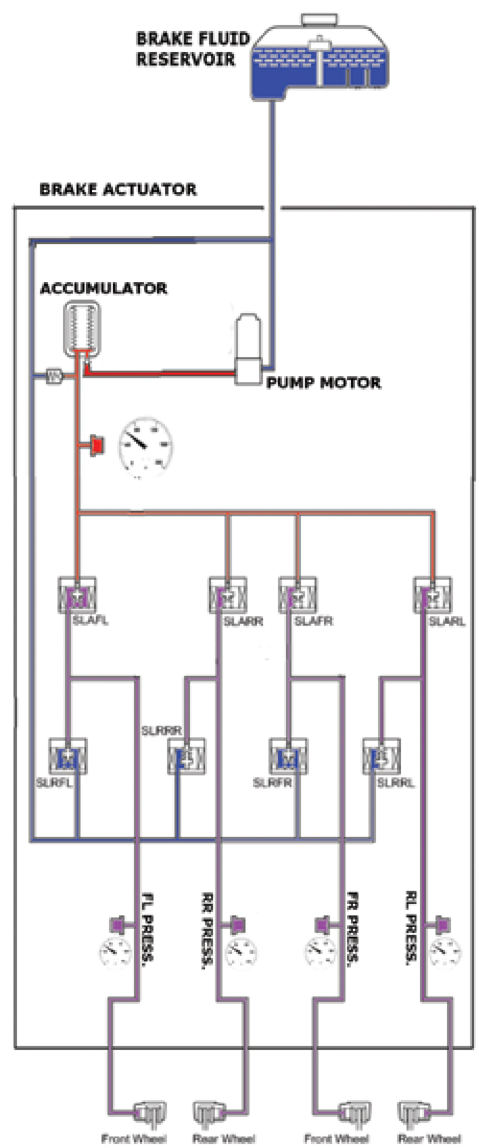
Pressure comes from the accumulator. Pressure can be released into the brake fluid reservoir. Each brake line is connected to two solenoid valves inside the actuator. One valve connects to the accumulator, the other to the reservoir. When the accumulator valve opens, the line pressure increases. When the reservoir valve opens the line pressure decreases.

There are eight solenoid valves (two for each wheel) called linear valves. Linear can mean, "of or related to lines", and these valves control the brake line pressure, so that definition sort of works and makes it easy to remember what they do. Or it can mean, "having an output that is directly proportional to the input" and that seems like a pretty good definition too as brake pedal input is proportional to the pressure of the linear valve output (if we forget about regen). However, the "real" definition here is the engineering definition of linear valve. A linear valve has a pintle shaped in a way that its flow rate is directly proportional to its lift. For example, if the valve is at 30% lift, the valve will flow 30% of its maximum flow rate. This type of valve makes fine and repeatable control of line pressure possible.

Now that we know how line pressure is manipulated, can we trust that linear valves are so precise right out of the box, that no calibration is needed? Nope. Just like O2 sensors were added to engine control to verify fuel maps were correct, the linear valves need a feedback loop and "long term fuel trim", as it were, in order to ensure accurate pressure modulation. The pressure for each caliper is monitored with a pressure sensor inside the ABS actuator. The caliper pressure sensors are used calibrate the linear valves and the calibration information is stored in the ABS control unit. So if the actuator or the control unit is replaced, the calibration must be repeated. The calibration can also be "undone" with a CONSULT. This will cause a warning light and braking feel that is noticeably out of proportion with the brake pedal pressure.

Putting it all Together

Let's review what we've learned and follow the action from the sole of the driver's shoe to the tread of the tire. When the driver presses the brake pedal, the amount of pressure and pedal acceleration are measured by the ABS ECU to determine the braking request. The ABS ECU and the HV ECU negotiate so that the maximum amount of braking request can come from the motor/generator as regenerative braking. The ABS ECU provides the remainder of the braking by applying fluid pressure stored in the accumulator to the wheels by precisely metering the pressure to each wheel with linear valves and wheel cylinder pressure sensors working together in a feedback loop. The blending of regenerative braking and conventional braking is so seamless that it's usually impossible for the driver to tell that there is any difference from a conventional car that wastes energy every time the brake pedal is pressed.



The pressure control system.

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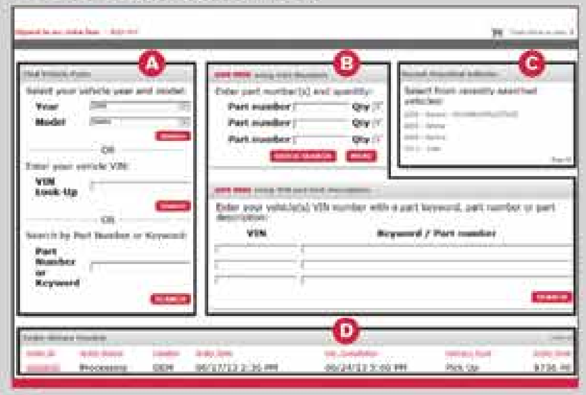

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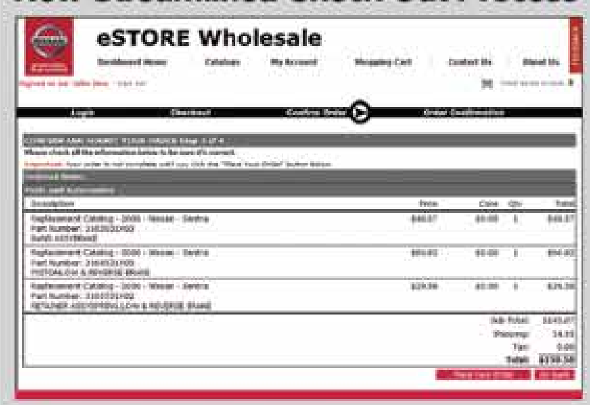

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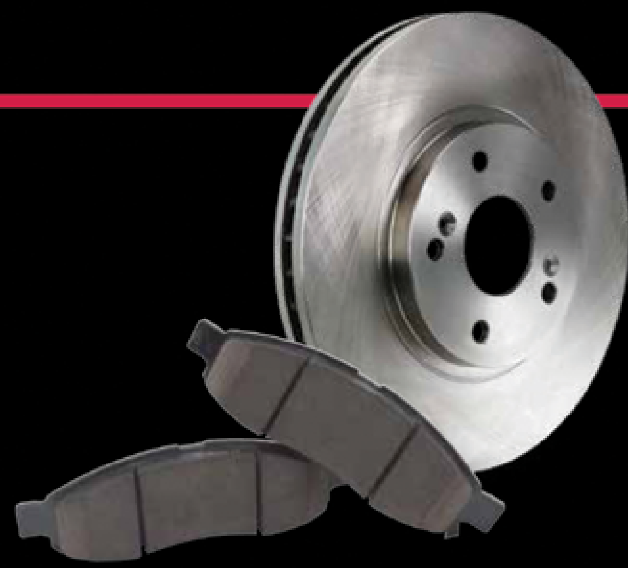

For newer vehicles and for customers who insist on using parts engineered for their exact vehicle, it's always recommended to use the original equipment (OE) part. OE parts from Nissan meet all Federal Motor Vehicle Safety Standards (FMVSS) to deliver optimal performance for each specific application. But for customers with older vehicles, or for customers who are very price conscious, an OE part may prove too costly. Fortunately, there is a high-quality solution.

Nissan's new high-quality line of brake parts can help retain this customer base and keep them from migrating to independent repair shops. Nissan Value Advantage brake parts can help increase retention, win customers back from the independent repair shops and increase profits at the dealership.

Tight Lateral Runout

Rotor runout should be checked on the vehicle and not the brake lathe, as the rotor may run true on the lathe, but not the vehicle. A runout of .005" can result in pedal pulsation or brake noise, and many competitive Aftermarket rotors exceed .005". Nissan Value Advantage brake rotors are ready to install out of the box with no turning required because they have a lateral runout of .004" or less. Excessive runout can cause friction material transfer after 5,000–7,000 miles, which can adversely affect pulsation.

Proper Balance

Excessive vibration in rotating rotors can cause unacceptable levels of noise and reduce the life of the rotor. 100% validation ensures proper balance and minimizes vibration. Nissan Value Advantage brake rotors meet OE requirements and are mill balanced to 2 inch-ounces. Many competitive Aftermarket rotors can exceed 5 inch-ounces.

Minimal Thickness Variation

Brake pads must contact the rotor flatly during braking to avoid pedal pulsation. As little as 0.0005 inches of thickness variation can result in pedal pulsation and noise. Nissan Value Advantage brake rotors have a thickness variation of 0.0004 inches or less… helping the rotor turn as true as possible inside the caliper, resulting in fewer pulsation issues.

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