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Cover image: 2013 Altima Coupe Interior; Courtesy Nissan North America.

Camshaft Control Systems Part IV:

Timing Chain Guides & Tensioners

An essential part of the timing chain system, guides and tensioners make sure the timing chain operates as it was designed. When symptoms occur, it's important to know what to look for and how to fix them.

In this article, we will explore guides and tensioners on Nissan timing chain engines. While the chain does all the heavy lifting of keeping the lower end of the engine in time with the upper end, it cannot perform this function properly without guides and tensioners. They are the unsung heroes of the timing chain system. However, they are also the most common source of issues. Tensioners can weaken and cause the chain to be noisy, loose, and in extreme cases even jump a tooth. Guides can wear and lead to noises and premature timing chain wear. Sometimes they even break completely and, if not repaired in a timely fashion, destroy the engine.

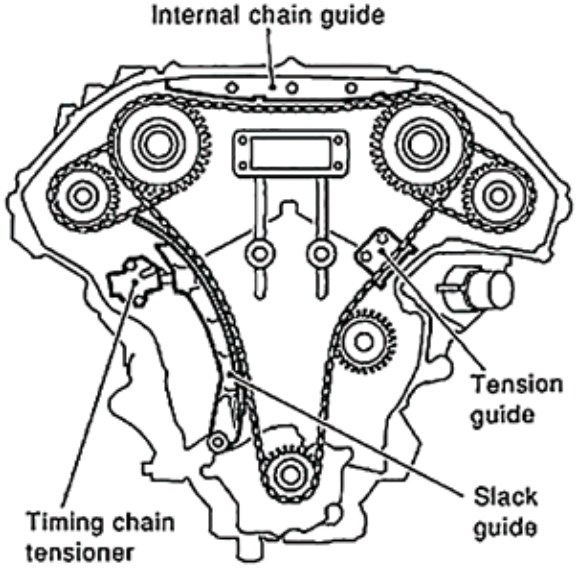
First, we will look at how the guides and tensioners are supposed to work in Nissan's most popular VQ type V6 engines: the VQ30, VQ35/37, and the VQ40. Then we will look at common, and some uncommon, failures in the tensioner and guide system on these engines. And, most importantly, we will learn what causes these failures, how to identify them, and how to repair them.

For a timing chain to operate properly, it must have the correct tension. If it is too loose, it will rattle or even jump a tooth and throw the engine out of time. A loose chain will also lead to accelerated wear of the chain and sprockets. If the chain is too tight it will whine, bind, and will lead to accelerated chain and sprocket wear. The 6-cylinder VQ30, VQ35, and VQ40 engines all use three tensioners to keep its main chain, and two secondary chains correctly taut. All of them operate using oil pressure generated by the engine's oil pump. The primary chain tensioners on these engines apply tension through the slack guide, while all of the non-primary chain tensioners have guides built into their plungers. The tensioners all also contain a ratcheting mechanism to keep them from loosening too much when the engine is turned off, and to compensate for gradual timing chain wear.

The timing chain guides are typically constructed using a metal framework covered by high strength plastic. The chain rides along the plastic surface to keep it quiet, while the metal structure keeps the guide from flexing too much. These V6 engines all contain five timing chain guides:

1. The slack guide, which spans most of the distance between the crankshaft and bank 1 of the cylinder head. This guide is acted upon by the main timing chain tensioner, and is perhaps the most crucial of all the guides.
2. The internal chain guide, which the main chain rides along between bank 1 and bank 2 at the top of the engine.
3. The tension guide, which is much smaller than the slack and internal guides, is mounted between bank 2 and the water pump. It ensures that the water pump bearing is not damaged by taking some of the axial stress off of it.

4-5. And finally, the two secondary guides that are acted upon by the secondary



Here we see the main timing chain guides on a Nissan VQ35. All the V6 engines have similar guides.

tensioner to keep the secondary chain properly tensioned.

The issues we typically see associated with guides are accelerated wear and breakage. Both almost always lead to timing chain noise, but the noise varies depending on the nature and severity of the guide wear.

Usually the damage from guide issues is limited to what is under the timing cover, but if ignored for too long they can lead to internal engine damage. Do not ignore timing chain related noises, as they will only get worse and lead to more damage.

Nissan's various V6 powerplants are all excellent engines, and are used in more Nissan vehicles than any other engine. They are typically trouble free engines, but can suffer from a couple of timing chain guide-related issues. These issues are usually identified by noise from behind the timing cover, and require only a stethoscope or similar tool to diagnose. Repairs, unfortunately, are much more time consuming. The first issue we will discuss is the main timing chain slack guide breakage, and how to repair it. Then we will discuss what happens when the secondary timing chain guides (commonly referred to as shoes) wear excessively, and how to repair them. Then we will look at some less common tensioner and guide issues, as well as problems with water pumps.

There is no TSB released from Nissan regarding slack guide breakage. It can be identified by a hard rattle on startup, typically after cold soak, from beneath the timing cover. Typically, the noise changes tune when the engine speed changes. As engine speed increases the rattle frequency increases, but the volume and distinctness decrease. Usually, the noise will go away once the engine warms up a bit, but not always. The first step in diagnosing this failure requires only a stethoscope. Probe around the timing cover area with it, and if the noise is coming from the right side (towards the rear in front wheel drive applications) on the upper half of the cover, then it is likely to be a broken slack guide. Luckily, there is an access panel that covers the main timing chain tensioner. It can easily be removed to verify this diagnosis. Remove the three bolts holding the cover down and pry it off. Be careful not to damage the mating surfaces though. Once this cover is removed, use a mirror to take a look at the tensioner. If its plunger is fully extended, then you have confirmed that the slack guide has broken and proceed with repairs. The reason the plunger is fully extended is the plastic portion of the guide has broken near the top, and the remaining portion has slid down the metal frame. The plunger should be pressing against a formed plastic section of the guide, but that section has slid down along with the rest of the guide's plastic. The plunger is then allowed to extend fully until it contacts the metal frame of the guide. The tensioner was not designed to extend this far, so it cannot provide proper tension to the guide, and ultimately, the chain. The noise that you hear is from the chain slamming back and forth into the guide and tensioner plunger.

Here we see the tensioner contacting the correct portion of the guide, but the guide has broken and started to slide down the frame.

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If the tensioner cover is removed and you find that everything looks normal, it is likely that the problem lies in the tensioner itself, or the lubrication circuit. It is possible that oil pressure is bleeding off while the engine is off, or that proper oil pressure is not reaching the tensioner quickly enough. Oil pressure bleed-off can be caused by something as simple as a poor quality, non-OEM oil filter. Nissan oil filters have anti-drain back valves built into them that keep this kind of thing from happening. Low oil volume will cause many problems, including weak timing chain tension. It should go without saying, but be sure to check oil level and condition before spending time investigating anything else.

Another possibility is that the chain tensioner itself has a leaking plunger seal. This will cause oil pressure to bleed off any time the engine is off, and can potentially not allow proper oil pressure to ever build in the tensioner. Luckily this chain tensioner can be replaced fairly economically, as it does not require removing the timing cover. If there is not a problem with the tensioner or the guide, the next possibility is that there are clogged filter screens in the timing cover that are not allowing proper oil volume to reach the tensioner quickly enough. The best way to check for this without tearing down half of the engine is to simply remove the oil filter and tensioner, and apply shop air to the oil filter mounting stud. The main chain tensioner is one of the first components to receive oil pressure after the filter. A steady stream of air should be felt at the tensioner oil feed hole. If it is not, then there is a restriction in the lubrication circuit that must be addressed.

Another item on Nissan V6 engines is excessive secondary timing chain guide wear. This can be identified by a high pitched buzzing or whining from the secondary timing chain area. It increases in frequency as engine speed is increased. If it does not increase in frequency, then there is likely to be another problem and it should be diagnosed properly, per the service manual. The noise is caused by the chain rubbing through the secondary tensioner shoes and thus riding on a surface that was not designed for this. This condition also makes it very difficult for the tensioner to properly tension the secondary timing chains. Nissan has released a TSB (NTB07-042d) detailing it, as well as upgraded tensioner shoes (P/N 13028-ZK01C) that don't wear out in this fashion.

The secondary tensioners themselves do not require replacement, as the worn shoes can be pried off of them easily. Special Service Tool J-50246 is required, however, to compress the new guide shoes into place

Here we see a broken slack guide has completely dropped, and the main tensioner plunger has fully extended. Notice how the plunger is contacting the metal frame of the guide. You can check for this relatively quickly by simply removing the main tensioner cover.

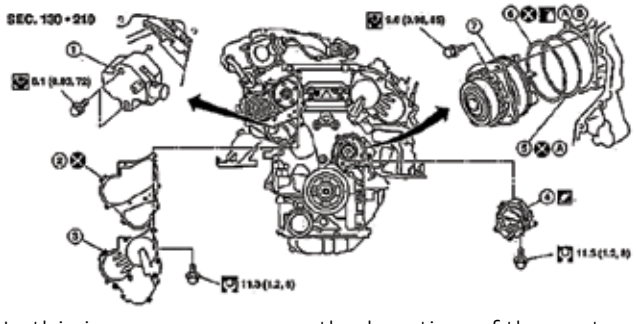
Typically the slack guide breaks near the top and the entire plastic portion slides down the metal frame.

once the old ones have been removed. The tool can be ordered from Nissan's Tech-Mate authorized tool and equipment program website at nissantechmate.com.

The TSB also requires replacing both secondary timing chains, as they wear excessively due to lack of proper tension. All other components under the timing cover, including the secondary tensioners, will typically be reused, but they must be carefully inspected to ensure they are not worn.

Nissan V6 engines drive the water pump with the timing chain. These water pumps can become noisy, and mislead you into thinking there is a problem with timing chains or guides. The tension guide is just above the water pump, so when we hear noises from the left side of the engine we must determine if the problem lies in the water pump or the tension guide.

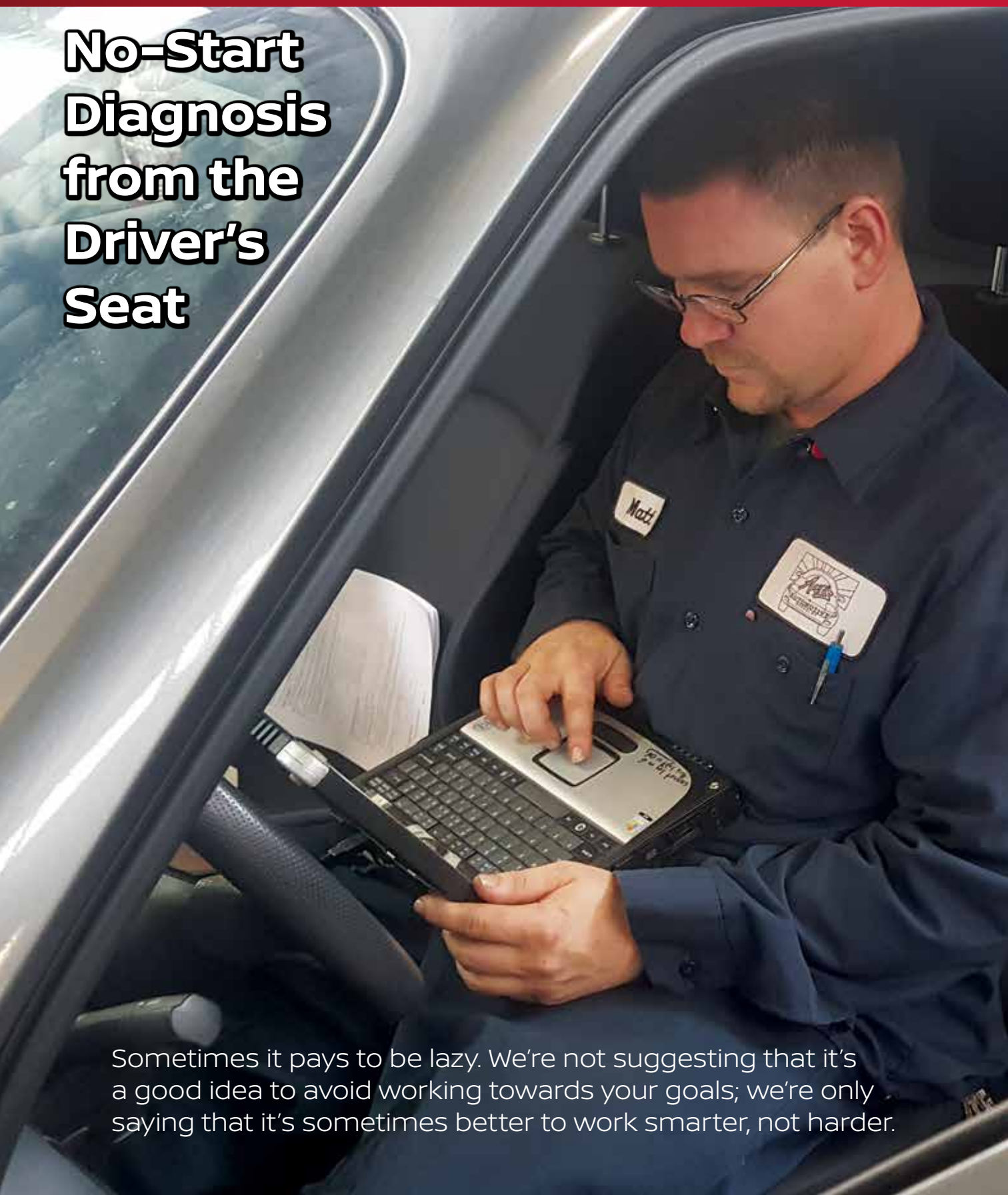
This is a secondary shoe being replaced without removing the secondary tensioner. It requires special service tool J-50246.


In this image we can see the location of the water pump, primary tensioner, and their covers in relation to the rest of the VQ35 engine.

Excessive wear to the tension guide will typically result in a higher pitched whine from the upper left of the engine, similar to the secondary tensioner whine. A noisy water pump, in contrast, will usually rattle, screech intermittently, or produce a wheel bearing type droning sound from the pump. Probe it with a stethoscope and try to determine if the sound is louder at the water pump cover or just above it. If there is a noise from the area, but you aren't sure if it is the pump or the tension guide, there is a fairly quick way to rule out the water pump. Set the engine to TDC compression for cylinder #1. Remove the water pump cover and primary tensioner cover or the valve timing control cover bank 1, which covers the tensioner on the newer engines. Release the tension by pulling the lever on the tensioner body downwards, pushing the tensioner plunger into the body, and then locking the lever using an Allen wrench. Then remove the tensioner bolts and the tensioner. Now that there is some slack in the chain, turn the crankshaft pulley approximately 20° counter clockwise. This transfers the slack to the water pump side of the engine so the pump can be removed. We do not need to remove the pump for this test, however, simply free it from the timing chain so it can be spun by hand. If any grittiness or roughness is felt, then the water pump is the problem. If the water pump feels normal, then the tension guide is likely the source of the noise.

While it is not possible to cover every scenario in which a component of the timing chain tensioner and guide system fails, this article should shed some light on what you are most likely to see fail in this system. The purpose of this article is to familiarize you with how the tensioners and guides are supposed to work, how to service them, and what to look for first. Servicing any of the timing chain guides requires removal of the timing cover, which is quite a lot of work. That is why diagnosing properly is so important. It is well worth spending an extra hour to be sure, rather than pulling the timing cover only to find that nothing under it is damaged.

No-Start Diagnosis from the Driver's Seat



Sometimes it pays to be lazy. We're not suggesting that it's a good idea to avoid working towards your goals; we're only saying that it's sometimes better to work smarter, not harder.

When faced with a car that cranks but won't start, it's best to do only the minimum amount of testing required to reach the correct diagnosis. If you can diagnose a crank/no-start quickly, everyone wins. Your customer will have a lower bill. You'll be more valuable to your employer. Your shop will develop a reputation as competent. And you'll be generating the predictable and profitable repairs that are the staples of a successful business.

So how does the lazy technician set about diagnosing a crank / no-start? Well, the goal is to do the minimum amount of testing required, but here's the difficulty: the minimum tests required will be different for just about every case you encounter. This means you'll have to evaluate and plan on your own, which reminds us of a very important point: time spent thinking isn't time wasted. It's the time spent "doing stuff" before planning that's wasted time. Sure, the guy "doing stuff" might look good when the boss checks in, but the guy who looks like he's daydreaming may just be on his way to finishing the car a lot sooner. Decide what you're going to test and how to test it before reaching for tools.

Flow Charts / Trouble Trees / Diagnosis in a Can

The diagnostic flow charts available on Nissan-techinfo.com aren't bad and will lead to the correct conclusion most of the time if you follow the instructions exactly. However, following the procedures in the service manual may not be the fastest way to complete a diagnosis. Flow charts do serve a purpose. Nissan wants to make sure their cars can be repaired and they know that there are different levels of familiarity and skill out in the field. Step-by-step diagnostic instructions are basically training wheels; they allow everyone to ride the diagnostic bike. However, more experienced diagnosticians are likely to find the training wheels just get in the way.

No Tools...

Your diagnostic planning should start before you even reach the car. The customer's complaint on the repair order may contain information that will influence your plan of action. If you're lucky, the repair order will contain information on how to reproduce intermittent failures. If the crank/no-start only occurs after a warm soak, or when the fuel gauge is under ½, or when it's raining or foggy, you can tailor your plan to take advantage of this information.

Observation

Confirming the customer's complaint is a pretty important first step, but you shouldn't limit yourself to "just" confirming the car won't start. Use your powers of observation to eliminate some tests and steer you toward others.

One test you can perform while verifying the complaint is a compression test. Well, not a real test with a gauge, but you can actually hear many compression problems. The starter's load and pitch change every time a piston comes up during the compression stroke. When cranking a healthy engine it might make a sound like: gyik-gyik-gyik-gyik-gyik-gyik-gyik-gyik.

Whereas an engine with a single low cylinder might sound more like: gyik-gyik-gyik-gwok-gyik-gyik-gyik-gwok. In other words, the starter pitch will be different when it isn't working against compression.

If all cylinders are low due to a broken timing chain, and overheated motor, or fuel washing the oil from the cylinder walls, you can hear that too; the pulses will be missing entirely and the cranking noise will sound far too even.

Your ear's cochlea isn't the only sensory organ you can employ to diagnose a cranky car. Your olfactory nerve is actually pretty good at detecting hydrocarbons. After the engine has been cranked for a while, you may smell fuel around the tailpipe. If you do, you might start by checking spark.

Diagnosis Procedure

1. Check Intake Air Leak

1. Start engine and let it idle.
2. Listen for an intake air leak after the mass air flow sensor.

OK or NG

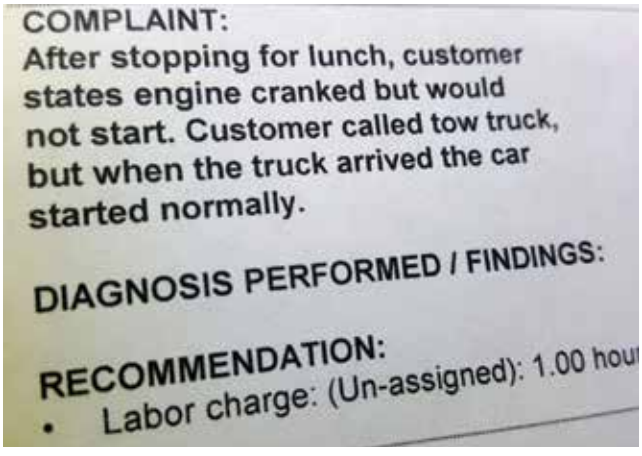
OK >> Go to 2.

NG >> Discover air leak location and repair.

2. Replace ECM

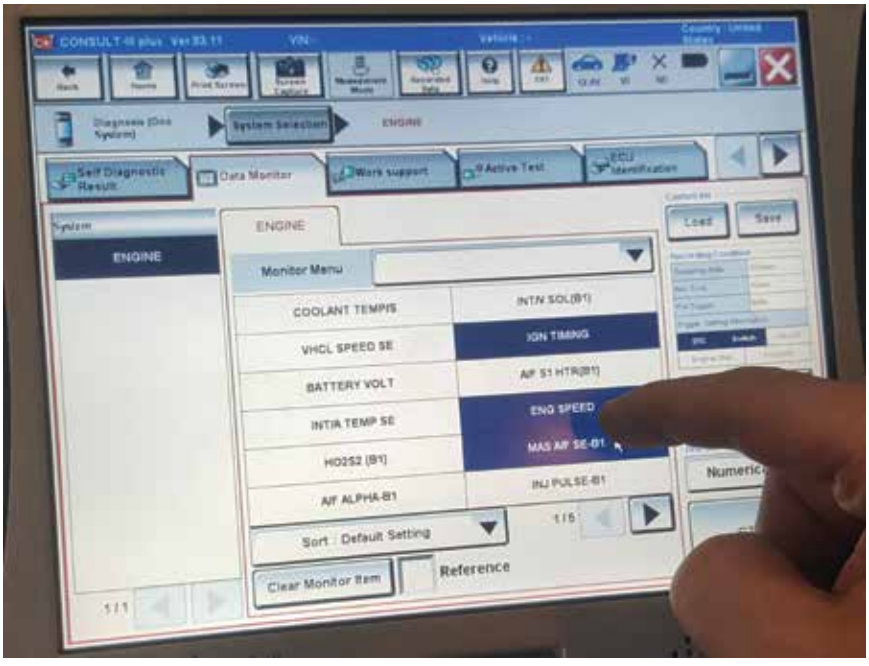
1. Stop engine.
2. Replace ECM.

Don't blindly follow flow charts. Instead, carefully "read between the lines" to find the original intent of the prescribed tests.



Look for clues about how to duplicate the symptom on the repair order.

Finally, you can look for trouble too. Noticing a flashing immobilizer light will save you a lot of diagnostic time. A missing MIL during the bulb check is also a good clue. Depending on the model, a bouncing tachometer needle may be a clue that you have a CKP signal. And a careful peek under the hood may reveal a torn intake boot or disconnected ground strap or connector. Forcing yourself to look and register what's happening while you confirm the customer's complaint can reduce the tests you need to perform and create a shorter path to a correct diagnosis.



Viewing too many parameters at once can slow the refresh rate, especially on older cars.

Codes

The check engine light won't alert you to trouble when a car cranks but won't start, even if the car has a code. The MIL comes on during the bulb check, and that's normal. It may or may not go out while cranking. Also normal. Because the MIL comes on when the engine is running to indicate a fault, and the engine never runs when there's a crank-no-start, you won't have a visual indication that there's a code stored.

This doesn't mean checking for codes is a waste of time though. On the contrary, a quick scan for codes is a great idea. You might find IAT and MAF codes that lead you to a loose MAF sensor connector. You might find several codes that lead you to a common bad ground. Or you might find that you can't communicate with the ECM, and that might lead you to a grounded 5V reference wire.

Live Data

While the scanner is already plugged in to check for codes, we may as well take a look at live data. When we're checking live data using the CONSULT III plus, it's important to think about refresh rate. Older cars will refresh very slowly if too many PIDs are being monitored. It's a good habit to clear all PIDs from the list and add only those you are interested in. This will improve the refresh rate on many cars and also provides a less cluttered and easier to read list. This also gives you a chance to think about what PIDs are going to be important.

Making a recording to play back is also a good idea. You can't see all the PIDs at the same time, and cranking the engine repeatedly will deplete the battery. Making a recording is better because you can analyze the data at your own speed and replay it as many times as you need to.

So what sensor inputs does the car need to start? The most important input is RPM. Usually the ECM will look to the crank position sensor (CKP), but some cars will be able to start using data from the cam position sensor (CMP) or CKP. Regardless, when cranking the engine you should see an engine RPM PID with a realistic cranking speed, usually somewhere around 250 RPM.

The mass air flow sensor (MAF) is another PID to check, but in order to know if the reading is "good", you'll need to check an identical car or have documented the data from previous testing. If the MAF reading is low, it may not be the sensor that's the problem. If the ECM hasn't learned the idle air control valve (IACV) or electronically controlled throttle (ECT) position or the IACV or ECT is sticking, air flow will be decreased. The same is true of vacuum leaks or engine mechanical problems.

The coolant temperature sensor is another quick and easy PID to check. An open sensor may be telling the ECM that engine temperature is -40°F. This can cause excess

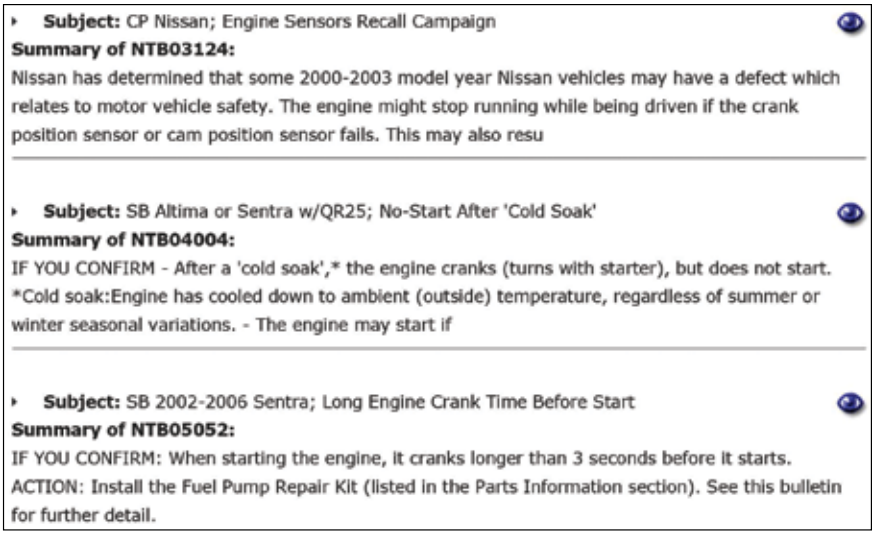
fuel delivery and fuel fouled spark plugs and washed cylinder walls. Likewise an excessively warm reading can cause insufficient fuel delivery and a mixture so lean the spark plugs can't get it to ignite.

Play the Odds

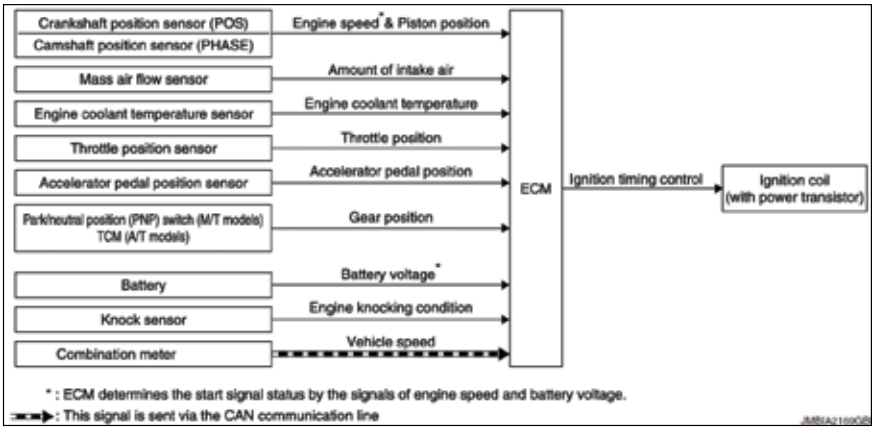
OK, so let's say that you have a car that won't start, you didn't notice anything unusual when you confirmed the symptom, it has no codes, and there's nothing telling in the live data. What next? Well, before deciding on what to test first, it would be a good idea to "cheat".

Before choosing a diagnostic direction, why not see if anyone else has any experience with the same symptom on the same model? Often the same "weak link" will cause the same symptom on thousands of cars. You could ask "the guy who knows everything" at your shop, unless you are that guy. Checking Nissan-techinfo.com for TSBs is another way to find shortcuts. You can also check for trends on Identifix if you have access. Use whatever you have at your disposal to check for a diagnostic direction.

While it's certainly good to work through problems yourself to build skills, we've got to remember that people are paying us by the hour, and whenever possible we should take the shortest route to a diagnosis. Every generation of every model will have some common failures. Always check to see if one of these pattern problems might apply to your situation before deciding what to test first.



Don't try to reinvent the wheel. Solutions to common and difficult to diagnose problems can be found on Nissan-techinfo.com



Working with incorrect assumptions can make diagnosis a real struggle. A quick skim of Nissan-techinfo.com will provide the information you need for accurate diagnosis.

Develop a Theory and Make a Plan

Hopefully you've found a clue or two by now and have some hunches about what might be causing the problem. If not, it's all right. If you're still thinking, "It could be anything!" make a plan to start testing in the middle. In other words, plan tests that will divide the possibilities down the center as much as possible. For instance, spray some starting fluid or propane into the intake and see if the car starts. If the car starts, you've eliminated spark, timing, and engine mechanical problems. If not, you've eliminated fuel problems. The opposite of this technique would be something like starting with a fuel pressure test, followed by checking the injector pulse, and so on.

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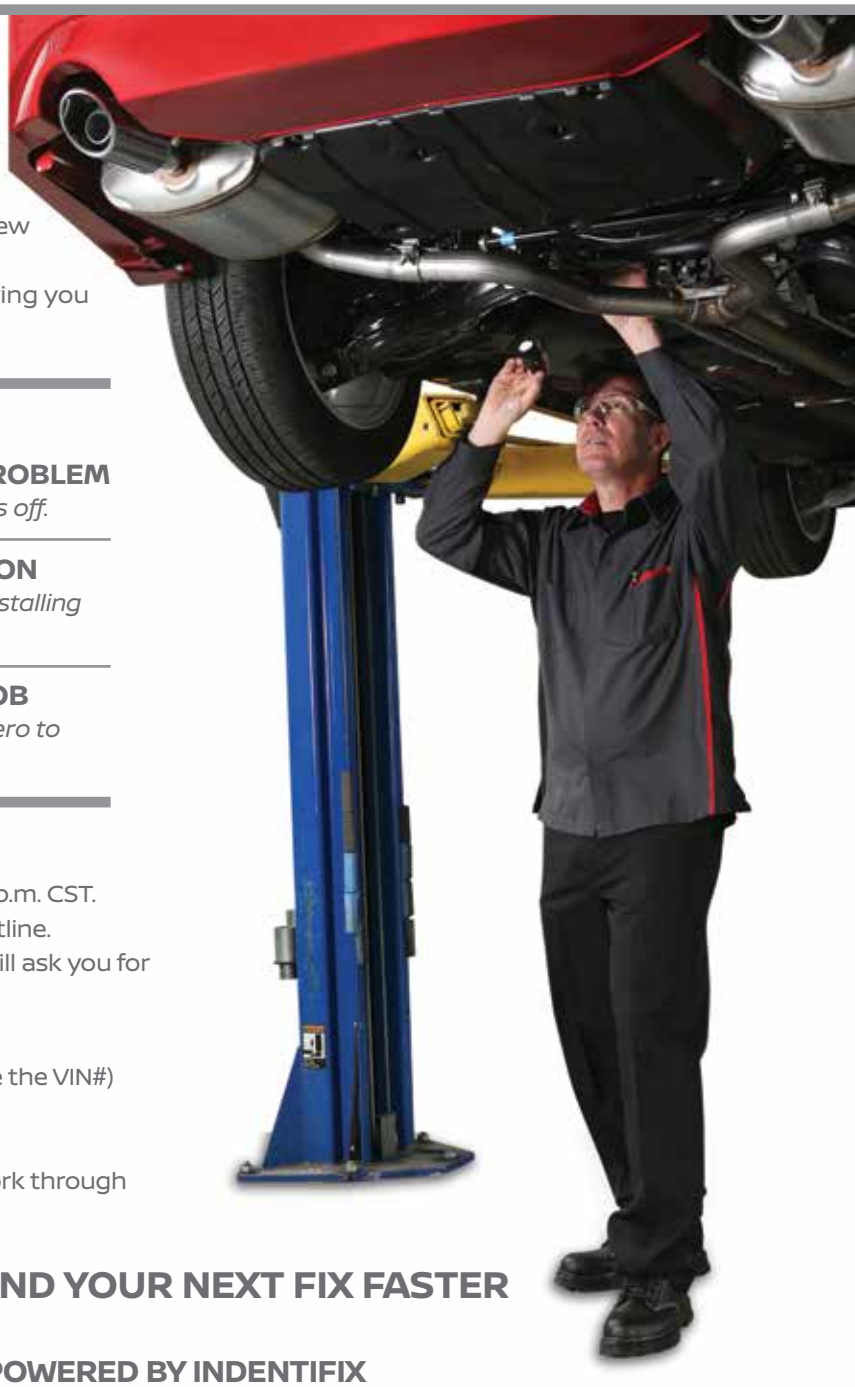

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There is an exception to this rule, if you have reason to believe that there is a particular cause for a problem, then it's a good idea to go directly to the area you suspect rather than testing from the center outwards. A blinking immobilizer light is a reason to go straight to the immobilizer or body ECU data list. A TSB indicating a rash of failing crank sensors is a good reason to focus on the crank sensor. A co-worker telling you that he just replaced two MAF sensors on the same model provides a valid reason to jump straight to the MAF PID in the data list.

Another important factor in making a plan is how difficult the tests will be. Which test should be next should be decided not only on the value of the test, both in elimination of other possibilities and the conclusiveness of the test, but also the time it will take to perform.

Know Before You Go

If you don't know how it's supposed to work, don't waste time testing. Look at a system description, wiring diagram, read between the lines in a flow chart, or do whatever you need to understand what you're about to test. That said, some systems and components are identical across many Nissan products, so the more experience you develop, the less pre-testing research you'll need. However, even when you think you know how a system works, always take a moment to skim the manual and confirm; don't make an assumption that it's like the other years and models you've encountered.

Testing

Testing is always the final step. Our natural tendency is to reach for tools and start to "work", but this is nearly always counter-productive for all but the very lucky technician. If you have a plan mapped out in your mind, go ahead and execute. If not, work on the plan before starting.

As mentioned previously, balance the quality of the test with the time it will take to perform. For instance, a fuel pressure test is far more conclusive than listening at the filler neck for the fuel pump. However, if you'll need to remove the cowl to check fuel pressure, it might be worth trading definitiveness and time, for speed and possibly misleading results. There are many examples of this type of trade, here are a few:

- Listening to an injector with a stethoscope vs. using an oscilloscope to check the voltage and current waveforms.
- Checking cranking vacuum vs. performing a compression test.
- Checking spark from a single easily accessed coil vs. removing the plenum to check all of the coils.

Don't Believe Everything You Think

A suspicion has a powerful influence on our thinking. If you strongly suspect an outcome, you're more likely to find it, whether it's true or not. How is this possible? Tests are black and white, right? There is a chance of error in any test you perform. You may make a bad connection with one of your voltmeter leads. You may rely on a sensor reading in live data, but fail to notice that the refresh rate is 8000ms and the reading you're looking at now was from 8 seconds ago, before you started to crank the engine.

There are all sorts of ways to make mistakes, and if the result is the one you were expecting, it's more likely you'll accept it. The inverse is also true. When an outcome is unexpected, we start looking for reasons why it's "incorrect". The best advice is to treat every test result like it's wrong. Always confirm a result with a different test before coming to a conclusion.

In Conclusion

You can become the go-to guy for no-start diagnosis, the guy the service manager calls when he wants the correct answer quickly. Just remember:

- Observe the symptom carefully.
- Use your CONSULT III plus to get more information.
- Use all the information resources at your disposal.
- Make a plan before testing.
- Understand how it works before making conclusions.
- Look for the easiest possible test.
- Confirm your findings with a different test to verify.

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Don't Sweat the Summer

Diagnosing Nissan HVAC Issues

As Summer arrives, we must be prepared for increased demand for air conditioning repairs. We'll focus on getting the necessary information from Nissan's TechInfo website, using the CONSULT III plus and addressing compressor issues.

Potentially complicated air conditioning problems should not be a reason to be apprehensive about offering HVAC repairs. A quick search online will support two important statements: 2015 was the hottest year on record; and, consumers highly rate the importance of working air conditioning for their cars. We can all expect that more customers will need help figuring out why their AC doesn't work this summer. Here we'll discuss logical diagnostic tips, and how to use the Nissan TechInfo website to find all needed information.

Getting Prepared for Anything HVAC

If your shop is expanding AC repairs to the Nissan brand, look at any vehicle's service manual section called "HA – Heating and Air Conditioning" and you'll find the "Preparation" portion outlines all the recommended service tools, including their Nissan Tech-Mate part numbers. Pricing and availability for these recommended service tools are excellent.

Take a moment to remember it is our responsibility as professional technicians to take proper precautions in handling refrigerant. Do not evacuate to the atmosphere, and use approved service tools for capture/recharging. Refrigerant R134a still contributes to environmental degradation. Also, be mindful that most fluorescent leak detection dyes will damage painted surfaces.

Where to Start?

A customer may ask for you to recharge their AC because they know it doesn't blow cold air. Don't skip asking them for more information. Does the AC start cold and get warm later, or vice-versa? If so, you might need to spend more time investigating the symptom than a simple recharge. Does it blow cold some days and not others? Does the heater work? By asking these few additional questions, you could give yourself a valuable lead as to where to check first.

As with fuel injection or ignition timing, having a general understanding of what the AC system is designed to do will help you tremendously when trying to figure out where to start or what went wrong. We'll address the components that create cold air through heat exchange, but be well aware that there may be no point in looking for refrigerant leakage if the blend is stuck too hot.

It is a universal law that heat energy only ever moves in one direction: from higher to lower temperature. The larger the difference between two temperatures, the faster the heat moves from the hotter into the colder. Both air conditioning and radiator cooling systems are engineered around the movement of heat energy. Both use a medium to hold the heat (refrigerant / radiator fluid), a method to flow the medium (compressor / water pump), or a way to dissipate heat stored in the medium (condenser / radiator).

The Medium

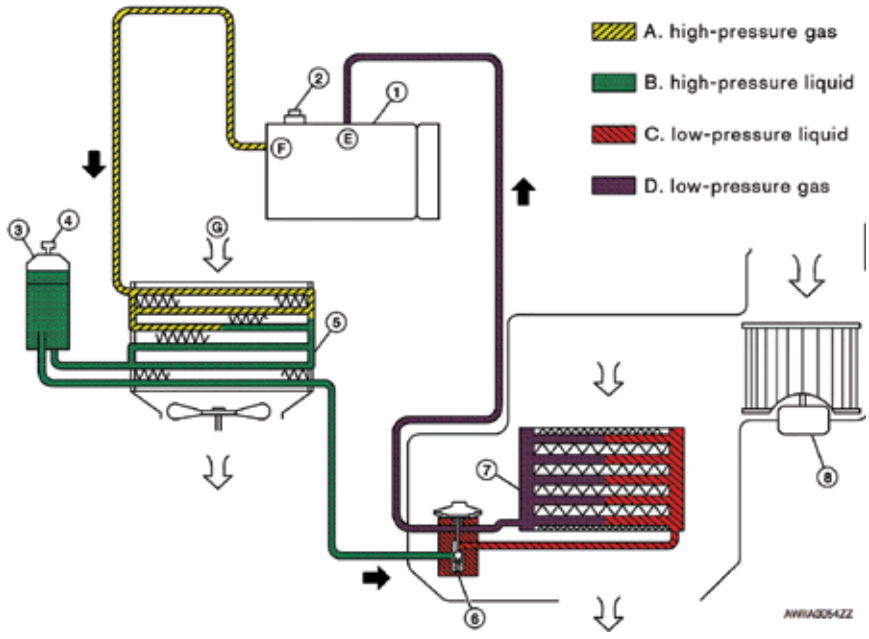
The lifeblood of the air conditioning is the refrigerant that facilitates the transfer of heat from one part of the AC into another. R134a is the most common refrigerant used in vehicles at this time, but new, more environmentally friendly refrigerant chemicals are beginning to appear. R134a will change from liquid to gas around -19°F, but this vaporization point will shift one degree higher for every increased pound of pressure per square inch. This 1:1 temperature to pressure relationship, and the ability to absorb heat, makes R134a excellent at moving heat from one location to another within air conditioning systems.

This diagram is a brief reminder of the AC flow. The compressor pushes high-pressure gas (A) into the

condenser, where it cools and becomes high-pressure liquid (B). The high-pressure liquid is metered into the low-pressure region inside the evaporator by the expansion valve. The drop in pressure also drops the refrigerant boiling point down to about 32°F (C). Drawing in heat from the cabin airflow passing over the evaporator fins, the low-pressure refrigerant liquid vaporizes and becomes low-pressure gas again (D).

With too little or too much refrigerant, the system pressures will be too low or high, and this prevents the system from operating correctly. For every Nissan vehicle, the service manual includes details about specific operating pressures, including altitude and ambient humidity considerations for AC cooling performance. This can be found under the "HAC – AC Control" section.

More often than not, an air conditioning system stops performing up to specification when the refrigerant leaks out. Be systematic in your approach to finding the source of a refrigerant leak. Check the high-flow Schrader valves of the high/low pressure service connections. Visually inspect every under-hood component for evidence of leak detection dye or residual refrigerant oil that may indicate a slow leak. A small amount of residual near the compressor pressure relief valve is normal. For suspected evaporator leaks, use a refrigerant "sniffer" (Nissan SST J-41995) in the evaporator plenum drain hose. In some models, you can remove the glove box and cabin filter to visually inspect the evaporator for leak detection dye. It is sometimes necessary to have a customer return to the shop later for a follow-up investigation if no leaks are found on the service appointment.



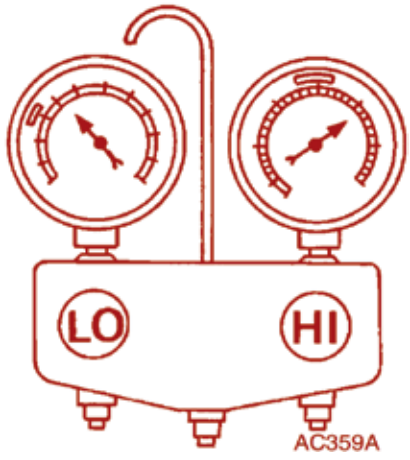
This 2004 Frontier lost its refrigerant recharge over the course of a week. Thankfully, this leaking high pressure hose was easy to identify.

What if the system was not discharged, but still malfunctioning? A fundamental understanding of the transition between the high-pressure and low-pressure sides of air conditioning will help logically identify potential problems.

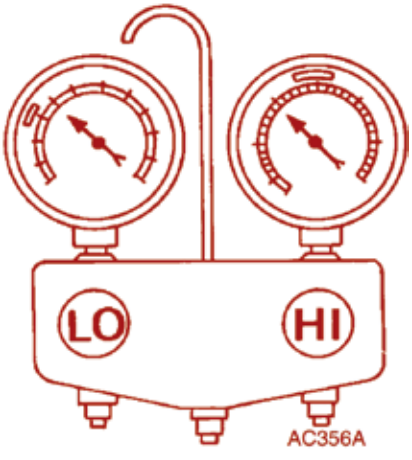
Moving the Medium: Compressor Operation

For the following, we are considering the 2010 Altima. According to the service manual, for 86°F ambient temperature, normal high-side pressure range is 177-217 psi and low-side pressure

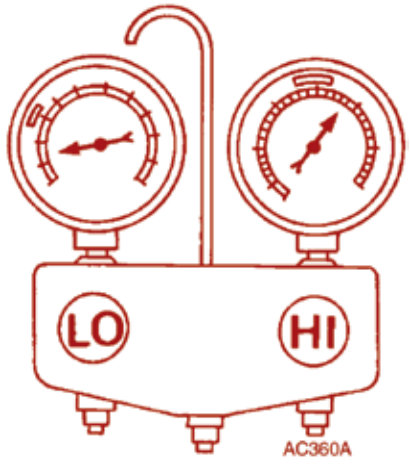
range is 35-43 psi. These figures are found in the "HAC – AC Control" section of the service manual. On each pressure gauge diagram,



High- and low-sides too high.



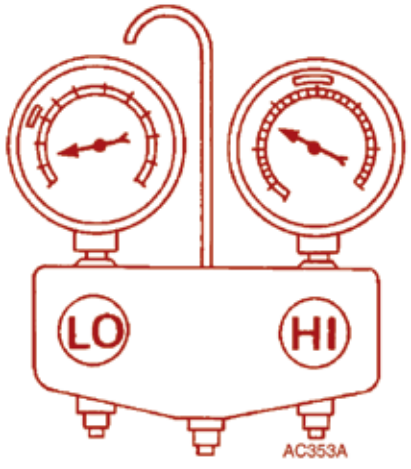
High-side too low, low-side too high.



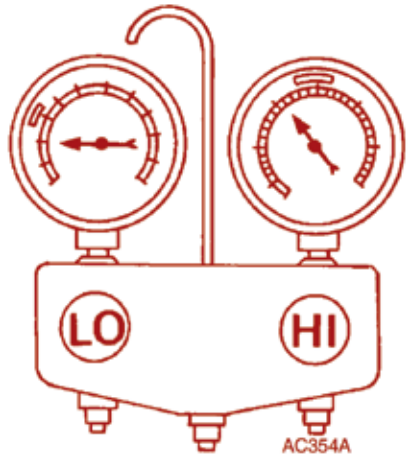
High-side too high, low-side too low.

this operating range is indicated on the dial face.

- **High- and low-sides too high**
  - *Possible cause:* overcharged system.
  - *If also:* the low-pressure line is NOT cold; *Possible cause:* restriction in condenser or poor heat exchange (because the condenser fan is inoperative).
  - *If also:* high-side pressure drops immediately when compressor stops its cycle; *Possible cause:* air trapped within the system.



High- and low-sides too low.



Low-side goes to vacuum

  - *If also:* evaporator is frosting over; *Possible cause:* expansion valve is stuck (partially) open at all times.
- **High-side too high, low-side too low**
  - *Possible cause:* expansion valve stuck closed.
  - *If also:* condenser is hot, but receiver/drier is NOT hot; *Possible cause:* condenser restriction or receiver/drier restriction.
- **High-side too low, low-side too high**
  - *If also:* high- and low-side pressures are equal; *Possible cause:* compressor is not operating
  - *If also:* high- and low-side pressures equalize soon after compressor stops cycling; *Possible cause:* compressor internals are defective
- **High- and low-sides too low**
  - *Possible cause:* system is partially discharged due to leak.
  - *If also:* pipe temperature near expansion valve is very low, or high-side pipe is cold to touch elsewhere; *Possible cause:* restriction at expansion valve or high-side pipe.
  - *If also:* temperature is different on inlet versus outlet sides of receiver/drier; *Possible cause:* deteriorated or saturated desiccant inside receiver/drier.

- **Low-side goes to vacuum**
  - *If also:* the system keeps cooling even after compressor stops cycling; *Possible cause:* water contaminating the refrigerant charge, icing the expansion valve, for example.
  - *Possible cause:* expansion valve stuck closed.

Control the Flow: Compressor Command Considerations

If air conditioning performance is spotty or intermittent, a customer's car may have a control malfunction. For most Nissan vehicles, when the AC or defroster switch is depressed on the instrument panel board, the front air control unit will output a COMPRESSOR ON signal to the BCM. Then, the BCM will transmit the COMPRESSOR ON signal to the ECM via CAN communications. The ECM determines whether the COMPRESSOR ON conditions are good. If the ECM judges the conditions acceptable, the ECM will command the IPDM E/R (Intelligent Power Distribution Module Engine Room – under-hood fuse and relay box) via CAN to turn on the AC compressor relay and provide power to the compressor.

Be sure to look up your vehicle's specific implementation of the command circuit components. For example, the 2014 370Z uses data from the combination meter to determine necessary data for its compressor cut-off consideration. Let's walk through how to evaluate each of these circuit components next.

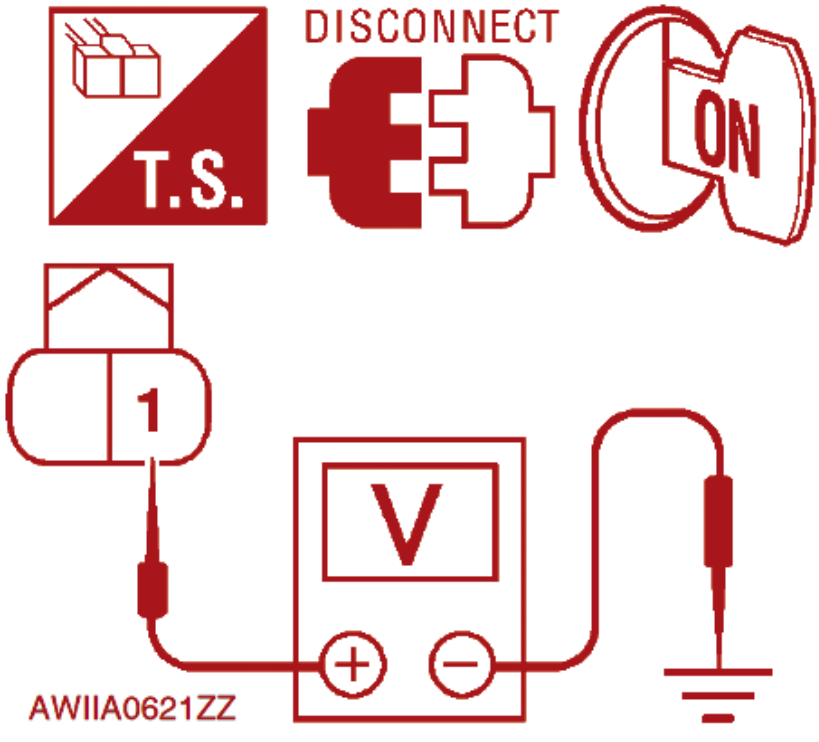
Diagnosing Compressor Circuit Failure

Before breaking out tools and going hands-on, check for appropriate technical service bulletins. All TSBs are available on Nissan-techinfo.com up-to-the-minute, and may point you in the right direction immediately. Specific information below pertains to a 2010 Altima, and can be referenced in the service manual "HAC" section.

On non-hybrid vehicles, the compressor is still belt-driven, so be sure to check whether the belt is in good health, in proper tension, and not misaligned to the compressor pulley.

Does the Magnet Clutch Not Engage?

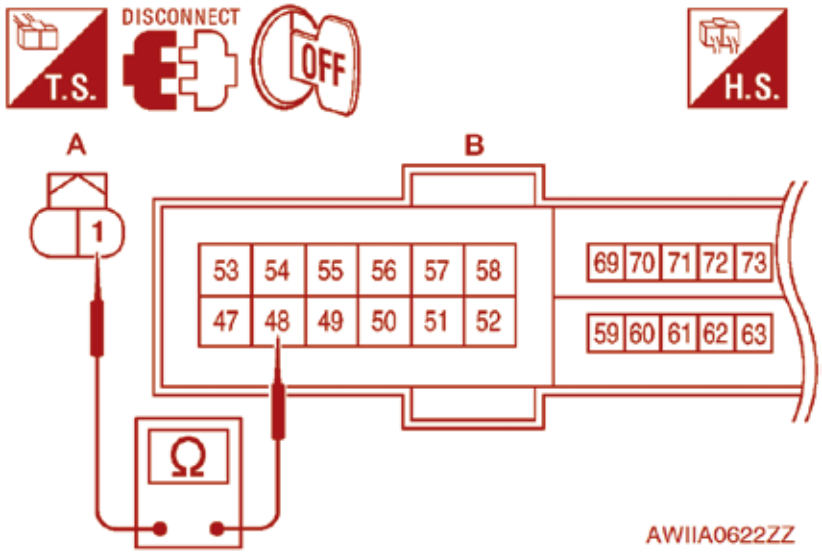
- Check the electrical circuit at the compressor connector first for power and ground. At this point, you can provide a 12v power source directly to the magnet clutch



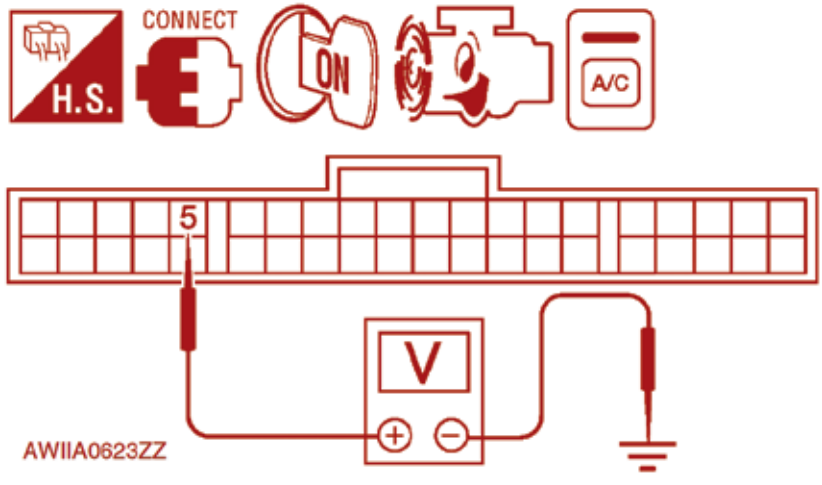
Each quick reference test diagram uses symbols to expedite diagnosis. The multimeter icon will show where to put the probe leads, and what to check for (voltage, amperage, resistance). The first icon along the top tells you how to orient yourself with the connector needed for testing: whether to look at it Terminal Side (TS), or from the Harness Side (HS) for back-probing. The second icon confirms you must disconnect the connector for testing. This third icon means Key on, Engine off. There is a separate icon for engine running, and all icons are found in the service manual "GI – General Information" section.

and confirm compressor operation.

- Check circuit continuity between AC relay in IPDM and AC compressor. Be aware that in some models, individual relays are not sold separately, and are intrinsic to the IPDM assembly.
- Check fuse in IPDM (exact location and amperage rating specified in service manual).
- Check for COMPRESSOR ON signal leaving the front air control connector when AC button is cycled.
- Check for continuity between front air control and BCM harness connections.



Testing the AC Compressor relay. Meter set to resistance. Check for continuity from AC compressor connector terminal 1 (TS) to terminal 48 of the IPDM harness connector viewed from harness side (HS).



Testing whether the compressor ON signal is leaving the front air control unit. Check the manual because the expected test results may not be obvious: Compressor ON signal = 0v; compressor OFF signal = 9-12v.

If everything checks out OK up to this point, there may be a CAN communications error. The CONSULT III plus can perform Local Area Network (LAN) testing. Perform an all-systems check, then click the CAN support monitor tab. Check for communications between BCM to ECM, and between ECM to IPDM.

It may seem heavy-handed to do all the testing outlined above, but it would be a real bummer to mistakenly replace a compressor assembly when the problem is control-related. The purpose of the above testing is to ensure that the compressor ON signal is capable of reaching the compressor magnet clutch, and once there, the clutch can cycle on.

Does the Magnet Clutch Circuit Test Good, but Still Not Engage?

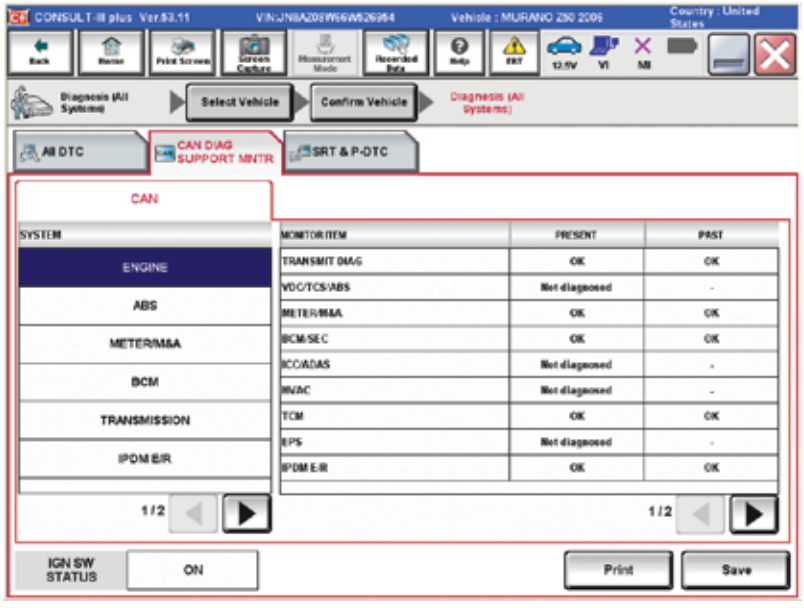
The ECM may have judged the operating circumstances such that the compressor cannot be turned on, and therefore it does not send the signal at all. We should check for the activation of safety or self-protection components:

- Check the refrigerant pressure sensor. For the 2010 Altima, compressor OFF signal will be transmitted if data from pressure sensor is less

than 17.4 psi, or greater than 398 psi. Note: this sensor test procedure is found in the service manual's "EC – Engine Control" section.

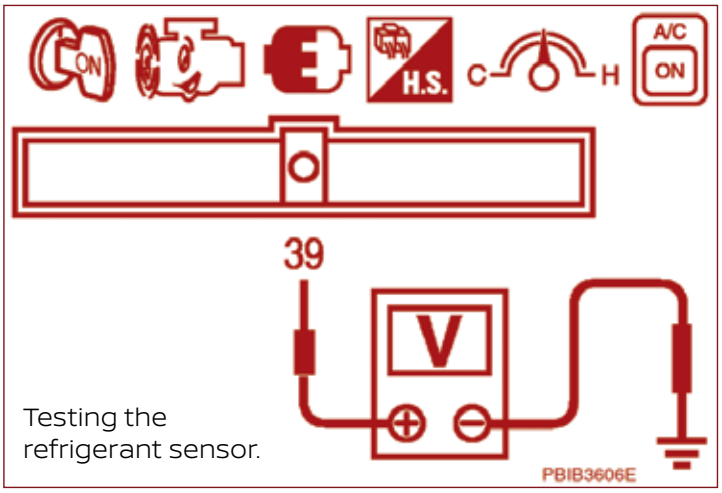
- Check the ambient cabin temperature sensor (for systems with automatic AC). Compressor OFF signal is sent when ambient temperature sensor data is < 23°F.

The ECM will also deny compressor ON signal if the vehicle is driven wide-open-throttle, if the engine coolant temperature is excessively high, while the engine is cranking, at excessively high or low engine speeds, or based on power steering demands while at low speeds.



CAN support monitor screen shows whether a control module is not responding, or has not responded recently.

At the end of the line, if a magnet clutch is determined to be faulty, Nissan offers complete rebuilt compressor assemblies at reasonable pricing. On most applications, individual clutch or coil components are not available separately.



Testing the refrigerant sensor.

Hybrid Vehicle Air Conditioning

It is worth mentioning that Nissan hybrid vehicles have different implementations for air conditioning. First, the engine is not always running, and therefore a belt-driven compressor would not operate unless the engine was started back up. Second, using the HV battery pack to power the compressor reduces engine load and increases fuel efficiency.

Electric AC compressors are three-phase motors and the refrigerant is suspended in non-conductive oil, different than standard vehicles' PAG oil. The two oils are not compatible, and using standard PAG or even normal fluorescent leak detection dyes can contaminate entire hybrid AC systems. Be sure to consult the specifics of the service manual before working on hybrid AC systems, and reference the previous Nissan TechNews article on hybrid compressors (August 2011, *High Voltage Air Conditioning*) at NissanTechNews.com for more details.

Finishing the Job with Confidence

Customers and technicians sometimes fear air conditioning repairs for the same reason: they may not succeed the first time. Properly educated, customers can be prepared for an initial recharge and then a follow-up leak check for repairs. Nissan Genuine Parts are priced competitively, and are perfect fit replacements to finish the job confidently. With support from Nissan's TechInfo website, nissan-techinfo.com, and their quality parts, you can tackle any AC problem – no sweat!

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Nissan Supplemental Restraint Systems

Damage analysis and repair using Diagnostic Trouble Codes

All photos
Courtesy of
Nissan of Union
City, GA

Supplemental Restraint Systems (SRS) – the air bags, seat belts, associated sensors, controllers, and instrument panel indicator lamps – include multiple layers of monitoring to help provide a 100% readiness status. Read on to familiarize yourself with some things that could light the SRS warning lamp on the instrument panel.

Just as sound systems have evolved from single channel mono devices to the multichannel surround sound of today, the air bags, seat belt pre-tensioners, sensors, controllers and other Supplemental Restraint System (SRS) components on Nissan vehicles have advanced to provide occupant protection during a collision. Nissan SRS is engineered to be robust and self-monitoring.

Notes for Technicians

Diagnostic information in this article applies only to the Nissan year and models mentioned. Consult the service manual for the Nissan vehicle on which you are working prior to doing any repairs.

Before servicing the SRS, turn the ignition switch off and disconnect both battery cables. For approximately three minutes after the cables are removed, it is still possible for the air bag and seat belt pre-tensioner to deploy. Do not work on any SRS connectors or wires until at least three minutes have passed.

When working near the air bag Diagnosis Sensor Unit or the air bag system sensors with the ignition on or engine running, do not use air or electric power tools or strike near the SRS components with a hammer. The vibration could activate a sensor and deploy an air bag. Also, do not use electrical test equipment to check SRS circuits unless instructed to do so in the Nissan service manual.

SRS Damage Analysis

The electronics used in Nissan SRS self-monitoring functions are so sophisticated that almost any failure in a restraint systems component will set a diagnostic trouble code (DTC) and light the SRS warning lamp on the instrument panel. Pulling DTCs at the estimating stage helps identify fault codes relating to the various air bags, seat belt pre-tensioners, crash zone sensors, control modules, and other SRS components, even in cases where there is no instrument panel warning light illuminated. Some codes point to a malfunction, some identify if various air bags, seat belt pre-tensioners, and other SRS components have been deployed and must be replaced, and some indicate a need for component calibration or initialization.

This information helps you get a preliminary feel for how extensively the restraint system has been damaged. It provides an efficient head start on development of a repair plan that results in complete and safe vehicle restoration. A complete damage analysis also helps make your estimate more thorough and accurate.

DTCs can indicate the need for further investigation of components or circuits that you may otherwise have missed. They can help prevent supplements for work that may have been better scheduled at an earlier point in the repair sequence, and avoid unanticipated late-stage sublets that delay job completion and increase the number of car rental days.

Warning Light Does Not Tell the Whole Story

The SRS warning light system may not provide a complete listing of system faults. Some faults may set a DTC, but not trigger a instrument panel light. A lit warning lamp does not always mean that a deployment has occurred, as some SRS malfunctions could occur without a collision. An unlit warning lamp could be hiding

previously stored intermittent faults that do not set a current code. And sometimes the absence of a warning light could indicate a dead bulb or other lamp problem, rather than an absence of DTCs.

Plug In – for a More Complete Picture

When you key-on the ignition, whether the air bag light comes on or not, plug your CONSULT III scan tool into the OBD II connector to get a list of all SRS fault codes. Codes that point to a specific source of the fault are relatively easy. For example, on the 2012 Altima, the codes B1033 and B1034 refer to crash zone sensor malfunctions. Diagnosis involves a visual check of the wiring harness connections, and if that is not the problem, replacement of the crash zone sensor.

A broad-based code may point to an entire circuit for you to investigate in order to pinpoint the exact fault. An example on the 2012 Altima is the code B1054, which refers to an open in the driver's air bag stage 2 circuit. That circuit includes the air bag, the Diagnosis Sensor Unit (DSU), the Spiral Cable (aka clock spring), related wiring harnesses and wires, and of course, power and ground. After replacing any faulty part, you'll calibrate or initialize the replacement component if required, then repeat the scan. If the code does not reappear, your repair is successful.

SRS Self-Diagnosis

Detailed SRS self-diagnosis results can be read using a CONSULT III plus. The warning lamp default in key-on, engine-off (KOEO) operation is User mode, which provides general problem alerts that may not tell the whole story. If there are no malfunctions, the light will come on for 7 seconds, then go off. If the light stays on, an air bag or seat belt pre-tensioner has been deployed, or there is a malfunction in the ACU, the air bag power supply circuit, or the warning lamp circuit. If the light does not come on at all, either the SRS controller – an Airbag Control Unit (ACU) in Nissan parlance — or the warning lamp itself is malfunctioning.

The Nissan SRS can provide more detailed diagnostic information for technicians, but you must first switch from User to Diagnostic mode (see sidebar: *How to Change Self-Diagnosis Modes*, p31). For a proper diagnosis, use the CONSULT III plus scan tool, as Nissan cannot verify the accuracy of other tools.

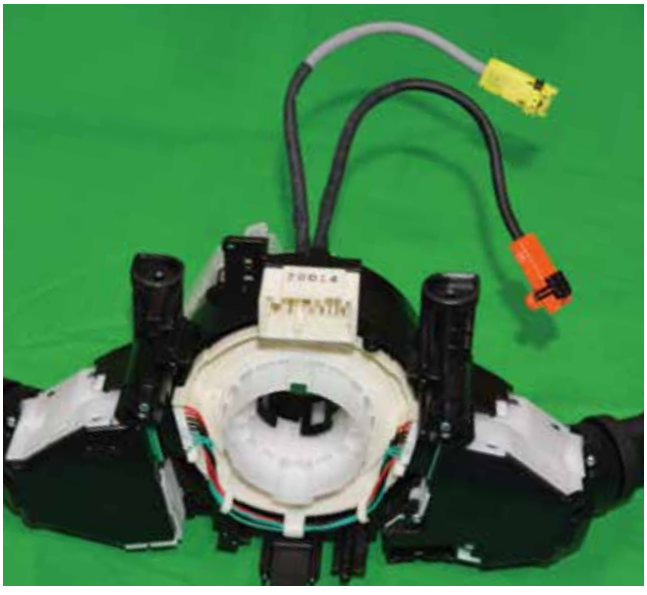
Scan, Inspect, Repair, Re-scan

A scan allows you to read and clear trouble codes, collect sensor and control module data, perform input and output tests, program, code, calibrate, or initialize replacement components, and conduct many other diagnostic functions. Generic scan tools may be simple code readers with only basic data collection capabilities. The CONSULT III plus is the only scan tool that enables you to perform every factory scan function needed for diagnosis and repair verification on Nissan SRS components. Additionally, it offers bi-directional communication capabilities so you can not only read, but also activate and test various

The electrical connections between the air bag and the diagnosis sensor unit pass through the spiral cable. The white nib at the top of the spiral cable assembly on this 2012 Versa must be centered while the wheels are pointed straight ahead, and the steering wheel held in place until installation is complete.

modules and system components, and allows you to code, re-flash or upgrade modules.

Once you have pulled all SRS-related DTCs, use CONSULT III plus to look up the explanation of each code. CONSULT III plus will present a logical repair order sequence to follow for each different code, based on Nissan service manual information. (Be sure to review this information carefully.) After each step in the sequence, re-scan to confirm that the DTC is no longer present. At the first step in which your re-scan did not show the same fault code popping up again, your repair of that malfunction has succeeded, and you can clear its code from memory. If the DTC is still showing, you have further diagnostic work to do.



The steering angle sensor mounts in the bottom of the spiral cable for this 2012 Versa. If the original SAS is undamaged, it can be transferred from the old spiral cable and dropped into place in the new one.

For example, the code "B1051" for the 2012 Altima points to a possible short to ground in stage 1 of the dual-stage driver air bag module. CONSULT III plus will tell you first to visually check the stage 1 wiring harness connection, and replace the harness if it has visible damage, a poor connection, or is loose.

If that does not clear the code, inspect the spiral cable circuit for damaged wiring or harness connections. Also inspect for continuity from the driver air bag module terminal 1 on connector M82, to terminal 29 on the spiral cable connector M29, and from the driver air bag module terminal 2 on connector M82 to terminal 30 on spiral cable connector M29. Check to confirm that there is no continuity to ground from terminal 1 or terminal 2 on the air bag module connector M82. Repair as needed and re-scan using CONSULT III plus.

The pre-tensioner for the 2014 Sentra, like an air bag, ignites a gas charge that then forces a gear or ratchet to move in a direction that tightens the belt. The pre-tensioner is deployed simultaneously with the driver's and front passenger's air bags, and must be replaced after a front collision in which the air bags and pre-tensioner are deployed.

If the same DTC reappears, replace the air bag diagnosis sensor unit, and re-check the system. If the code is still present, replace the driver air bag module, and re-scan. If the code appears again, replace the related wiring harness.

Scan once again. If you made it this far into the repair order sequence, you will have inspected and replaced everything in the driver's air bag stage 1 circuit, and the

fault will have been eliminated. Clear the DTC, and move on to the next fault code, if any.

Spiral Cable, AKA: Clock Spring

The steering wheel mounted driver's air bag requires electrical connections to be maintained while the wheel is being turned. Nissan's spiral cable connects both the power and ground sides of the driver air bag circuit. It winds and unwinds as the driver turns the steering wheel, all while maintaining hardwired electrical connections.

All driver air bag DTCs; B1049 - B1052 and B1054 - B1057, require inspection of the spiral cable circuit if the prior diagnostic step revealed no damage to the driver air bag wiring harnesses.

Inspect the spiral cable for any sign of damage to its wiring, connectors, or housing. Look for burns or melted connectors to the driver air bag. The ignition of gas when the air bag deploys generates enough heat to melt the plastic connectors to the spiral cable. If there is no visible damage to the harnesses, check for continuity on both the power and ground sides of the circuit. If there is continuity on the power side, but not on the ground side, the spiral cable can be re-used.

Check the Nissan service manual for the exact points that must align with each other on the spiral cable and the steering wheel. The spiral cable has, in most cases, enough extra length to rotate approximately 2.5 turns in either direction. With the front wheels pointed straight ahead, the spiral cable must be installed in the neutral position of approximately 2.5 turns of the cable from either end position back to the center. If it is not centered properly during installation, it could break as the steering wheel is rotated during driving.

Complex System, Simple Repair

Nissan's Occupant Classification System (OCS) uses input from technology in the front passenger seat to determine if there is an occupant, and whether their weight is in the range of a young child or an adult. The information is fed to the ACU. If the front passenger is a child, the ACU may not deploy the air bag. Depending upon the crash severity and the age and model of the Nissan vehicle, if the right front seat occupant is an adult, the ACU may activate the passenger air bag in two separate stages timed a few milliseconds apart, to stagger the impact of the air bag's explosive force against the seat occupant.

The OCS in the 2012 Altima includes a sensor mat and a control module. Trouble codes B1017, B1020 and B1021 all point to a fault in the 2012 Altima's OCS control module. Code B1018 suggests that the sensor mat is malfunctioning. Code B1019 covers any other possible causes of OCS failure. The sensor mat and control module are both built into the front passenger seat cushion, and form

The driver's and front passenger's air bags for most 2007 and newer Nissans are a dual-stage design that includes connections for two separate inflator circuits, one for partial inflation in a minor collision, and a second for maximum inflation in the event of a higher impact. Shown is the driver's air bag for a 2014 Sentra.

a single assembly. Do not attempt to disassemble the right front seat cushion assembly. The repair for any of these five different DTCs is replacement of the entire front passenger seat cushion assembly.

The only circumstance in which there are OCS repair options on the 2012 Altima is if your scan reveals DTC B1022, which points to a communication failure between the OCS control module and the air bag diagnosis sensor unit (DSU). Even then, the repair order sequence is brief.

1. Visually check the wiring harness connection
2. Replace the harness if it has visible damage
3. If the DTC is still current, replace the RH front seat cushion assembly (do not disassemble)
4. If the DTC is still current, replace the air bag diagnosis sensor unit (DSU)

Seat Belt Pre-tensioner Diagnosis? Use Only CONSULT.

Beginning with the 1999 Maxima, Nissan included seat belt pre-tensioners in the SRS, and expanded that to other models in subsequent years (check your Nissan service manual for details on which SRS components are on the vehicle in your bay). On the 2012 Altima, DTCs B1209 (front collision detection) and B1210 (side collision detection) require you to replace all seat belts, including pre-tensioners, after a collision in which pre-tensioners were deployed.

It may not be easy to tell simply by visual inspection whether or not a seat belt pre-tensioner has been activated. If a pre-tensioner was deployed, but has not been replaced, the ACU will not clear the fault code. Instrument panel warning lights can't tell you the deployment status of a given pre-tensioner. You'll need to use CONSULT to determine which pre-tensioners have been activated.

How to Change Self-Diagnosis Modes

To switch from User to Diagnosis mode:

1. Turn ignition from OFF to ON.
2. Within 1 second after air bag light comes on for 7 seconds and turns off, turn the ignition switch off.
3. Wait for 3 seconds.
4. Repeat steps 1 to 3 two more times (total of 3 times).
5. Turn ignition switch ON again. (Turn to Diagnosis mode.) Repeat the above four steps, in the same order, to switch from Diagnosis back to User mode.

NOTE: In User mode, if the air bag warning light has come on for 7 seconds and then is not blinking, there is no malfunction, and the system will not switch to Diagnosis mode. In Diagnosis mode, if no malfunction is detected, you can switch back to User mode by turning the ignition from OFF to ON.

Once in Diagnosis mode, the air bag warning lamp will flash on and off in a different sequence for each SRS component or system where it sees a malfunction. After the initial 7 seconds on, the lamp will begin a flash pattern that is associated with the malfunctioning component. Refer to your Nissan service manual for descriptions of all flash patterns used in the SRS warning lamp system.

The warning lamp system covers additional SRS component faults. It uses flash patterns that are unique to each type of malfunction. The flash pattern will repeat until you make the indicated repair, after which you can clear the code.

CONSULT III plus is the Nissan factory diagnostic tool for the SRS. It records and displays the same information as the warning lamp system, plus additional data that further narrows the diagnostic search. CONSULT III plus displays DTCs for individual SRS components, identifies whether the fault is likely on the power or ground side of the circuit, and points out if two circuits may be shorted together.

CONSULT III plus is very useful for finding intermittent faults. An intermittent incident that occurred in the past but is not being detected currently can be reviewed by going to the SELF DIAG (PAST) option in CONSULT III plus. You can then replace the malfunctioning component and clear the code. If the incident was previously repaired but not cleared from memory, erasing it is easy using CONSULT III plus.

If the warning lamp lights up, but you can find no DTC using CONSULT III plus, one likely cause is that the fault was repaired, but the trouble code was not cleared in the ACU. Clear the DTC by turning the ignition switch OFF for at least 1 second, then back ON.

The Nissan Supplemental Restraint System is a multi-channel structure featuring multiple layers of protection for vehicle occupants, continuous self-monitoring, and reporting for driver notification and technician diagnostic assistance. Failure of any one SRS component will keep that vehicle in your bay, but the Nissan SRS does an excellent job of pointing you to the malfunctioning part(s). |

The Airbag Control Unit is Boss

The ACU continuously monitors the operating status of all SRS sensors, air bag assemblies, seat belt pre-tensioners and buckle switches, the OCS, and the restraint systems warning lamp portion of the combination meter, on vehicles equipped with these components. It maintains a real-time record of the status of all SRS components. It turns on the instrument panel warning lamp, and records trouble codes (DTCs) for diagnostic use by technicians armed with the Nissan CONSULT III plus scan tool.

In a collision event, it sends the signal to the squib to ignite the appropriate air bag(s) and seat belt pre-tensioner(s).

Replace All Deployed SRS Components

If any SRS components have been deployed, you must replace the deployed components and also replace the ACU. If you see the B1209 or B1210 codes while working on a 2012 Altima or Maxima, don't stop at just replacing the air bags and belt pre-tensioners. The DTCs disappear only after you also replace the ACU.

Do not install the new ACU before replacing all other SRS components. One common error is to replace the deployed air bags, but not notice that the seat belt pre-tensioners also need replacing. If you install a new ACU, but have not yet replaced the seat belt pre-tensioner, the replacement ACU will see it and set a fault code. You will have to replace the pre-tensioner, but because the only way the DTC can be erased is to replace the ACU, you must then also install another new control module.

Is Everyone Ready?

All SRS components must continuously update the controller of their operating status. Once all malfunctioning or damaged components are replaced, you must calibrate, initialize, or program the replacement ACU to ensure that it can communicate with each new component. Use CONSULT III plus to see the part number of the original ACU before disassembling the vehicle. You'll need the part number and code or I.D. for its software programming, to ensure ordering the correct replacement. Check the service manual for procedures to initialize or program the ACU before removing the original unit.

The air bag diagnostic sensor unit monitors operating status of all SRS components, sets trouble codes, and activates air bags and seat belt pre-tensioners in a collision or rollover event.

Nissan air bag connectors feature two types of lock, to provide reliable electrical continuity. Orange squeeze tabs on the side lock horizontally, and a black clip on the top snaps into place to lock the connector vertically.

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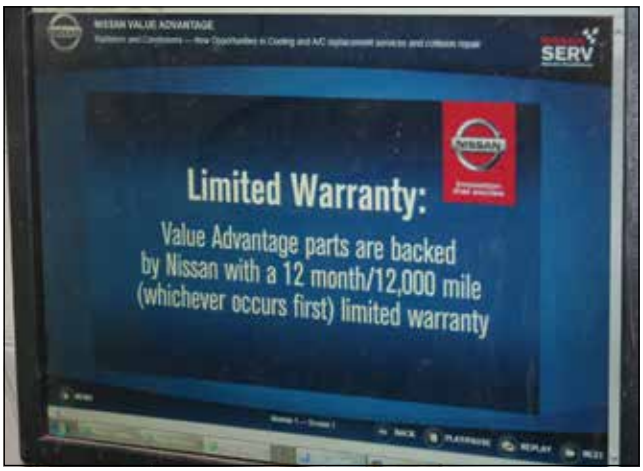

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For the older vehicle that would make complete and proper repairs with OEM parts cost inefficient because of age or condition – there's a solution.

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Nissan Value Advantage Parts is a line of popular replacement parts designed and built to compete with aftermarket parts. These parts are tested and validated by Nissan engineers for fit, form, and function to ensure optimum quality, precise fit and perfect function. They are cost-competitive with aftermarket parts, but deliver the confidence and peace of mind that comes with using Nissan parts. Your customers will appreciate your efforts to help them keep the cost down and keep their vehicle "All Nissan." And, you get and retain more customers.

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