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TechNews

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Real World Air Conditioning Service and Diagnosis

Voltage Drop Testing

Getting Cooling System Diagnosis Right the First Time

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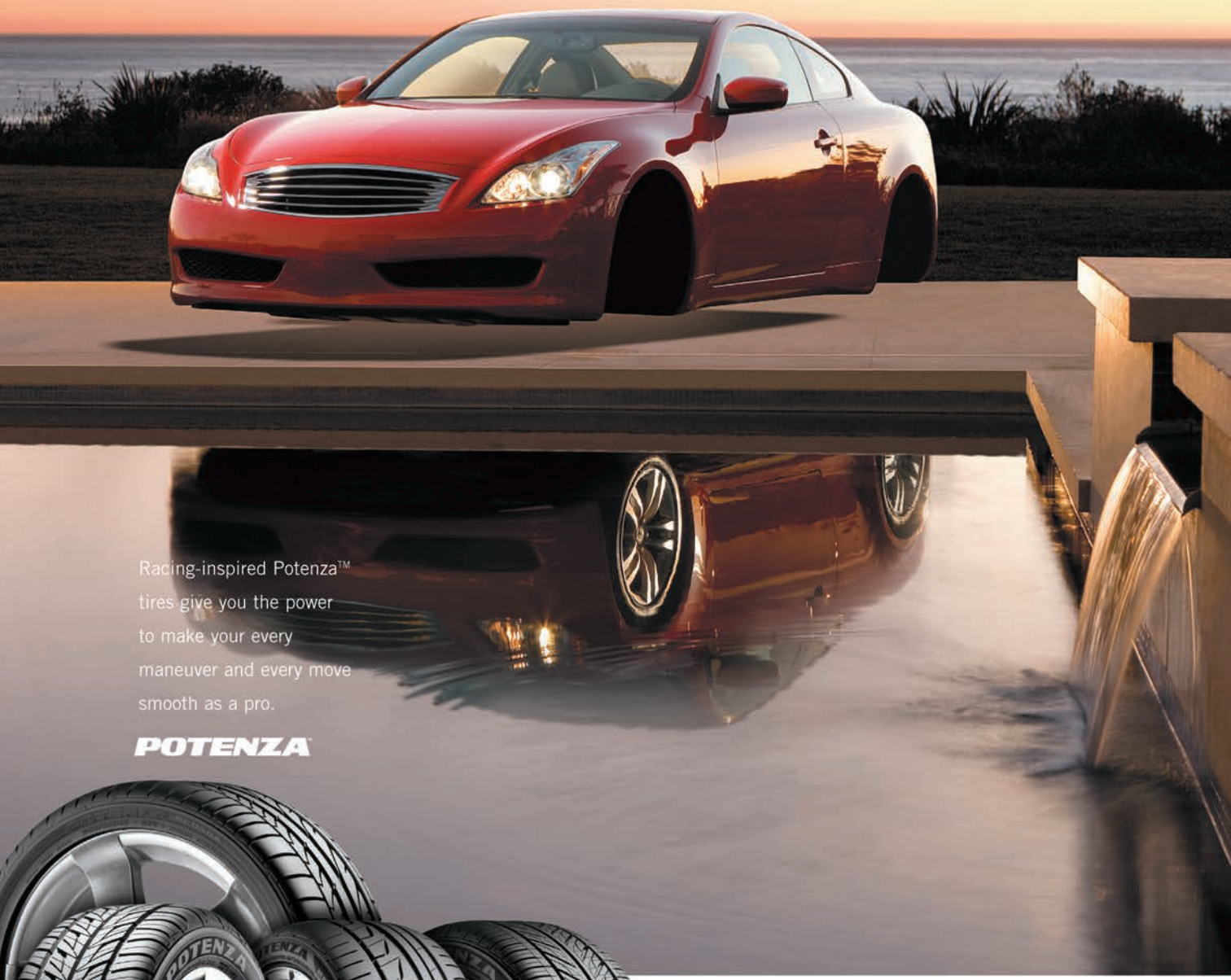

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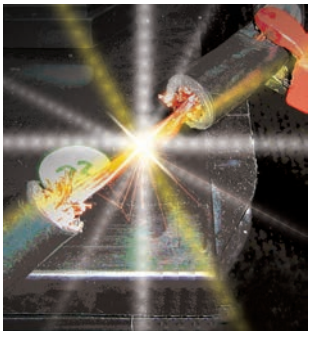

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Real World Air Conditioning Service and Diagnosis

Common sense troubleshooting by the numbers

All too often, air conditioning articles toss around words like "superheat," "subcooling," "non-condensables," and "latent heat," as if everyone knows what they are. These words may be fine, but we don't use them every day, and most likely we don't really understand what they mean if they stand by themselves without context. But understanding them and their application to air conditioning work will enable us to do a better job of diagnosing faults correctly, and of doing appropriate and quality A/C service work.

Re-evaluating Your Tools

A set of pressure gauges and their readings have been solid tools for air conditioning diagnosis since the day A/C was introduced. They're still important tools, but today's vehicle designs and service port locations can limit their usefulness.

In this article we hope to introduce an important addition to your arsenal of diagnostic tools: the "contact pyrometer" – or, more simply, a temperature probe that you put in contact with air conditioning lines.

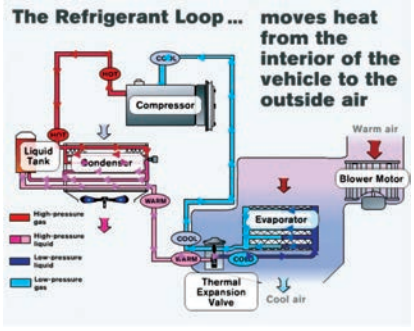
Although a contact pyrometer isn't a Nissan/Infiniti "required tool," it's inexpensive and easy to use in conjunction with your existing equipment, such as a DMM.

If you have the budget for it, there are stand-alone pyrometers that provide up to four channels of temperature readings simultaneously.

Diagnosis Still Starts with the Basics

Some air conditioning repairs can be gravy work, but the tough diagnostic jobs can become real headaches unless we understand some basic operational principles.

Add a temp probe to your DMM, Or spring for a special tool



This is an image of the refrigerant loop from Nissan training material. Let's use it to see why we can do a better job of diagnosing a problem with a temperature probe.

Nissan training has helpfully labeled our locations as Hot, Warm, Cold, and Cool, but we can do better than that by first applying some numbers to them, then providing guidelines as to what the numbers mean. As we go along, we'll define some of the words mentioned at the beginning of the article to show how they can help us in A/C diagnosis.

The Condenser is the Subcool Place

We'll start with the job of the condenser, the place where "subcooling" takes place. Subcooling is the "latent heat" that the condenser continues to shed even after the refrigerant condenses into a liquid. The marvel of refrigerant is this ability to absorb and release latent heat until it changes state – that is, when it changes from a gas to a liquid and from a liquid to a gas.

Subcooling is directly related to "superheating," which is the latent heat that the evaporator continues to absorb even after the refrigerant turns into a gas. In other words,

the ability of the evaporator to cool the passenger compartment is directly related to the amount of subcooling that takes place in the condenser.

When everything is working properly in a fully charged system, all the refrigerant charge flowing into the condenser will change to liquid shortly after entering. When this occurs, proper "subcooling" has taken place; we'll have nothing but liquid refrigerant hitting the expansion valve for maximum cooling effect.

If the refrigerant charge is low, there will be voids in the liquid line (bubbles), and cooling effectiveness will be reduced. Additionally, lubricating PAG oil won't circulate properly if there's not a full charge. A/C compressors with a low charge will run considerably hotter and noisier as a result.

How "Cold" is Subcool?

So, what if we measure the temperature on both sides of the condenser?

Although it would be useful to measure the pressure, when was the last time you saw a high-side fitting on both the compressor and the liquid line? I think you'll agree, the answer is "NEVER."

Fortunately, pressures and temperatures are closely related in an air conditioning system. Since we can't measure the pressure or the flow in an A/C system, we're going to use our contact pyrometer to get an idea of what's happening.

There's not much in the way of published specs on what the temperature changes in an automotive A/C system should be, but here are some numbers that have worked for us. Like anything else, if you start checking temperatures on various vehicles on your own, you'll rapidly get the feel for what's typical, and for what happens when things aren't right.

Air Conditioning Check Sheet (to be completed with every AC job)

Vehicle year, make, and model								
	Bad	OK	% Air					
A/C comtamination check				Note: More than 1% air should be evacuated				
Conditions: Engine at idle, AC blower on high blow, doors open, AC set to recirculate, climate control set to max cold								
	High	Low	Duct	Amb.	Cond In	Cond out	Evap in	Evap out
Before Repair Readings (Clutch Engages)								
Functional testing results	OK	Not OK	N/A					OZ
Condenser/Radiator Fan				R12/R134 recovered				
Fan Clutch								
Blower (All Speeds)								
Air Distribution (All Directions)								
Debris in Condenser								
Leaks (Electronic)								
Leaks (Dye Check)								
High Side Cap								
Low Side Cap								
Visual Inspections (Belt, Hoses)								
Belt Tensioner								
Compressor/Clutch (noisy, etc)								
	High	Low	Duct	Amb.	Cond In	Cond out	Evap in	Evap out
After Repair Readings (Clutch Engages)								

Note: If duct temp is more than 5 degrees warmer than Evap out line, suspect a problem in the climate control, blend door, or heater control valve.
Advise office more diagnosis is needed.

Using this A/C evaluation check sheet will assure that you don't miss anything.

Testing Do's and Don'ts

A comprehensive check chart will go a long way in maintaining the consistency of your cooling system work.

Such a chart really helps to pull all the numbers together in one place, which allows the technician to make an intelligent diagnosis. It also helps reduce the number of problems caused by poor customer communications, such as a complaint of "poor cooling" when the real problem is the fan blowing only on Low, or the duct air getting routed only out of the defroster outlets. We've included an example of such a chart.

If you observe these rules:

- **DO** have the engine at idle
- **DO** have the A/C set to High Blower and Recirculate
- **DO** have all the vehicle doors open
- **DON'T** put a fan in front of the condenser
- **DON'T** crank the engine rpm up with a throttle stick

You can use these observations:

(Note: These temperatures are for illustration only. Always check the approved Nissan/Infiniti service manual specifications from the technical website as there can be great differences depending on temperature and humidity).

- Condenser inlet to condenser outlet difference: 20 to 50 degrees F.
- Evaporator inlet to evaporator outlet difference:
  - Expansion valve system (most Nissan vehicles): 4 to 14 degrees F. increase (the "superheat" reading, actually).
  - Fixed orifice tube (used on some Nissan Quests): -5 to +5 degrees F., with zero degrees being optimum.
- Ambient temperature to duct temperature difference: 30 degrees F. of drop, minimum.

- Temperature drop across any other component in the system: 2 degrees F., maximum. Anything more indicates a restriction.

Notice that when everything is right, the drop between ambient temperature and duct temperature should be very close to the same as the drop across the condenser. That is because the refrigerant is being used to "pump" the heat from inside the car and deposit it in front of the radiator so it can be dissipated to the atmosphere.

Problems, Problems!

So, what goes wrong? Naturally the most common problem is an undercharge condition. This usually results in a duct temperature that is less than 30 degrees F. cooler than ambient, and a customer with a complaint.

If you measure the temperature drop across the condenser in this case, you might be surprised to find that it's greater than 50 degrees F. If you're a flat-rater, and you can't detect a leak in the system, you might be tempted to shoot eight ounces of refrigerant into the system to see what happens.

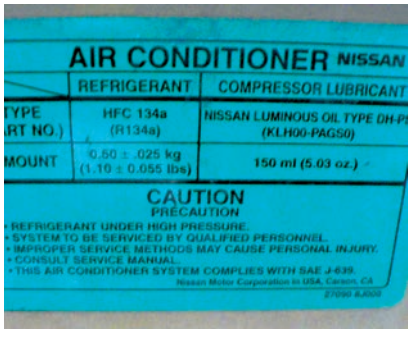
So what's the trouble with that? Maybe nothing, but you'll be much better off checking the refrigerant purity, and seeing how much air is in the system. Anything more than 1% air is too much; 0% is preferred

Air is a "non-condensable." That is, no matter how much you compress and cool it, it's not going to turn into a liquid, and it's not going to aid in cooling.

The optimum way to get the best outlet temperature is to evacuate the old refrigerant, pull a vacuum of 29 in. Hg for ONE HOUR with the system warm (that is, an underhood temperature of about 90 degrees F.), then recharge to the precise specification for the vehicle.

Start the diagnosis by testing the refrigerant

Look for the refrigerant label under the hood, or refer to the ESM (Electronic Service Manual) available on the Nissan Service Information website (http://www.nissan-techinfo.com), or the Infiniti Service Information website (http://www.infiniti-techinfo.com), as the case may be.



Use the specs on the underhood A/C label, or the Service Information website.

A common question technicians ask is, "If one hour is the correct time for a vacuum, why does the machine default to ten minutes of vacuum?" Although it's a fair question, we don't necessarily have a great answer for it. Perhaps the manufacturers think that 10 minutes is better than nothing. But consider what pulling a deep vacuum does: ideally, it removes all of the air, and boils the water out of system by dropping its boiling point. That takes time. Having the underhood temperature warmer will accelerate the process.

Moisture in the system creates all sorts of problems. It reacts with the PAG oil to create acid that eats stuff up. It can freeze in the expansion valve and cause hard-to-diagnose intermittent cooling issues by restricting the refrigerant flow. So, set up the machine to deep vacuum for an hour, and go work on something else until it's done.

Case Study #1 - 2004 Altima

This article can't cover every possible scenario, but we'll start by looking at a 2004 Nissan Altima with a customer complaint of, "A/C not working very well."

Here are the Altima's readings:

- High side: 125 psi
- Low side: 18 psi
- Ambient temperature: 93 F.
- Duct temperature: 70 F.
- Condenser inlet temperature: 160 F.
- Condenser outlet temperature: 104 F.

- Evaporator inlet temperature: N/A (not accessible)
- Evaporator outlet temperature: 86 F.

We have a drop in air temperature of only 23 degrees; the condenser drop reading, at 54 degrees, is too high; and the evaporator outlet, at 86 degrees, is way too high.

Testing the refrigerant shows no contamination, and 0% air. If we were going to "flat-rate" one by shooting in 8 oz. of refrigerant, this would be a good one to do it on, but let's not.

The whole system only holds 18 oz., so it's important that we fill it accurately. You should suck it all the way down, extracting 10 ounces of R134a, and pull a one hour vacuum.

Let's look at our new numbers:

- High side: 190 psi
- Low side: 30 psi
- Ambient temperature: 95 F.
- Duct temperature: 50 F.
- Condenser inlet temperature: 153 F.
- Condenser outlet temperature: 113 F.
- Evaporator outlet temperature: 55 F.

See anything interesting here? The change between ambient temperature and duct temperature is now 45 degrees. The change across the condenser is now 40 degrees. This gives us a high degree of confidence that everything is working nearly perfectly. All the heat collected inside the car is being dumped outside and dissipated by the cooling fan.

Now, let's switch the fan to Low blower and watch what happens to the numbers:

- High side: 180 psi
- Low side: 24 psi
- Ambient temperature: 95 F.
- Duct temperature: 45 F.
- Condenser inlet temperature: 145F.
- Condenser outlet temperature: 121 F.
- Evaporator outlet temperature: 44 F.

As you can see, switching the fan from High to Low blower changes the numbers – particularly the temperature drops – quite a lot. This is because we are not extracting the maximum "cold" out of the available "cold" (latent heat) in the evaporator.

Some people like to check final readings on Low blower because it makes for lower numbers. That's fine, but it doesn't work for the purposes of using the diagnostic numbers. Likewise, it's not fair to blow a hurricane at the condenser with a high speed fan, or drip water over the condenser with a hose, or crank up the engine speed. None of these will help diagnose a problem realistically.

Naturally, we should check this system for a leak. But unless you're better than we are, you'll have a hard time finding the source of a leak that resulted in the loss of just 2 oz. per year of refrigerant in four years – but more on that later.

Case Study #2 - 1995 Sentra

Now let's consider another one, a 1995 Sentra with 240,000 miles on the odometer. We've already tried sucking it down and refilling with the exactly proper charge.

Here are the Sentra's readings afterwards:

- High side: 200 psi
- Low side: 38 psi
- Ambient temperature: 103 F.
- Duct temperature: 75 F.
- Condenser inlet temperature: 137 F.
- Condenser outlet temperature: 121 F.

We have an ambient temp of 103 degrees and the duct is doing only 75 under our idle conditions. We drive it down the road and manage only 69 degrees. This customer is not going to be very happy.

So, what's wrong? Our pressures don't look too bad, with 38 psi on the low side and 200 psi on the high side. We check temperatures and we have only 137 degrees going into the condenser and 121 coming out.

We can safely say that this Sentra's compressor is just not up to doing the job. At that kind of an ambient temperature, we should have a condenser inlet temperature way above 150 degrees F. It's not at that temperature because the compressor can't make the pressure or the heat.

With the fitting being located on the liquid line, the high side pressure can't give us a conclusive diagnosis. Sorry, there are no after-repair readings. Not many owners of 240,000-miler Sentras are buying compressor jobs.

Case Study #3 - Air in the System

We didn't come across a Nissan or Infiniti with air in the system before press time, so the following numbers are from a 1998 model of a different make. However, since it's an expansion valve system like most all Nissans and Infinitis, the principals are the same.

The customer complained that sometimes the cooling was "inadequate." Our guess is that the air also had moisture in it, which would freeze in the expansion valve and restrict flow, since the temperature drop in our test is pretty good in spite of the non-condensables.

Testing the VW's refrigerant showed no contamination, but it did show 11% air.

Here are the "before" readings:

- High side: 240 psi
- Low side: 28 psi
- Ambient temperature: 94 F.
- Duct temperature: 56 F.
- Condenser inlet temperature: 199 F.
- Condenser outlet temperature: 105 F.
- Evaporator outlet temperature: 45 F.

Notice that the numbers are just about fine for customer comfort, but terrible for the compressor longevity. That high temperature of the condenser inlet is directly related to the compressor case temperature and the oil performance.

Here are the readings after pulling a one-hour deep vacuum, then properly recharging it:

- High side: 240 psi
- Low side: 42 psi
- Ambient temperature: 100 F.
- Duct temperature: 52 F.
- Condenser inlet temperature: 151 F.
- Condenser outlet temperature: 123 F.
- Evaporator outlet temperature: 54 F.

Notice that the ambient temperature has changed, so the other numbers are affected too, but the most obvious difference is in the condenser inlet and outlet temperatures, which have changed radically for the better.

Oil Crises

Do you measure the oil you pull out of the system when you vacuum it? You'd better. The example 2004 Altima holds only 5 ounces, so you don't want to short change it. Always use new PAG oil appropriate to the application and let the vehicle pull it in with a vacuum.

Changing the pump's oil maintains its ability to pull the deep vacuum needed.

Nissan bulletin NTB95-068 and Infiniti bulletin ITB96-007 list the PAG types and amounts, as well as the R134a charge quantities, for '90s-era models (available for download on the Nissan/Infiniti Tech News web site, www.infiniti-techinfo.com). Specs for newer models can also be found on the Nissan and Infiniti Service Information web sites.

Speaking of a vacuum, do you change the oil in you're A/C machine vacuum pump on a regular basis? Notice the warning on our Robinaire machine telling us it's time to change the pump oil

The oil in the vacuum pump gets diluted and contaminated by the refrigerant oil pulled out of each system, eroding the pump's ability to pull the deep vacuum necessary to proper maintenance.

Most of the machines meeting the J-2788 standard are very easy to service. By the way, this SAE standard dictates very high accuracy, automatic air purging, and 95% recovery of used refrigerant, which has added a lot of confidence to AC servicing.

What about leak detection

Despite fancy and expensive leak detectors, it's hard to find leaks in an R134a system for a number of reasons.

The single greatest one is probably the fact that oil doesn't mix well with R134a – not at all like it did with R12 – so that when there's a leak, there's often no sign of the telltale oil stain typically shown by R12 systems.

Although most Nissan and Infiniti models since 2000 have shipped with refrigerant containing UV dye, even dye testing doesn't work as well with 134a systems as it did in R12 systems, since oil is the carrier for the dye.

The lesson is: do as careful a job as you can with your detector, and try to test the system under the worst possible conditions – preferably right after a hot shutdown.

Forget about leak testing with the engine running; the cooling fan will dissipate the traces of refrigerant too fast.

Note too that 134a is heavier than air, so always test for leaks along the bottoms of components. (Now, how does that stuff get all the way up in the stratosphere – air currents, maybe?)

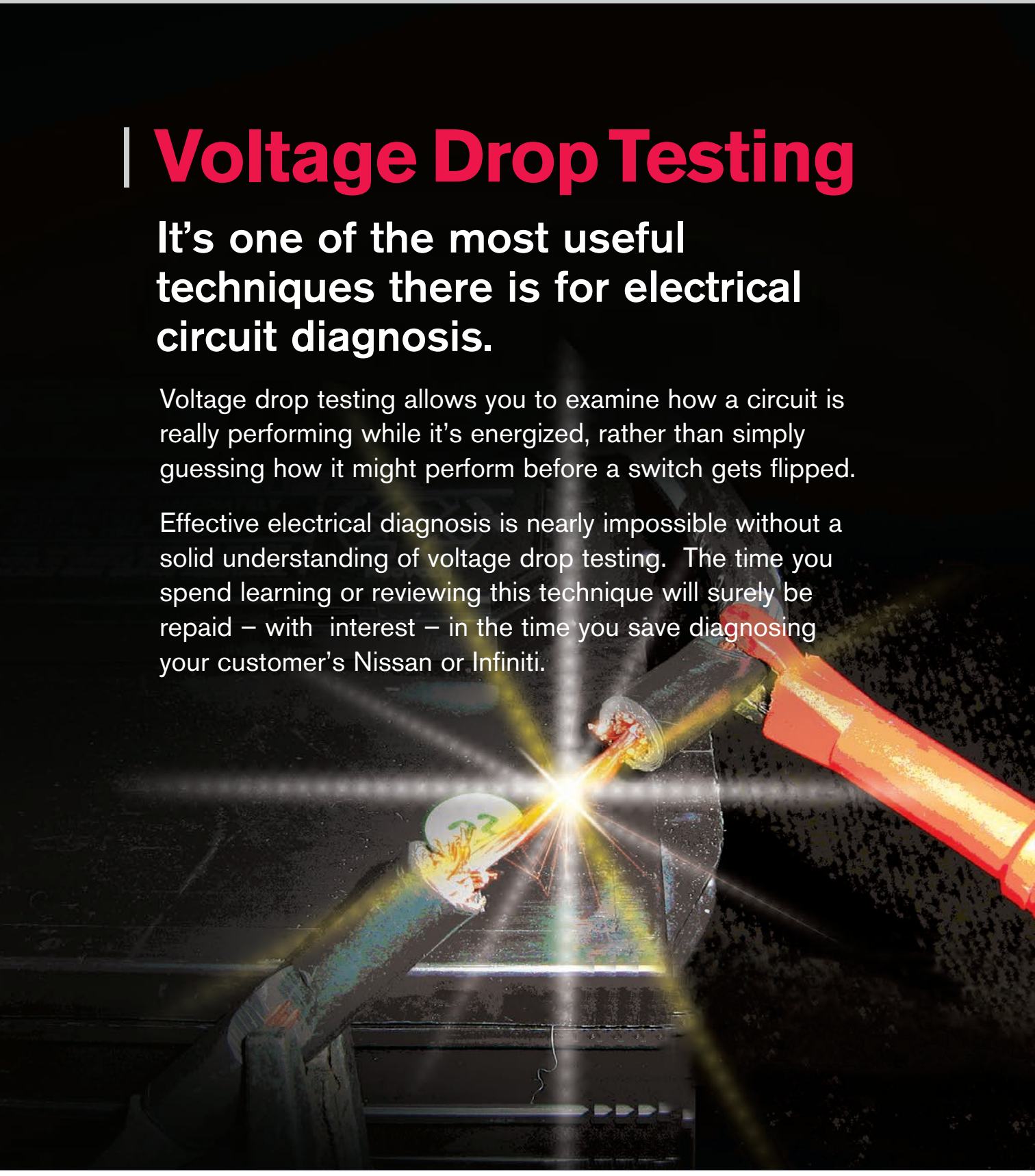
Keep cool!

Voltage Drop Testing

It's one of the most useful techniques there is for electrical circuit diagnosis.

Voltage drop testing allows you to examine how a circuit is really performing while it's energized, rather than simply guessing how it might perform before a switch gets flipped.

Effective electrical diagnosis is nearly impossible without a solid understanding of voltage drop testing. The time you spend learning or reviewing this technique will surely be repaid – with interest – in the time you save diagnosing your customer's Nissan or Infiniti.



What it is

A voltage drop is the difference in voltage measured between two test points in an energized electrical circuit. Or, you could think of it as the amount of voltage "used" by a segment of a circuit.

As with all voltmeter testing, measurements are taken by placing the voltmeter probes in parallel with the section of the circuit you want to measure. The points of measurement can be both on the positive side of the circuit (before the load), both on the negative side of the circuit (after the load), or one on the positive side and one on the negative side (across the load).

Measuring voltage drop differs from measuring voltage potential because voltage drop measurements are taken while the circuit is energized. Current must be flowing in the circuit in order to do a voltage drop test – the switch, relay, driver, or whatever is controlling the circuit must be closed to do voltage drop testing – otherwise, you're just measuring voltage potential.

Why do it?

You perform voltage drop testing to determine whether the circuit loads are receiving enough voltage to operate properly. If they're not, you can "divide and conquer" to determine how much voltage each section of the circuit is consuming in order to determine why the loads aren't receiving adequate voltage.

In an ideal circuit, all of the voltage is used by loads, and little or no voltage is used by the parts of the circuit that aren't loads. So, what is – and what isn't – a "load?"

- A load is any device that uses voltage to perform some type of useful work. In the context of an electrical circuit, this means that electrical energy is changed into some other type of energy.

  For example:
  - Electricity supplied to a motor is changed to torque and heat.
  - Electricity supplied to a solenoid is changed to linear force and heat.
  - Electricity supplied to a control unit is used for sensor and actuator logic, and ultimately changed into motion and heat.

Wiring, connectors, switches, relay contacts, and crimp joints are not loads. Even so, they do consume some voltage. These parts of the circuit don't do any productive work themselves – any voltage they use robs the loads of the voltage they need to work properly – so it's best if they use as little voltage as possible.

Energy never disappears; it just changes from one form to another. If a connector is using power, you may wonder, "Where is it going?" The answer is: the power is being converted to heat. This heat provides no benefit. On the contrary, the heat generated by an unwanted voltage drop can be destructive. For instance, a loose pin fit in a connector may result in the connector housing melting.

Voltage drop testing is an excellent way to determine how much of the supply voltage the electrical loads are using, and how much voltage is being used on the way to and from the loads.

When a good circuit goes bad

Voltage drop is created by resistance to current flow. The "garden hose" analogy helps to explain this.

Imagine a garden hose with a lawn sprinkler attached to the end (the sprinkler is the load in this example). Water is flowing through the hose and out of the sprinkler.

If you pinch the garden hose with a pair of needle nose pliers to block some of the flow, what happens? The pressure on the faucet side of the pliers will be very high.

You could test this by trying to squeeze the hose. The high pressure will make it difficult or impossible to collapse the hose with your fingers. Since voltage is electrical pressure, you can expect to measure a high voltage on the positive side of a resistance.

The pressure on the sprinkler side of the pliers will be low. If you squeeze the hose with your fingers, the low pressure will make it easier to squeeze. Once again, since voltage is electrical pressure, you can expect to see lower voltage on the negative side of a resistance.

Voltage drop is measurement of the difference in voltage between one point in a circuit and another point in a circuit.

Marshall your forces

There are two necessities for voltage drop testing – a wiring diagram and a voltmeter. Grab the diagram first.

Understanding how the circuit you're testing should function is the first step. Sometimes proper circuit function will be obvious when you look at the diagram. Other times, you'll need to read the circuit description in addition to looking at the diagram.

Regardless, know what you expect to see at any given test point before reaching for the meter. It may occasionally seem like you are spending too much time researching the circuit, but taking the time to understand and plan your attack before you start "working" will result in a faster diagnosis overall.

If there's no system description available for the circuit you're testing, but there is a diagnostic flow chart, look at the wiring diagram, then completely read the flow chart, taking the time to consider the reasoning behind the tests it shows. This will reduce the likelihood of misunderstanding any of the tests or their desired outcomes, and will give you the opportunity to verify a failure by using more than one test – always a good idea.

You'll find everything you need to understand your circuit on the Nissan Service Information web site (http://www.nissan-techinfo.com), or the Infiniti Service Information web site (http://www.infiniti-techinfo.com).

The circuit diagrams, system descriptions, connector views, harness layouts and locations of all kinds are easily accessible on these web sites. You can print what you need, or bring your laptop to the car with you for reference.

Major meter

The voltmeter is often the only piece of electrical test equipment you'll need to make an accurate electrical diagnosis. Although there are many differences that make some voltmeters easier to use than others, there's one requirement for any meter you plan to use: it must have adequate impedance.

Impedance is the meter's resistance to current flow. In voltage drop testing, the connection of the meter should have no effect on the circuit being tested.

A meter with low impedance may cause excessive current flow when it's connected. If it's used on a circuit with sensitive electronic components, they can be damaged. Most digital meters have adequate impedance (look for 10 megohm in the spec sheet). Analog meters rarely have adequate impedance.

A voltmeter is always connected in parallel with an electrical circuit. This means that current has a "choice" of flowing through the circuit or through the voltmeter. Since the resistance of the voltmeter is very high (10,000,000 ohms or more), very little current flows through the meter, leaving the circuit to operate in the same way it would operate without the voltmeter connected.

Keep the ohmmeter away from the fray

Many of you will know that electrical resistance is measured with an ohmmeter. So, if resistance to current flow is what causes voltage drops, why not test for resistance with an ohmmeter instead of using voltage drop testing?

The answer lies in the amount of current flow. An ohmmeter works by pushing a tiny amount of current through the component being tested – usually much less than a milliamp at a very low voltage.

This tiny trickle will easily flow through many restrictions that would resist flow when operated at their normal current level. The higher the level of current flow in a circuit, the less useful your ohmmeter becomes.

A circuit designed to draw a lot of current will have thick heavy gauge wires. Have you ever really considered why? When a large amount of current is pushed through a small gauge wire, the wire will act as a resistor; voltage will drop across the wire as a result. To make matters worse, current through a resistance will create heat, which will increase resistance, and cause an even greater voltage drop.

Take a look at Figure 1. This is a negative battery cable with some of the wire strands removed to reduce the gauge of the cable in a small section. The insulation has been stripped away on either side to allow an ohmmeter to be attached in parallel to the injury. Notice that the ohmmeter is reading near zero? This cable is OK so far as we can tell with the ohmmeter.

In Figure 2 we tested the voltage drop while the cable was powering a small 5W light bulb. The meter is reading 0 volts, which means there is no voltage drop across the section being measured. This is excellent, since the cable is not a load, and in an ideal circuit, we would only see

voltage drop across loads. The cable still looks like it's OK.

However, look what happens when we use a carbon pile to simulate the load of a starter motor. (Figure 3) The voltage drop starts to climb as soon as the load is increased. As you can see in the picture below, the wire gets red hot; the voltage drop increases radically once the circuit is loaded.

It's unlikely that you'll find a customer's car with a battery cable modified like this one, but it's common to see frayed battery cables (Figure Four) and ground straps, or loose or corroded battery terminals, which all amount to the same thing.

Cars with bad motor mounts or missing battery hold-downs often develop breaks in the cables where they've been flexing. Voltage drop testing is the only good method of testing battery and alternator cables because of the heavy current loads they carry.

Always go with the flow

Because voltage drop testing relies on current flow to work, testing an open circuit provides no useful results.

Let's go back to the garden hose example for a moment. If we cut the hose about a foot before the sprinkler, then plug it with a cork, water flow will be completely blocked. Since an open is infinite resistance to flow, this is the water hose equivalent of an open circuit.

Now, if we pinch the middle of the hose with needle nose pliers again, what will the pressure difference be on either side of the pliers?

If the faucet were open, the hose would be hard on either side of the

Figure 1
This battery cable has been altered to simulate internal damage

Figure 2
The cable carries enough current to light up a small bulb.

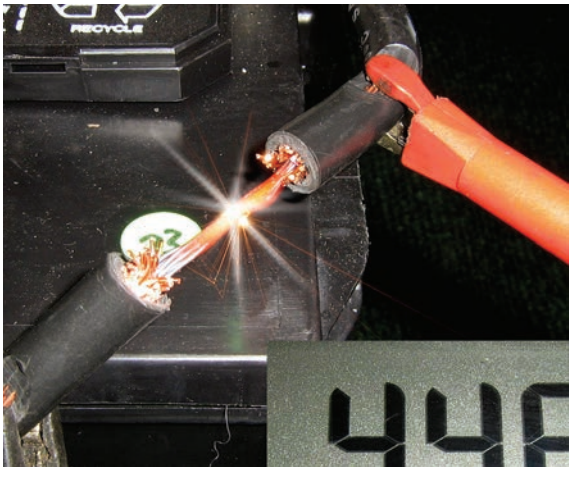


Figure 3
But it can't carry the current for a starter motor.

Figure 4
Frayed ground straps can cause voltage drops on the negative side of a circuit.

pliers -- there would be no pressure difference / no voltage drop. If the faucet were closed, the hose would be soft on both sides of the pliers -- there would still be no pressure difference / no voltage drop.

This is exactly what will happen on an electrical circuit. If a fan motor circuit is switched on the ground side, and the switch is open, performing a voltage drop test from the positive battery terminal to the positive terminal on the motor will show 0 volts.

No voltage drop, but does that mean there's no resistance on the positive side of the circuit? Not at all. As soon as we close the switch, current will flow through the resistance, and voltage will drop across the resistance. In other words, now that the circuit is completed (no opens), voltage drop test results will be useful.

This is not to say a voltmeter can't be used for diagnosis on an open circuit; it can. For instance, an open circuit could be found by following the circuit with a voltmeter until the voltage went from high to low. However, any areas of high resistance could not be found until the open circuit was repaired and current was flowing again.

Stay connected

Never unplug any component or connector prior to testing. This may be obvious to you, given that current must be flowing to do a voltage drop test, yet unplugging a component before checking for voltage is such a common mistake it bears mentioning.

If you unplug a fuel pump connector, and measure 12.7V on the harness connector, does that mean the fuel pump is getting adequate voltage when the circuit is energized?

Since any resistance in the circuit will not drop voltage until current is flowing, and current can't flow until the fuel pump is plugged back in to complete the circuit, the only thing you'll know from this test is that there's not an open circuit; so don't wait until after you've replaced the fuel pump to test the voltage drop across the pump with the pump plugged in and the circuit energized.

Divide and conquer

As we stated earlier, the first step in voltage drop testing should always be studying the circuit. Even if you've already memorized the wiring diagram, it still might be a good idea to give it another look.

Deciding where to test first depends on two considerations:

- Where the circuit can best be divided into two equal parts
- How accessible the desired test points are

Asking the following questions will usually lead you in the right direction:

- What load is not performing properly?
- Can I access it easily?
- If access is difficult, where is the closest test point that's easily accessible?

Where to start?

Testing voltage drop across the load is usually the best place to start. In Figure Five, the drop across the load is 8.6 volts.

Since the primary objective of voltage drop testing is to determine whether the load has adequate voltage to operate, this one test may be all you need to complete the diagnosis.

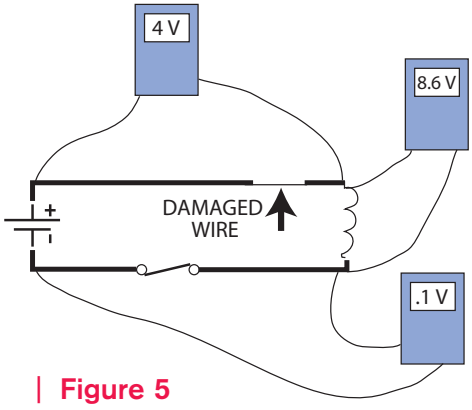


Figure 5
Voltage drop in this circuit is likely to prevent the load from functioning properly.

If the load has adequate voltage, and it doesn't operate, the component (load) is bad, and needs to be replaced. You're finished with the diagnosis, and can move on to other work.

If the voltage at the load is inadequate (as it is in this example), you'll need to find out why. The quickest way to do this is to check voltage drop from the positive battery terminal to the load, and then from the negative battery terminal to the load.

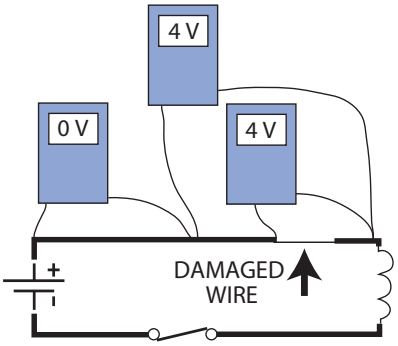


Figure 6
Narrow your search until the cause of the drop is pinpointed.

Divide and divide again

Once you've determined whether the drop is on the positive side or the negative side – or a combination of both – you can begin to narrow the location of the resistance further.

The voltage drop in this example (Figure 5) is on the positive side of the load. This is what you're likely to find most of the time. Since today's automobiles use a negative ground system, most of the potential trouble points – relays, connectors, switches, crimp joints, etc. – are all more common on the positive side.

That being said, never assume. The ground side of the circuit is every bit as capable of causing problems as the positive side, even though it may not seem as likely to do so.

Once you've determined whether the voltage drop is on the positive or negative side of the load, the best way to find its cause is to split the section you've tested in half, similar to what you did by dividing the circuit in the first place.

You could, as an alternative, isolate the voltage drop by leaving one lead connected to the positive terminal, then moving the other lead to each test point in sequence, but chances are it would take longer this way.

To divide the positive side, connect one lead to the positive terminal and the other lead to a test point roughly in the middle of the positive side of the circuit.

Which test point you should choose will also depend largely on accessibility. You won't save time by dividing the circuit evenly if you must remove the dash to do it.

If you have no voltage drop on the first half of the positive side, move on to the other half. Continue to divide sections in half until the source of the voltage drop is found.

Testing sequence in starter and alternator circuits

The starter and the alternator will both cause the available battery voltage to change substantially – the starter due to its heavy current input, and the alternator due to its heavy current output.

For these reasons, the sequence for voltage drop testing on a starter or alternator circuit differs from testing other circuit loads. It's best to start testing them by checking the voltage drop on the positive side and then the negative side.

If you were to start by testing across the load, as in our previous example, you'd need two voltmeters, one across the battery and one across the load. Starting your tests by dividing the circuit is just as quick, requires less equipment, and provides additional information.

Acceptable losses

Please remember the primary objective of voltage drop testing as you consider these specifications below:

- Wire with no connectors 0.001V or less
- Switch 0.3V or less
- Ground connection 0.1V or less
- Positive battery cable 0.5V or less
- Negative battery cable 0.1V or less
- Alternator B+ cable 0.5V or less

Your chief concern should always be whether the load has adequate voltage to operate properly.

If a wiper/washer switch has 0.6V drop, and the wiper/washer motor has a 13.0 volt drop, and doesn't spin, the motor's the problem, not the switch. Might the switch be considered bad? Maybe, but it's certainly not the cause of the wiper/washers not working.

By focusing on whether the load has adequate voltage rather than a militant application of "rules of thumb" you'll be able to provide your customer with superior advice.

Nissan & Infiniti Parts Department

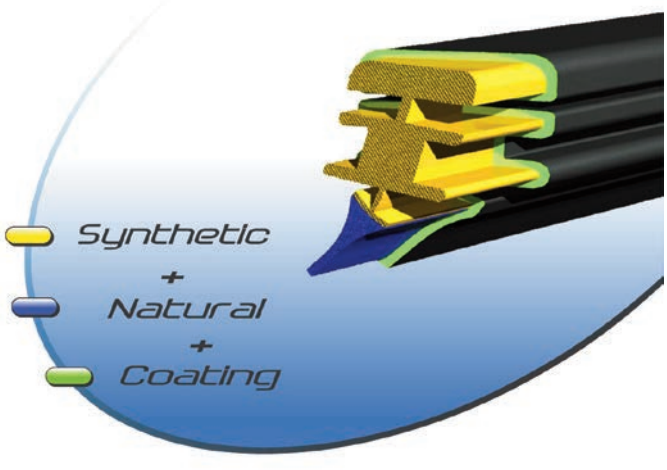
I Can See Clearly Now

In winter weather, the wiper blades on your customer's Nissan or Infiniti become an important safety feature. Deliver top service by inspecting the wipers for proper operation each time the vehicle is entrusted to you for service or repair. Testing the wiper/washer system takes just a few moments, but can pay big dividends in customer satisfaction, and help improve your shop's bottom line.

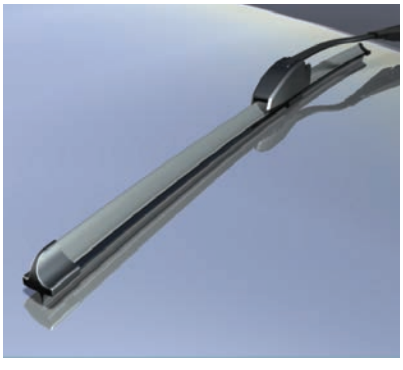
Whether it's Conventional Premium, or the newest FlatBlade style, your local Nissan/Infiniti Wholesale Mechanical Program Dealer can supply a Genuine Nissan/Infiniti service replacement wiper blade for almost any vehicle on the road.

The Conventional Premium wiper blade combines a synthetic rubber upper body with a natural rubber wiping edge to provide superior wiping performance in extreme hot and cold temperatures and best-in-class wipe quality. A specific protective coating on each blade reduces the likelihood of chatter and squeak, providing smoother, quieter operation throughout the life of the wiper blade. The result? It wipes like new longer.

FlatBlades, the latest word in wiper technology, combine the three-part synthetic /natural / coating construction of Conventional Premium blades with an aerodynamic low profile, a must for many of today's windshield designs.



FlatBlades contain an integrated internal "flexor" support structure, which provides more than 1,500 continuous contact points for improved performance when compared to the four to eight pressure points of conventional wiper blades. No external frame joints means no components to freeze or become clogged with ice or snow during foul-weather driving.



The **FlatBlade's** integrated spoiler helps keep the blade flat against the windshield (it's been tested at high speeds), and enables enhanced aero-acoustics, reducing wind noise.

FlatBlades are original equipment on many late model Nissan and Infiniti vehicles, but can easily be fit to many older model vehicles as a high-performance upgrade. Your local Nissan/Infiniti Wholesale Mechanical Program Dealer will be glad to assist you.

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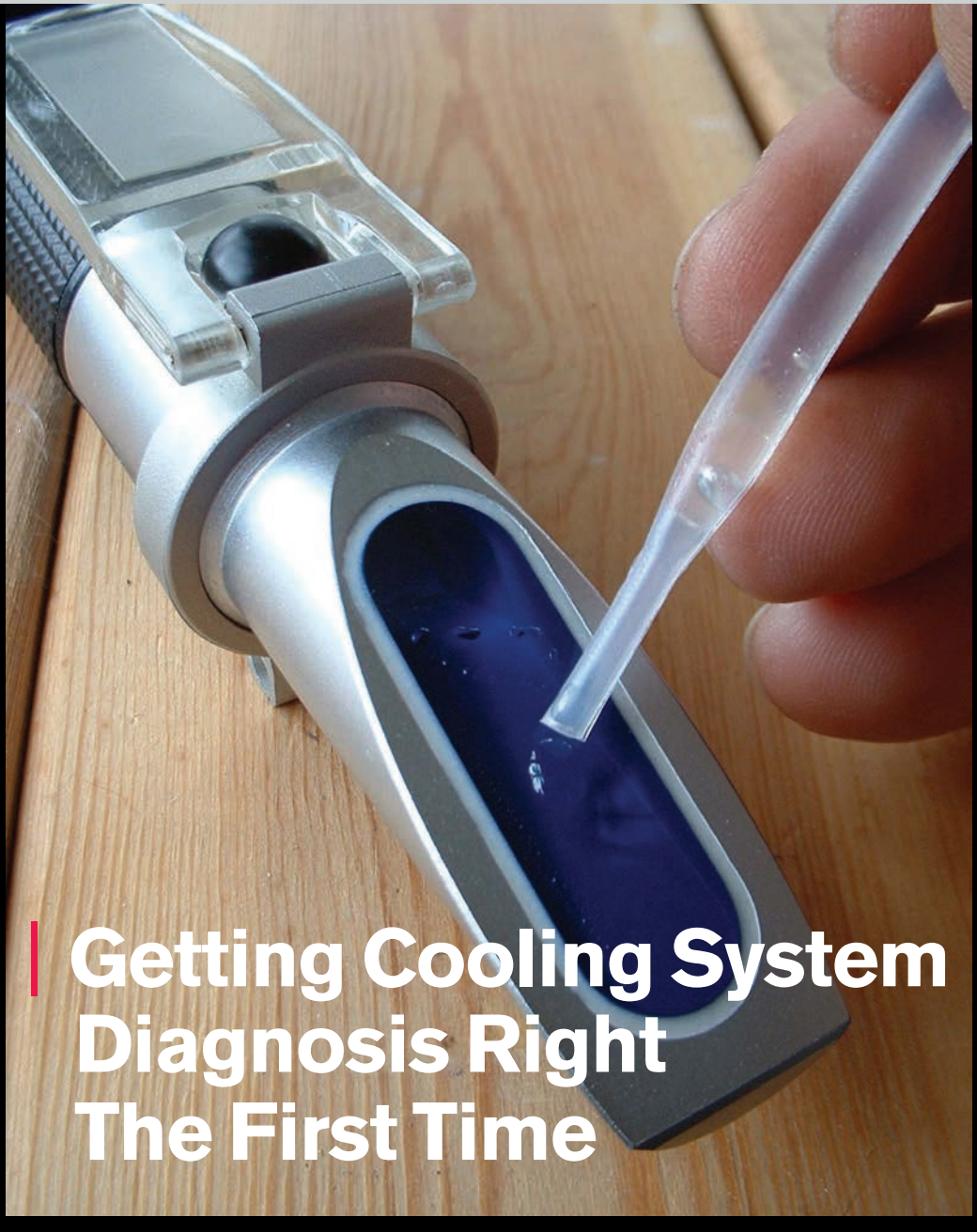

Getting Cooling System Diagnosis Right The First Time

From the customer interview, pressure testing and antifreeze to fans, thermostats and radiator capacity.

A cooling system is simple. Right? It's so simple the whole systemcan be summarized in only one sentence -- Heat from the engine is absorbed by coolant in the water jacket, then pumped through the thermostat to the radiator, where it's released when air flows across the fins from a cooling fan or the movement of the car.

Despite its seeming simplicity, getting cooling system diagnosis right the first time can be a challenge. Getting it wrong is not only frustrating for everyone involved, it can lead to additional damage and cost. This article will provide you with tips to help ensure your customers need only come in once to have their cooling system problems fixed.

Talking To The Customer

Good cooling system diagnosis starts with a good interview when the car is dropped off. Spending a few moments talking to your customer before you begin can save a lot of time once the meter is running. If the customer reports the car only overheats on the freeway, you know to look for a flow problem such as a restricted radiator, a thermostat that does not fully open, blocked radiator fins, or -- in rare cases -- an eroded water pump impeller. If the customer reports the car overheats when driving around town, but cools at higher speeds, you'll know to check the fan operation.

It's also a good idea to ask customers how they know the car engine is overheating. Is the gauge reading high? Is there steam coming from under the hood? Are there puddles of coolant on the ground? By asking these questions, you avoid spending time "diagnosing" a dripping A/C evaporator, or investigating a car that "felt hot" when your customer was adding oil to the engine.

It's also important to find out whether the customer has added any coolant. If the car overheated due to low coolant caused by a slow leak or lack of maintenance, but the customer filled the system before bringing the car in, knowing this tidbit may be very helpful in your diagnosis.

The interview also gives you an opportunity to gauge your customer's knowledge about the cooling system and provide a better understanding if necessary. For instance, if your customer says, "It was overheating for about five minutes before I heard the knocking noise," you'd explain that pulling over and stopping as soon as it's safe to do so is the best course of action when the car starts to overheat.

Start with some quick basic checks

Take a few moments to look for signs of engine damage before you start your cooling system diagnosis. Checking for melted plastic parts, such as a timing cover or the radiator filler neck, is a quick way to gauge how hot the engine was. Most plastics melt at over 400 deg. F. If the engine was over 400 degrees, damage is more likely than if the engine was "only" at 270 degrees. Testing the head gasket is also a good idea, but more on that later.

Informing your customer that there is a high likelihood of damage, and recommending appropriate additional testing before he or she spends money fixing the cooling system, will help to adjust your customer's expectations to match reality. If everyone is on the same page, it's far more likely that your customer will be satisfied, even if the needed repair turns out to be a large one.

You should also make a habit of checking the oil before you begin testing. This may seem unrelated to the job at hand, but it's not. When an engine is overheating, it will consume far more oil than an engine running at normal operating temperature, so it's possible the oil level is dangerously low. Failing to adjust the oil level before testing could lead to disaster during testing.

This quick check also gives you an opportunity to look for coolant contamination or overheated oil. If the oil has been "cooked" it will have a characteristic burnt odor and should be changed. If the motor oil has a coffee and cream color, or looks like a strawberry milkshake, there is likely a problem with the engine sealing or the transmission cooler.

Before you start the car, refer to the appropriate Nissan/Infiniti ESN for instructions on filling the cooling system. Basically, the procedure includes filling the radiator and overflow bottle, and bleeding the system to ensure there is no trapped air. Most Nissans have one or more bleeders that make removing trapped air easier. On models without bleeders, use the J-45695 Cooling System Refill Tool or equivalent to draw a vacuum on the cooling system

before filling. You should also test the coolant ratio before starting the car. If you wait until the engine has been warmed up, you'll need to work around a pressurized system. Another reason to test coolant at room temperature is hydrometer and non-temperature-compensated refractometer tests are not accurate when performed with warm coolant.

A weak mixture is unlikely to be the sole cause of overheating, since the boiling point of straight water is 265 deg. F. at 15 PSI, and water is an excellent conductor of heat. However, a rich mixture can cause overheating. Straight coolant does have a very high boiling point -- about 387 deg. F. at sea level -- but 100% coolant is a very poor conductor of heat. A rich mixture may cause symptoms similar to a bad radiator or flow restriction.

It should be mentioned that coolant has functions beyond transferring heat and increasing the boiling point. Weak or acidic coolant should be replaced to prevent future cooling system problems. Your customer is likely relying on you for maintenance advice as well as diagnosis of the immediate problem.

Testing the Vehicle When the Coolant Level is Low

Low coolant is a common cause of overheating. If the coolant is low, you'll need to find out why. Coolant may be low because it has leaked out, boiled over, or been consumed by the engine.

Checking for a combustion chamber leak is a good place to start testing, not because it is the most likely cause of overheating, but because it's helpful to know if you have a head gasket sealing problem early in the diagnostic process.

Using a five-gas analyzer to check for hydrocarbons (HC) is a quick and accurate method of finding out if combustion gases are entering the cooling system, typically through a blown head gasket. However, it's not without its pitfalls. As your five-gas analyzer manufacturer will surely tell you, "Moisture is the enemy of all five-gas analyzers." A steamy radiator neck is a very moist environment indeed. There are three steps you can take to avoid damaging your analyzer:

1. Use a polyethylene water bottle with a hole in the top to avoid accidentally sucking coolant into your analyzer.
2. Don't run the test any longer than necessary.
3. Let the analyzer run for 15 minutes after the test to allow moisture to evaporate.

Performing the test and analyzing the results properly are key to avoiding unnecessary repairs. Most five-gas analyzers require a warm-up period before they can deliver reliable readings. Some analyzers take longer than others, so you will need to be familiar with the characteristics of yours.

While the analyzer is warming up, it can be normal for the HC PPM reading to climb. It's important not to misconstrue the rise in HC PPM during warm up as an indication of combustion gas in the cooling system.

HCs can often be measured in the overflow bottle on a car with a leaking head gasket. However, even very high readings in the overflow bottle (say 100 PPM or more) should not be viewed as a conclusive test. There can be other explanations for the presence of HCs -- contamination through additives, or someone filling the system with a poorly-chosen container are just two possible explanations.

In order to make a conclusive test you must measure an increase in HCs at the radiator neck, which is affected by revving the engine. In other words, snap the throttle several times to verify that the HC PPM goes up right afterwards, and then back down after the engine idles for a while.

Whether the results of the HC check are positive or negative, you should proceed with the rest of your testing. Head gasket failure may be the cause of the overheating, or it may be a result. If the test is positive, check for anything that might have caused the head gasket failure before you do the repair.

UV Leak Detection

There are several methods of checking for cooling system leaks, but Nissan/Infiniti recommends the UV dye test. This is especially useful when you suspect there is a leak that is either intermittent or very small. Once the UV dye is added to the coolant, the car can be driven for hours -- even days -- until the coolant level drops. When a technician shines an ultraviolet light on the residue from the coolant leak, it will glow bright green or yellow. A UV dye test is useful whether the loss of coolant was due to an external leak or a boil-over. No matter where the

| Figure 1 – The Nissan/Infiniti-recommended UV method is a great way to find leaks, but make sure you use a dye formulated to work with water-based fluids, such as Part Number J-29545-6A.

coolant "disappeared" to, there will be a glowing trail to follow.

A word of caution though: always use dye designed for water-based fluids when working on Nissan cooling systems. Using a dye designed for oil-based fluids may damage cooling system components. A top quality Nissan approved cooling system dye, part number J-29545-6A, can be purchased through Tech-Mate -- http://www.nissantechmate.com

| Pressure Testing

A pressure test is straightforward, but there are a few things to consider. First is the length of the test. A slow leak will not show up in 30 seconds, so be willing to move on to other work and give the system a little time to leak under pressure. Also, Nissan usually recommends pressure testing at a pressure higher than the cap relief pressure. For instance, on a 2005 Altima with a cap pressure of 14 PSI, the recommended testing pressure is 23 PSI.

Don't forget to test the radiator cap. If the cap can't hold its rated pressure, the system will lose about a quarter of its capacity to the overflow the first time it's warmed up. Also, be sure to check the return valve on the radiator cap by pulling it out with your fingernails, especially if you find the overflow bottle overfull and the radiator low. If the rubber on the radiator cap seal is swollen, replace the cap and check for the presence of oil or other cooling system contaminates that might have caused the swelling.

If you decide to pressure test with a warm engine because you suspect there's a leak affected by thermal expansion, be sure that you never have the engine running while your pressure tester is attached (there is no relief valve on a pressure tester, so you can damage your customer's car). Also, be aware that a pressure drop as a

warm engine cools is normal, not a sign of a leak.

Testing the Vehicle When the Coolant Level is OK

We've covered the possible causes for coolant loss and how to check for them, but what if the temperature gauge is reading too high and the coolant level is OK? Any good diagnostic effort must begin with an effort to confirm the customer's complaint. After checking the coolant level and doing a visual inspection, you can catch many cooling system problems using the in-bay methods that follow.

Starting cold, run the engine at 2,000 rpm in Neutral with the high beams and rear window defogger on. The electrical loads will cause the engine to work a little harder, reducing the time it takes to warm the engine.

Test thermostat operation by feeling the radiator hoses as the engine warms. Both the upper and the lower radiator hoses should be cold when you start. Let's assume the thermostat is in the lower hose water outlet. After the engine has run for a while, the upper hose should gradually warm as the engine warms the coolant, but the lower hose should stay relatively cold. Once the temperature gauge reaches the halfway point, the lower hose temperature should suddenly increase from cold to about the same temperature as the upper hose. If both hoses gradually warm together, there's a good chance the thermostat is stuck open. You will also be able to diagnose a thermostat that's stuck closed with this test -- the lower hose will stay relatively cold as the gauge reaches the halfway point and beyond.

Read the description of the system in the appropriate ESM on the Nissan/Infiniti Service Information website so you'll understand exactly how it's supposed to work. Let's imagine what happens when the thermostat is stuck halfway open. Driving around town, the engine will run too cold because the thermostat allows coolant flow through the radiator all the time. The amount of flow would be more than sufficient to cool the engine. When driving on the freeway or up hills, the thermostat still allows flow all the time, but the volume of flow will be insufficient to cool the engine. A short time after the thermostat opens, the fan(s) should come on, then go off. Different models have different strategies for cooling fan operation. If in doubt, refer to the system description on the Nissan Service Information website (http://www.nissan-techinfo.com), or the Infiniti Service Information website (http://www.infiniti-techinfo.com).

No matter which model you're working with, make sure the air conditioning is off for the fan test, because you may mistake the fan's cycling with the A/C compressor for a normal fan cycle.

Finally, check temperature gauge accuracy. If your gauge is reading 7/8ths, and the coolant temperature is 195 deg. F., there is problem with gauge accuracy. Modern Nissan cars use the CTS, ECM, BCM, and CAN to provide gauge control. You can use the Consult II or Consult III for quick diagnosis of these systems. For older Nissan cars, you'll need to substitute resistors for the temperature sender, check wiring, check the instrument voltage regulator, etc.. All the specifications, diagrams, and system descriptions are available in the appropriate Electronic Service Manual on the Nissan and Infiniti Service Information websites.

Testing the Vehicle on the Road

One advantage to the in-bay test method is that you don't risk overheating while test driving far away from the shop. However, some problems won't show up in the bay. If the problem isn't apparent after the in-bay test, you'll need to test drive.

Before heading out towards the closest freeway grade or big hill, double check your visual inspection. Are all the fan shrouds and air dams in place? Is there debris in the radiator fins, or anything else that would block air flow? If the overheating problem is particularly wily, you may need to wait for a very hot day.

On your way to your favorite freeway or hill, note the temperature gauge reading.

Once you begin driving up hill, the needle shouldn't move from where it was during light-load driving. If it does, inadequate cooling system capacity is likely. Since all Nissan vehicles have ample cooling system capacity, this means there's a problem -- a thermostat that's not opening fully, or a radiator with a flow problem.

Post Road Test Inspection

Once you're back at the shop, you'll need to do some additional testing based on your observations during the road test. If it looks like you have a flow volume or heat transfer problem, you'll need to test the thermostat and radiator. Directly testing the thermostat is

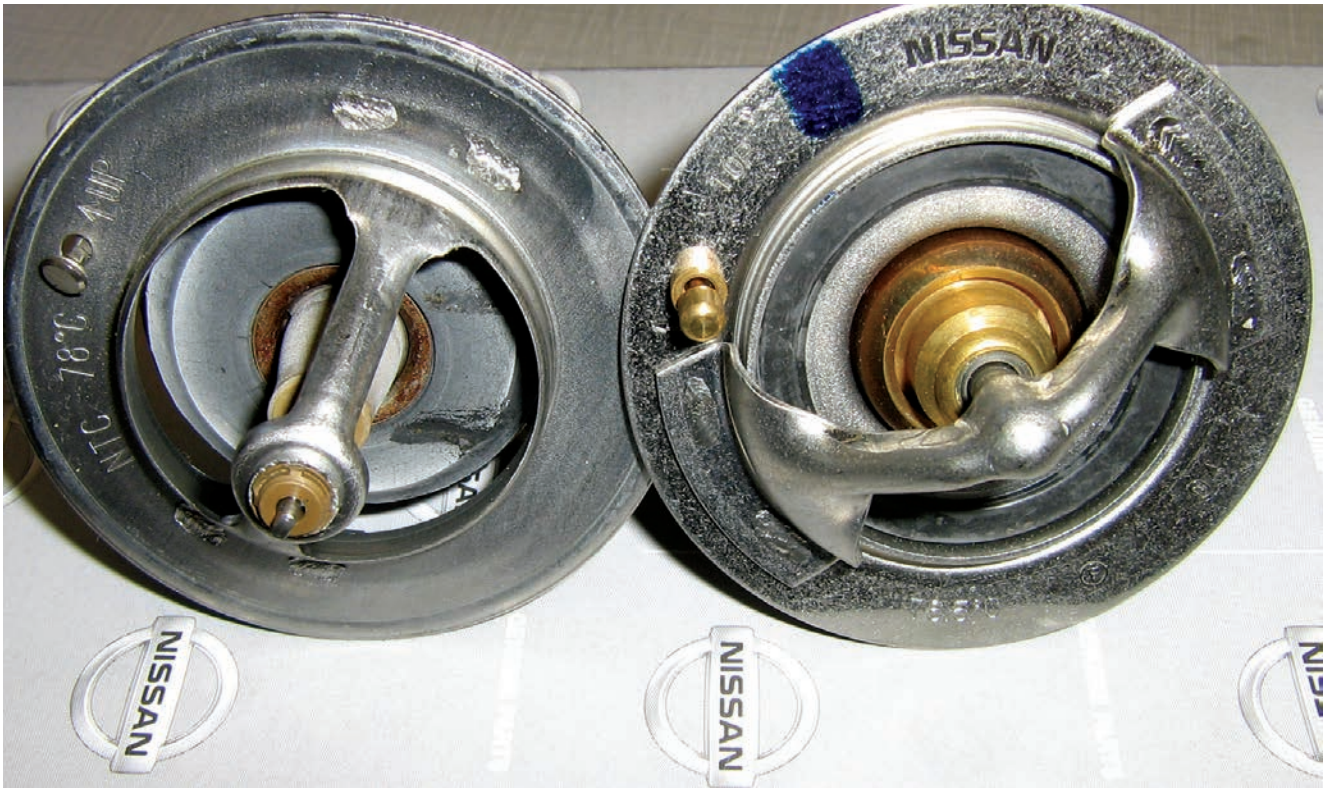

Figure 2 – A thermostat stuck paritally open

straightforward. Remove the thermostat from the car. Place it in a pot of water warmed to Nissan's thermostat opening specification (available online, but usually around 180 deg F.). Then measure the valve lift (also available online, but usually around 10mm). If you don't have a hotplate and aluminum pot, you can purchase them inexpensively. They are necessary if you really care about doing diagnosis properly.

Regardless of whether or not the thermostat is OK, consider replacing it with a Genuine Nissan part. After all, the thermostat is a moving part that does wear with use. The primary reason to check it is not to decide whether or not to replace it; it's to decide whether the radiator or the thermostat is causing the overheating.

Accurate radiator bench testing is impossible for most shops, so the basic rule of thumb is this: Îf the temperature gauge rises above its normal position under load, and the thermostat tests normally, the radiator is likely the culprit, and ought to be replaced before further testing. There are some less likely possibilities -- like a clogged by-pass tube or eroded water pump impeller -- but running down every possibility, no matter how unlikely, is not a good diagnostic strategy.

Quality control

Regardless of what cooling system problems you find and correct on your customer's Nissan or Infiniti, attention to your final quality control routine is very important. First, always use Genuine Nissan/Infiniti LLC (Long-Life Coolant) because nothing else meets all of the stringent specifications the engineers had in mind when they designed the engines for these vehicles. Finding and replacing a radiator with a cracked tank may seem like a slam dunk, but taking the time to verify that the whole system works properly after the repair is what separates the lucky mechanics from the good mechanics. This means verifying thermostat opening and fan operation, a good test drive, and letting the engine cool for a final coolant level check before delivering the vehicle, every time.

Nissan performance

Nissan Motorsports Competition Parts is excited about the addition of a new line of parts they have included to their already expansive offering – The Power Pup by Bully Dog.

Nissan is not the manufacturer of Bully Dog Power Pup products, nor is it the warrantor. Nissan does not recommend or endorse the use of Bully Dog Power Pup products. Nissan simply offers Bully Dog Power Pup products for sale through Nissan Motorsports Competition Parts.

In recent years electronic tuning devices have become very popular within the automotive aftermarket. One of the companies at the forefront of the popular tuning devices is Bully Dog Technologies, most well known for their product for diesel powered trucks and SUVs. In 2005 the company released their first product for gas powered vehicles, the Gas Power Pup.

Unlike some products in the market, the Bully Dog Power Pup is a downloader, not a plug in module. The difference is pretty simple, the Power Pup downloader plugs into the OBDII port usually located under the dash of most vehicles. Once plugged in the downloader walks the installer completely through the process of downloading the tuning maps onto the vehicles ECU. To complete a download it takes just a few minutes, usually less then ten.

In May of 2008 Bully Dog released their popular downloader for Nissan Titan and Armada, before the product started shipping Bully Dog had pre-sold their entire first production run. It was evident, Nissan owners want better fuel economy and the ability to tune their drivetrain for optimum performance, all of which the Bully Dog Nissan Power Pup delivers, in an easy to use package at a very affordable price for the consumer and the dealer.

The Nissan downloader has a number of tuning maps, each is based on the fuel octane level that the consumer is using in their Nissan, using premium fuel the Power Pup delivers more then 20 horsepower. The engine produces more power by being more efficient, a more efficient engine also achieves better fuel economy, a very popular feature with the current price of fuel. In addition, the Nissan Power Pup allows for tuning of various drivetrain settings, including being able to raise or lower the vehicles maximum speed and rev limiter. By accessing the Bully Dog website, customers are able to download engine management "maps".

This is intended for off-road use only, and is not legal for use on public highways or motorways.

For further information about the Bully Dog Nissan downloader contact Nissan Motorsports Competition Parts at 888-833-3225 or email Nissan Motorsports Competition Parts at: nmc.race@nissan-usa.com.

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Alhambra
Alhambra Nissan
626.289.6161

Antioch
Antioch Nissan
925.755.2600

Bakersfield
Nissan Of Bakersfield
661.835.8600

Berkeley
Mc Kevitt Nissan
510.848.2206

Carson
Superior Nissan Of Carson
310.835.1178

Cerritos
Cerritos Infiniti
562.402.7855

Cerritos
Cerritos Nissan
562.402.2277

Chico
Chico Nissan, Inc.
530.891.1777

City Of Industry
Superior Nissan/Puente Hi
626.965.5060

Clovis
Nissan Of Clovis
559.297.6919

Colma
Serramonte Nissan
650.994.1661

Concord
Dirito Bros Concord Nissan
925.676.4400

Concord
Niello Infiniti
925.676.0200

Corona
Corona Nissan
951.735.3360

Downey
Downey Nissan
562.334.1090

Duarte
Performance Nissan
626.305.3000

Dublin
Dublin Nissan
925.452.8000

El Cajon
Mossy Nissan El Cajon
619.588.0500

El Monte
Power Nissan El Monte
626.350.8868

Elk Grove
Infiniti Of Elk Grove
916.405.7000

Elk Grove
Nissan Of Elk Grove
916.405.5000

Escondido
Infiniti Escondido
760.796.5500

Fairfield
Nissan Of Fairfield
707.402.3200

Folsom
Folsom Lake Nissan
916.608.5300

Fontana
Fontana Nissan
909.574.2288

Fremont
Superior Nissan/Fremont
510.651.5800

Fresno
Lithia Nissan Of Fresno
559.436.6000

Gardena
Gardena Nissan, Inc
310.532.1600

Glendale
Glendale Infiniti
818.543.5000

Glendale
Glendale Nissan
818.240.6000

Hanlees
Hilltop Nissan
510.222.4900

Huntington Beach
Surf City Nissan
714.842.6666

Imperial
Rogers & Rogers Nissan
760.352.2900

Irvine
Oc Nissan-Irvine
949.951.7575

Los Angeles
Universal City Nissan Inc
818.769.8100

Millbrae
Daland Nissan, Inc.
650.697.8397

Mission Hills
Superior Nissan/Mission
818.920.1100

Mission Viejo
Infiniti Of Mission Viejo
949.916.4200

Modesto
Central Valley Nissan Inc
209.526.3320

Monrovia
Metro Infiniti
626.303.1000

Montclair
Infiniti Of Montclair
909.625.8990

Montclair
Metro Nissan Of Montclair
909.625.5575

Napa
Napa Nissan, Inc.
707.253.1551

National City
Mossy Nissan, Inc.
619.474.7011

Oakland
Bay Bridge Nissan/Oakland
510.588.2100

Oakland
Infiniti Oakland
510.639.2000

Oceanside
Mossy Nissan Oceanside
760.720.9797

Ontario
Empire Nissan, Inc.
909.390.9977

Orange
Stadium Nissan
714.633.8430

Oxnard
Team Infiniti
805.485.9998

Oxnard
Team Nissan
805.485.8787

Petaluma
North Bay Nissan, Inc.
707.769.7700

Redlands
Metro Nissan Of Redlands
909.793.3377

Redwood City
Peninsula Infiniti Llc
650.369.4000

Riverside
Riverside Infiniti
951.324.8282

Riverside
Raceway Nissan
888.251.9911

Roseville
Sacramento Infiniti, Inc.
916.969.4000

Sacramento
Maita's Nissan Sacramento
916.488.5400

San Bernardino
Nissan Of San Bernardino
909.885.3883

San Diego
Kearny Mesa Infiniti
858.573.1700

San Diego
Pacific Nissan
858.581.3200

San Jose
Capitol Nissan
408.978.1234

San Leandro
San Leandro Nissan
510.347.4000

Santa Clara
Frontier Infiniti
408.243.4355

Santa Clara
Stevens Creek Nissan
408.983.5900

Santa Cruz
Santa Cruz Nissan
831.426.5100

Santa Monica
Infiniti Of Santa Monica
310.394.1888

Santa Monica
Santa Monica Nissan, Inc.
310.998.2200

Santa Rosa
Nissan Of Santa Rosa
707.545.7050

Selma
Selma Nissan
559.896.5000

Sherman Oaks
Miller Nissan, Inc.
818.787.8400

Signal Hill
Schaiers' Nissan/Long Bch
562.426.0333

Simi Valley
First Nissan
805.526.9700

Stockton
Stockton Nissan
209.956.6500

Sunnyvale
Falore Nissan
408.735.6888

Temecula
Quality Nissan/Temecula
951.676.6601

Thousand Oaks
Nissan Of Thousand Oaks
805.497.4515

Torrance
Infiniti South Bay
310.325.5555

Torrance
Power Nissan Torrance
310.370.7401

Tustin
Infiniti Tustin
714.832.6111

Tustin
Tustin Nissan
714.669.8282

Valencia
Valencia Nissan
661.255.2020

Vallejo
Vallejo Nissan, Inc.
707.643.8291

Van Nuys
Miller Infiniti, Inc.
818.782.1000

Victorville
Valley Hi Nissan
760.241.1700

Visalia
Nissan Of Visalia
559.734.3333

West Covina
West Covina Nissan
626.732.1000

Westlake Village
Infiniti Of Thousand Oaks
818.865.9600

Woodland Hills
Woodland Hills Nissan
818.346.6200

COLORADO

Aurora
Infiniti Of Denver
303.671.6000

Aurora
Tynan's Nissan Inc
303.341.7330

Centennial
Go Nissan Arapahoe
303.790.7333

Colorado Springs
South Colo Springs Nissan
719.550.3030

Colorado Springs
Woodmen Nissan
719.234.1000

Englewood
Larry Miller Nissan
303.762.9922

Greeley
Ehrlich Vehicles, Inc.
970.353.5333

Lakewood
Empire Lakewood Nissan
303.232.8881

CONNECTICUT

Greenwich
Infiniti Of Greenwich
203.869.0255

Hartford
Harte Infiniti, Inc.
860.524.1993

Hartford
Harte Nissan, Inc.
860.549.2800

Manchester
Decormier Motor Sales Inc
860.643.4165

Middletown
Middletown Nissan, Llc
860.632.6550

Milford
Napoli Nissan
203.877.5141

North Haven
Executive Nissan
203.239.5371

Shelton
D'addario Nissan
203.929.5391

Simsbury
Hoffman Nissan
860.651.3256

Wilton
Bruce Bennett Nissan
203.544.8371

DELEWARE

New Castle
Sheridan Nissan, L.L.C.
302.326.6100

Newark
Porter Infiniti
302.368.6305

Newark
Porter Nissan
302.368.6300

FLORIDA

Clearwater
Lokey Motor Company
727.531.4774

Clearwater
Lokey Nissan
727.789.8100

Coconut Creek
Infiniti Of Coconut Creek
954.861.6100

Coral Springs
Coral Springs Nissan Inc
954.753.1700

Davie
Warren Henry Inf Of Davie
954.734.2500

Daytona Beach
Daytona Nissan
386.274.6800

Fort Lauderdale
Maroone Nis/Ft Lauderdale
954.527.3400

Fort Myers
Sutherlin Nissan
239.415.8600

Jacksonville
Atlantic Infiniti, Inc.
904.642.0200

Jacksonville
Coggin Nissan At The Ave
904.880.3000

Jacksonville
Mike Shad Nissan/Jacksonv
904.389.3621

Lakeland
Jenkins Nissan, Inc.
863.686.2800

Miami
Bill Seidle's Nissan Inc.
305.633.8000

Miami
Esserman Nissan, Ltd.
305.626.2600

Miami
Maroone Nissan Of Miami
305.448.7431

Miami
South Motors Infiniti
305.256.2000

Miami
Warren Henry Infiniti
305.652.9999

Naples
Naples Nissan
239.643.3800

Orlando
Celebrity Nissan
407.657.9500

Pembroke Pines
Maroone Nissan/Pembroke
954.433.3400

Port Charlotte
Harbor Nissan
941.629.1171

Sarasota
Coast Infiniti
941.924.1211

Sarasota
Gettel Nissan Of Sarasota
941.923.1411

Tallahassee
Kraft Nissan
850.576.6171

Tamarac
Sawgrass Infiniti
954.360.9400

Tampa
Courtesy Nissan Of Tampa
813.870.3333

Tampa
Infiniti Of Tampa
813.879.3223

Village Of Palmet
Maroone Nissan Of Kendall
305.259.2600

West Palm Beach
Infiniti Of Palm Beaches
561.615.3300

West Palm Beach
West Palm Nissan
561.683.7100

Winter Haven
Hill Nissan, Inc.
863.299.2161

GEORGIA

Buford
Sutherlin Nissan Mall/Ga
678.714.1885

Chamblee
Capitol City Nissan, Llc
770.455.1122

Conyers
Conyers Nissan
770.922.7600

Decatur
Nalley Nissan
888.956.0099

Duluth
Gwinnett Place Nissan
770.476.7771

Duluth
Infiniti Of Gwinnett
678.812.8500

Gainesville
Carriage Nissan
770.532.6335

Kennesaw
Town Center Nissan
770.423.9691

Lilburn
Stone Mountain Nissan
678.252.3100

Macon
Paul Walsh Nissan Inc.
478.781.8440

Marietta
Team Nissan Of Marietta
770.422.4546

Morrow
Nissan South
770.968.1360

Rome
Heritage Nissan
706.291.1981

Tifton
Interstate Nissan, Inc.
229.382.7777

Union City
Infiniti Of South Atlanta
770.774.9151

Union City
Nissan South Union City
770.964.4900

HAWAII

Honolulu
Infiniti Of Honolulu
808.836.0848

Honolulu
New City Nissan
808.524.9111

Lihue
Nissan Of Kauai
808.245.6731

Waipahu
Tony Nissan
808.680.7150

ILLINOIS

Barrington
Motor Werks Infiniti, Inc
847.381.8900

Buffalo Grove
Arlington Nissan/Buffalo
847.590.6100

Countryside
Continental Motors Inc
708.352.9200

East Peoria
Uftring Nissan, Inc.
309.690.6200

Highland Park
North Shore Nissan
847.433.7900

Libertyville
Liberty Import Center
847.680.8000

Lisle
Infiniti Of Lisle, Inc.
630.241.3000

Loves Park
Anderson Nissan, Inc.
815.633.3460

Matteson
Hawkinson Nissan, L.L.C.
708.720.4800

Niles
Star Nissan, Inc.
847.647.1555

Northlake
Al Piemonte Nissan Inc
708.343.3800

Oak Lawn
Kelly Nissan, Inc.
708.499.1000

Orland Park
Infiniti Of Orland Park
708.403.4700

Orland Park
Orland Park Nissan, Inc.
708.403.1300

Wood River
Autocenters Nissan, Inc.
618.251.3000

INDIANA

Indianapolis
Andy Mohr Nissan, Inc.
317.298.2000

Indianapolis
Dreyer&Reinbold Infiniti
317.573.0222

Indianapolis
Ed Martin Nissan
317.359.9231

Indianapolis
Hubler Nissan, Inc.
317.888.9227

Indianapolis
Tom Wood Nissan, Inc.
317.848.8888

Noblesville
Butler Nissan
317.774.9300

IOWA

Des Moines
Willis Infiniti
800.373.1836

KANSAS

Olathe
Mc Carthy Olathe Nissan
913.324.7200

KENTUCKY

Lexington
Glenn Infiniti
859.263.2848

Louisville
Sam Swope Infiniti
502.499.5070

LOUISIANA

Baton Rouge
All Star Nissan, L.L.C.
225.272.9330

Baton Rouge
Infiniti Of Baton Rouge
225.753.4433

Harvey
Ray Brandt Nissan Inc
504.367.1666

Houma
Greg Le Blanc Nissan
985.447.1111

Metairie
Premier Nissan/Metairie
504.455.5800

Metairie
Ray Brandt Inf/Metairie
504.832.2005

MARYLAND

Annapolis
Sheehy Infiniti/Annapolis
443.837.0300

Baltimore
Antwerpen Security Nissan
410.298.4400

Baltimore
Bob Bell Chevrolet/Nissan
410.288.2500

Bel Air
Bel Air Nissan, Subaru
410.879.1133

Clarksville
Antwerpen Nissan, Inc.
410.531.5703

Ellicott City
Norris Nissan West
410.465.5550

Frederick
Frederick Nissan
301.662.0111

Glen Burnie
Sheehy Nissan
410.760.3500

Laurel
Tischer Nissan
301.498.3322

Marlow Heights
Passport Nis/Marlow Hgts
301.423.8400

Rockville
Darcars Nissan
301.309.2200

Salisbury
Pohanka Nissan/Salisbury
410.548.4700

Silver Spring
Herb Gordon Nissan
301.890.8200

Timonium
Nationwide Motor Sls Corp
410.252.8000

Waldorf
Sheehy Nissan Of Waldorf
301.843.5300

MASSACHUSETTS

Auburn
Bertera Nissan, Inc.
508.832.9611

Beverly
Roland D. Kelly Nissan
978.922.1405

Bourne
Nissan Of Bourne
508.759.4400

Danvers
Kelly Infiniti
978.774.1000

Fitchburg
Ron Bouchard's Nissan
978.345.1800

Hyannis
Balise Nissan Of Cape Cod
508.771.3636

Lynnfield
Kelly Nissan Of Lynnfield
781.598.1234

Marlborough
Marlboro Nissan
508.481.3232

Medford
Colonial Nissan/Medford
781.395.5300

Norwood
Infiniti Auto Of Norwood
781.329.3040

Raynham
Mastria Nissan, Inc.
508.824.8614

West Springfield
Jerry Rome Nissan
413.746.2266

MICHIGAN

Farmington Hills
Suburban Nissan/Farm Hill
248.471.0044

Grand Rapids
Pfeiffer Infiniti, Inc.
616.940.8989

Novi
Suburban Infiniti, Inc.
248.471.2220

Portage
Cole/Gilmore Pn-Cd-Nissan
269.323.3200

Traverse City
Traverse City Auto Plaza
231.946.5540

Troy
Suburban Infiniti Of Troy
248.731.3300

Troy
Suburban Nissan, Inc
248.649.2300

MINNESOTA

Bloomington
Feldmann Imports Inc.
952.837.6300

Bloomington
Luther Inf Of Bloomington
952.888.5555

Brooklyn Park
Brooklyn Park Automotive
763.424.4400

Burnsville
Walser Nissan
952.435.5550

Golden Valley
Jim Lupient Infiniti
763.546.5577

Inver Grove
Heig Luther Nissan
651.457.5757

Maplewood
Kline Nissan
651.379.4300

MISSOURI

Creve Coeur
Plaza Infiniti
314.301.1707

Ellisville
Moore Nissan
636.394.0330

Kansas City
Jay Wolfe Nissan
816.459.4800

Kansas City
Major Infiniti, Inc.
816.941.0770

Saint Louis
Suntrup Nissan Volkswagen
314.892.8200

Springfield
Infiniti of Springfield
866.963.2577

MISSISSIPPI

Brandon
Gray-Daniels Nissan Brand
601.948.3050

Gulfport
Pat Peck Nissan
228.864.6411

Hattiesburg
Petro Automotive Group
601.264.4411

Jackson
Deuce Mcallister Niss Jak
601.352.2626

Jackson
Gray-Daniels Nissan North
601.956.7522

Tupelo
Carlock Nissan Of Tupelo
662.844.3113

MONTANA

Billings
Billings Nissan, L.L.C.
406.655.1111

Bozeman
J.C. Billion Inc
406.582.7777

Missoula
Missoula Nissan, Inc.
406.549.5178

NORTH CAROLINA

Cornelius
Lake Norman Infiniti
704.237.8000

Gastonia
Nissan West
704.867.0000

Greensboro
Crown Nissan
336.292.9191

Greensboro
Modern Infiniti, Inc.
336.852.5981

Matthews
Infiniti Of Charlotte
704.847.9010

Raleigh
Crossroads Infiniti, Inc.
919.981.5656

Winston Salem
Modern Inf/Winston-Salem
336.767.7800

Winston Salem
Modern Nissan, Inc.
336.767.8260

NEBRASKA

Omaha
Infiniti Of Omaha
402.592.2200

Omaha
Nissan Of Omaha, Llc
402.493.4000

NEW HAMPSHIRE

Manchester
Team Nissan, Inc.
603.644.8326

Nashua
Infiniti Of Nashua
603.891.1400

Nashua
Peter's Auto Sales, Inc.
603.889.1166

NEW JERSEY

Avenel
Nissan Woodbridge
732.815.2500

Bloomfield
Lynnes Infiniti
973.743.3100

Bloomfield
Lynnes Nissan City Inc.
973.743.2111

Butler
Route 23 Nissan, L.L.C.
973.838.0800

Cherry Hill
Cherry Hill Nissan, Inc.
856.667.8300

Egg Harbor
Townsh Holman Infiniti
609.383.6100

Englewood
Infiniti Of Englewood Llc
201.568.1200

Flemington
Flemington Infiniti
908.782.6868

Flemington
Flemington Nissan
908.782.3673

Freehold
Dch Freehold Nissan
732.780.3600

Hasbrouck Heights
Meadowlands Nissan
201.796.5050

Maple Shade
Holman Infiniti
856.231.4400

Monmouth Junction
Acme Nissan
732.821.9300

North Plainfield
North Plainfield Nissan
908.755.6400

Stanhope
Lynnes Nissan West, Inc.
973.347.2200

Toms River
Pine Belt Automotive, Inc
732.349.3030

Union Beach
Pine Belt Nissan/Keyport
732.264.4333

Woodbury
Woodbury Nissan, Inc
856.853.0150

NEW MEXICO

Albuquerque
Garcia Infiniti
505.217.3000

Albuquerque
Melloy Nissan
505.265.8721

Albuquerque
Reliable Nissan
505.338.3888

NEVADA

Henderson
Douglas Nissan
702.558.5800

Las Vegas
Desert Nissan
702.871.7000

Las Vegas
Planet Nissan
702.876.8000

Las Vegas
Towbin Infiniti
702.252.8800

Las Vegas
United Nissan
702.457.8061

NEW YORK

Albany
Armory Nissan Inc.
518.641.7777

Amherst
Mike Barney Nissan
716.833.9888

Bayside
Star Nissan, Inc.
718.423.0500

Blauvelt
Rockland Nissan
845.358.6700

Brooklyn
Bay Ridge Nissan, Inc.
718.238.8000

Brooklyn
King's Nissan Inc
718.376.0538

Greenvale
Baron Nissan, Inc.
516.621.2300

Huntington Statio
Habberstad Nissan, Inc
631.439.7000

Jackson Heights
Koeppel Nissan Inc
718.898.7800

Lynbrook
Legacy Infiniti, Ltd.
516.536.9000

Malta
Nissan Of Saratoga, Llc
518.886.4800

Manhasset
Infiniti Of Manhasset
516.773.1000

Mt. Kisco
Nissan City North
914.242.3990

New York
Infiniti Of Manhattan Inc
212.399.1900

Ozone Park
Nissan Of Queens
718.835.8300

Port Chester
Nissan City/Port Chester
914.937.1777

Saint James
Competition Infiniti
631.361.4636

Schenectady
Lia Nissan
518.579.2000

Smithtown
Smithtown Nissan, Inc.
631.361.9696

Syosset
Legend Nissan, Ltd
516.496.8181

West Islip
Atlantic Nissan Superstor
631.587.0700

Westbury
Advantage Nissan
516.338.5600

White Plains
Pepe Infiniti, Inc.
914.428.0900

OHIO

Bedford
Infiniti Of Bedford
440.439.0400

Brunswick
Ken Ganley Nissan,Inc.
330.273.1555

Columbus
Germain Nissan
614.418.4500

Dayton
Matt Castrucci Nissan
937.434.4723

Dublin
Infiniti Of Columbus, Llc
614.793.1000

Hilliard
Buckeye Nissan, Inc.
614.771.2345

Streetsboro
Classic Nissan
330.422.7300

Tallmadge
Tri-City Nissan
330.633.3234

Toledo
Yark Nissan
800.848.9275

Willoughby
Sunnyside Nissan
440.951.1100

OKLAHOMA

Broken Arrow
Nelson Nissan
918.258.6581

Edmond
Bob Howard Nissan, Inc.
405.478.5380

Oklahoma City
Bob Moore Infiniti, Inc.
405.748.8000

Oklahoma City
Hudiburg Nissan, Inc.
405.631.7771

Tulsa
Jackie Cooper N
918.249.9393

Tulsa
Riverside Nissan, Inc.
918.628.0280

OREGON

Beaverton
Beaverton Infiniti
503.626.8822

Eugene
Lithia Nissan Of Eugene
541.686.2211

Gresham
Gresham Nissan Subaru Inc
503.661.1200

Medford
Lithia Nissan
541.773.3655

PENNSYLVANIA

Allentown
Rothrock Motor Sales, Inc
610.439.8485

Ardmore
Infiniti Of Ardmore
610.649.3600

Camp Hill
Brenner Nissan
717.697.8400

Concordville
Concordville Nissan
610.459.8900

Conshohocken
Conicelli Nissan
610.825.4200

Doylestown
Fred Beans Nissan/Doylest
215.345.6900

Erie
Porreco Nissan, Inc.
814.860.8377

Exton
Exton Nissan(Sarr Ops,Lp)
610.594.7400

Fairless Hills
Peruzzi Nissan
215.943.6200

Feasterville
Colonial Nissan Inc
215.364.1100

Harrisburg
Faulkner Nissan, Inc
717.558.8220

Montgomeryville
Montgomeryville Nissan
215.661.9300

Moon Township
West Hills Nissan
412.262.9020

Pennsdale
Alexander Nissan Inc.
570.546.4925

Philadelphia
Chapman Nissan Llc
215.492.1200

Pittsburgh
Cochran Nissan/South Hill
412.343.3200

Pittsburgh
Pittsburgh East Nissan
412.824.9020

Pleasant Hills
Bowser Nissan
412.469.2100

State College
Nissan Of State College
814.238.2447

West Chester
Infiniti Of West Chester
610.696.6700

Wexford
Wright Automotive Group
724.935.4646

Willow Grove
Infiniti Of Willow Grove
215.784.9320

York
Apple Nissan, Inc.
717.755.9504

RHODE ISLAND

Warwick
Inskip Infiniti
401.821.9790

West Warwick
Inskip Nissan
401.821.1510

SOUTH CAROLINA

Charleston
Baker Infiniti Charleston
843.852.4001

Charleston
Morris Motors, Inc
843.571.2810

Columbia
Dick Smith Nissan
803.256.6600

Greenville
Crown Nissan Greenville
864.254.7700

Hardeeville
Key Infiniti, Llc
843.208.9100

Hardeeville
Key Nissan, Llc
843.208.2700

Rock Hill
Harrelson Nissan, Inc.
803.668.171

TENNESSEE

Bartlett
Wolfchase Nissan
901.255.3800

Chattanooga
Prebul Inf Of Chattanooga
423.899.8934

Jackson
Carlock Nissan Of Jackson
731.422.4658

Johnson City
Tri-Cities Nissan, Inc.
423.282.4731

Knoxville
Harper Infiniti, Inc.
865.690.1970

Memphis
Jim Keras Nissan Inc
901.373.2800

TEXAS

Arlington
Don Davis Nissan, Inc.
817.467.7911

Austin
Austin Infiniti, Inc.
512.454.9489

Austin
South Point Nissan
512.444.1400

Austin
Town North Nissan
512.451.7411

Conroe
Streater-Smith Nissan
936.760.2446

Corinth
North Texas Nissan
817.267.6411

Corpus Christi
Ed Hicks Nissan, Ltd.
361.854.1955

El Paso
Casa Nissan, Inc.
915.772.1488

El Paso
Hoy-Fox Infiniti
915.775.8585

Euless
Grubbs Infiniti, Ltd.
817.318.1200

Farmers Branch
Bankston Nissan Of Dallas
972.450.2400

Fort Worth
Thornhill Nissan
817.560.9000

Houston
Baker-Jackson Nissan No
281.890.5656

Houston
Baker-Jackson Nissan So
713.661.9955

Houston
Clear Lake Infiniti
713.589.4000

Houston
Mcdavid Nissan
713.941.0600

Houston
Mossy Nissan
281.496.2200

Houston
North Houston Infiniti
281.569.3100

Houston
Southwest Infiniti
713.779.2800

Humble
Robbins Nissan
281.446.3181

Irving
Bankston Nissan In Irving
972.438.4300

League City
Clear Lake Nissan
281.557.5300

Lewisville
Bankston Nissan Lewisvill
972.420.9500

Longview
Patterson Nissan/Longview
903.758.4135

Mcallen
Bert Ogden Nissan
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