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# TechNews

NISSAN

INFINITI


- LEAF
- Transmission Diagnosis
- Glue & Stick
- EPS
- Dealer Listing

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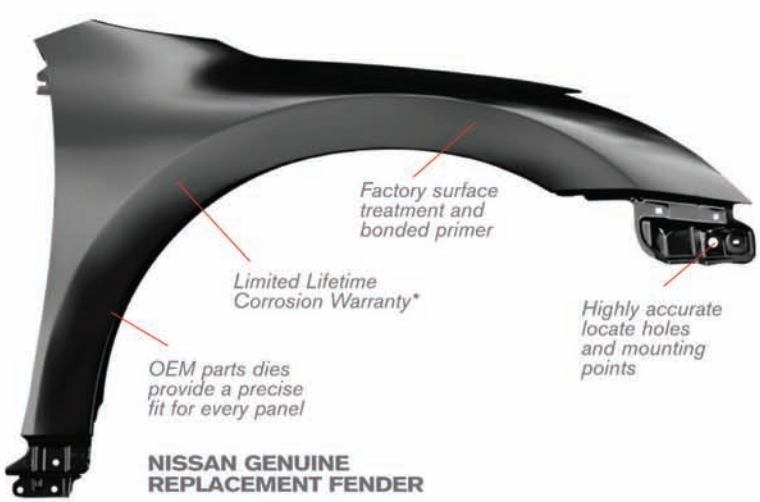


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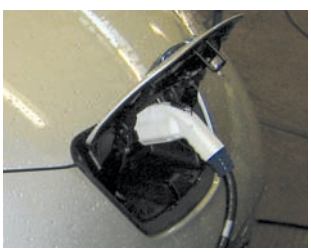

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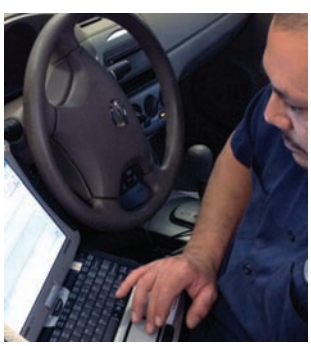

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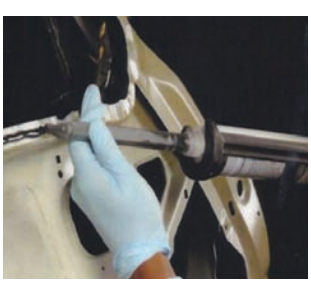

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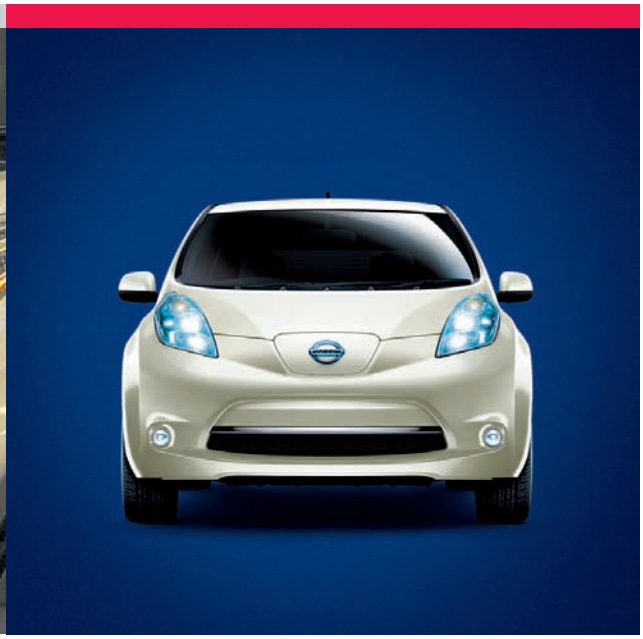
# New Growth: The Nissan LEAF



Nissan's all-electric LEAF incorporates both new and existing technologies. This article will familiarize readers with the unique features and design of this car, and provide insight into its expected maintenance and service needs in the future.

The LEAF was introduced in 2011 as Nissan's pioneer vehicle for the future of electric cars. It has a distinctive body design not based on any other platform in the Nissan fleet, giving it a road presence unlike any other compact car. Prominent LED headlights and a long LED cluster tail light, coupled with blue-chrome accents make the LEAF impossible to confuse with other vehicles. plus, once you pop the hood, nearly the only thing that looks normal is the faux "valve cover." Let's take a closer look at the features of the new LEAF to try to strip away some of the mystery.

**The stylish faux valve cover is set on top of the inverter unit and creates a traditional engine bay appearance.**

## Overview

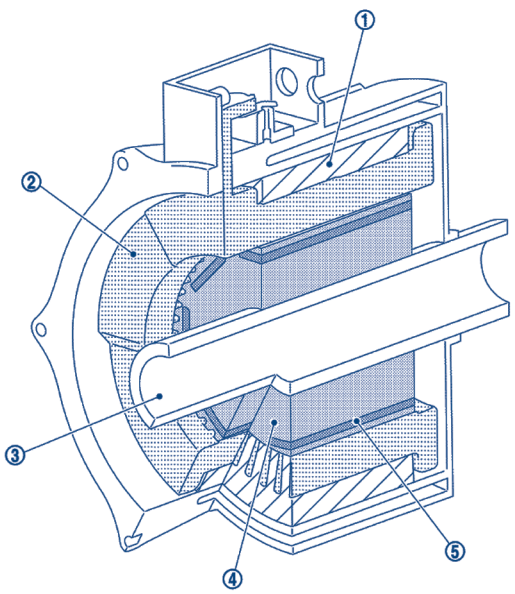
The LEAF is a front wheel-drive car, utilizing an all-electric three-phase traction motor and reduction gear to drive the CV axles. The motor gets its power from a lithium-ion battery pack composed of 48 modules in series, each containing four laminated cells to produce a total of 403V. A water-cooled inverter changes battery power as necessary from DC to AC to drive the motor, and, likewise, from motor-generated AC (from regenerative braking) to DC to charge the battery pack. Regenerative battery charging is achieved by converting the kinetic energy of the already moving car into power through induction within the traction motor. The suspension is independent MacPherson struts in the front, and a solid I-beam in the rear with shocks. Steering input is rack and pinion, with an electronically-controlled electric power steering rack. It's equipped with standard ABS using four-wheel disc brakes. Vehicle Dynamic Control (VDC) is standard, and enhances safety and handling.

The instrument panel has two separate displays for the driver, showcasing unique LED styling for electric power consumption, and Nissan's usual dot-matrix information screen. An integrated navigation unit comes standard, using GPS and telematics to show the vehicle's estimated range and nearby quick charge locations.

## Powertrain

The first description of the LEAF is invariably that it's "an electric car," so we should begin with how it works without an internal combustion engine.

The traction motor takes the place of a conventional engine, and generates torque from precisely-controlled electromagnetic fields. The motor is basically two primary components: the permanent magnet rotor, and the coil windings of the stator. Information about temperature or speed sensor locations, cooling tubes, and high-voltage connections, or other specific components can be found in the service manual.




**The traction motor consists of the stator core (1), coil windings (2), output shaft (3), rotor core (4) and permanent magnet (5).**

When three-phase AC current is applied to the stator coil windings, a controlled electromagnetic field is generated. This field pulls on the permanent magnet inside the rotor, causing the rotor to chase the generated field. The Vehicle Control Module (VCM) can create a constantly rotating electromagnetic field using a rotor position (angle) sensor, much as an internal combustion engine regulates ignition and fuel using crank and cam sensors. The torque generated by the electric motor is approximately proportional to the amperage of the current, whose frequency (or pulse timing) affects the rotational velocity. Current application is controlled by the VCM monitoring position with the traction motor resolver and current flow from a sensor within the inverter.

Some DTCs (Diagnostic Trouble Codes) will limit the rotor rotational speed, the torque output of the motor, or both as a precaution. A P3240 "Drive Motor Current Control Malfunction" may set if the VCM does not see expected changes in current application due to sensor error or an internal problem. The LEAF requires a CONSULT-III plus for diagnosis and repair.

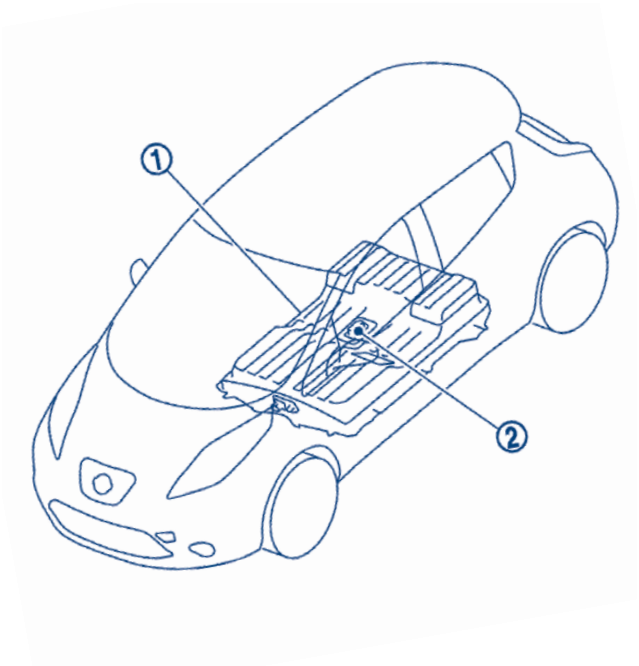
Like an internal combustion engine that performs

differently according to changes in the intake charge and timing, an electric motor is dependent upon the frequency and amperage of the supplied current. It is the job of the VCM and the inverter to create the equivalent of an intake charge for the traction motor. It does this by adjusting voltage based on two calculated values: target force, and motor torque request signal. Because the resistance within the system is constant, changes in voltage affect amperage proportionally – think Ohm's Law.

Target force is based upon sensor input from the accelerator pedal position, vehicle speed, and shift position. Other systems like ABS or VDC will send torque-down signals to the VCM to reduce motor torque output. Once determined, the VCM will command the inverter to convert DC from the battery pack into AC of the specific amperage (torque) and frequency (rotational speed). Thanks to thermodynamics, this conversion work also generates heat which is transferred into the cooling system and dissipated by the radiator in a traditional manner.

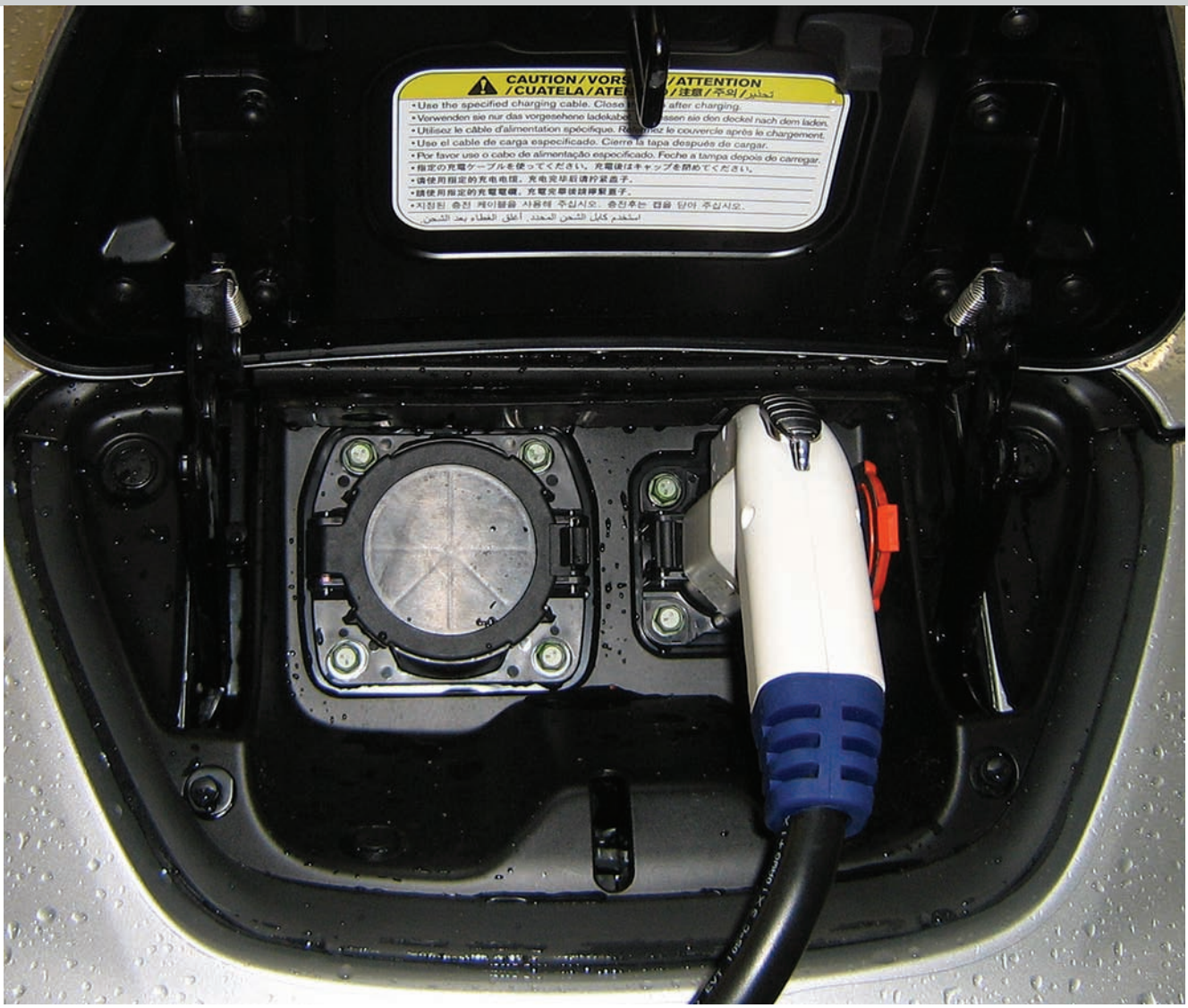
The LEAF also charges the battery by working in the reverse of the above method. Instead of creating synchronous electromagnetic fields, during regeneration the outer field is maintained stationary. The rotor magnet moves through the field creating a current flow by the electrical property of induction. This AC current is captured by the inverter, converted to DC, and stored in the battery pack. The VCM performs the regenerative charge constantly at deceleration, effectively slowing the vehicle. In ECO mode, the LEAF will regenerate more aggressively; however, in both modes, when the battery is at the fully charged state, no regeneration is performed. This is to protect the battery from overcharging.

The heart of the powertrain is the 403V Li-Ion battery pack, arranged beneath the floor of the leaf. Every cell of the 48 modules is monitored, and the CONSULT-III plus can display many relevant PIDs for the battery pack, such as module voltages, total voltages, charging/discharging voltage differences, and the four battery temperature sensor signals. Yes, if there is a battery cell malfunction, a DTC will point directly at the problem cell. Considering the pack weighs a total 648 lbs., we should be thankful that any one of the modules can be replaced in the event of failure.




**This diagram indicates the location of the 403V lithium-ion battery pack (1) and the service plug (2).**

The LEAF comes standard with two ways of charging the battery pack at home using domestic AC. The "Normal Charge" method requires professional installation of a 240V source at home, and achieving a full charge will take approximately six hours. The "Trickle Charge" method will allow 120V household electricity to fully charge the battery in approximately 21 hours. The trickle charge method is not recommended for normal use according to the Owner's Manual, but can be useful when at a friend's house. This charging method may use power a bit erratically, charging and discharging capacitors for example, that may trip household breakers or cause other leaks to ground. Anecdotally, it appears that the trickle charge is not recommended due to its unreliability. Using the trickle charge method will not cause damage to the vehicle. It is best to follow Nissan's recommendation.




**The port on the left is for quick charge. Shown here, the LEAF is using the shop's 240V to get a little charge while in for service.**

An optional "Quick Charge" port can be installed in the LEAF, allowing a zero to 80% State of Charge (SOC) in about 30 minutes. These high-powered stations are available in some locations, and can be found using the LEAF's navigational unit. However, repeated Quick Charging may shorten the lifespan of the battery pack.

Every 12 months, regardless of mileage, Nissan requires the annual Battery Usage Report for warranty purposes. This must be done with the CONSULT-III plus. We will discuss the report below in the maintenance section.

## Transmission and Drivetrain

The LEAF does not have a CVT or planetary gear transmission, but rather a reduction gear that looks much like the gears in a shop roll-up gate. The electric motor output speed and torque can be precisely controlled so there is no need for a conventional transmission's changing gear ratios. On top of the reduction gear housing is where the electronic park position actuator lives, and a parking pawl is found inside the case. The LEAF uses a unique parking feature, which can be set or released with

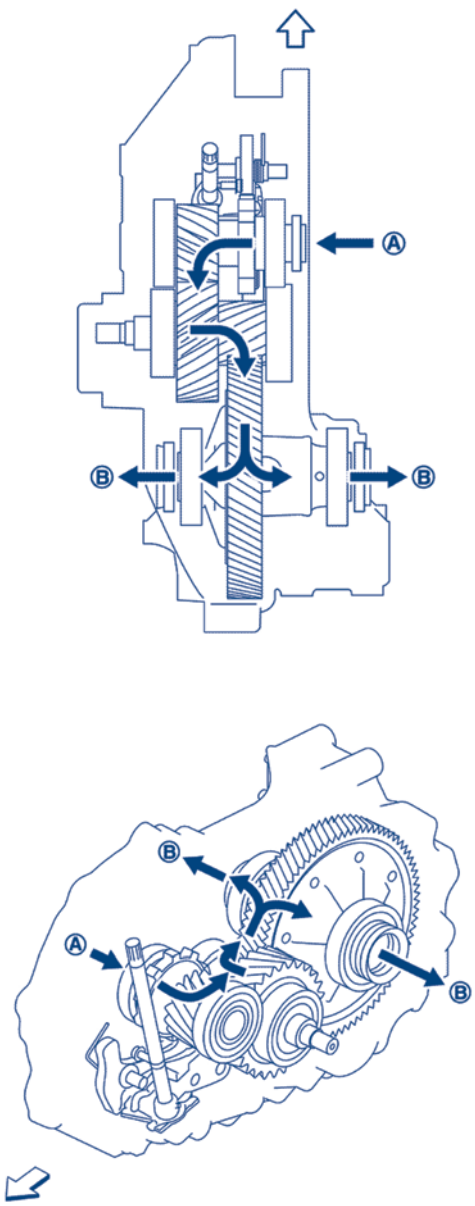
the electric shift selector, which inputs the command (park, drive or reverse) to the shift control module.. Once set, the BCM transmits the ON/OFF command to the electronic shift control module. The shift control module alerts the VCM of the signal, then commands the parking actuator to operate, which will lock or unlock the parking pawl appropriately. This is the electric parking brake in the rear wheels, not the parking gear in the reducer, and has nothing to do with shift selection. The LEAF cannot be shifted while in OFF or ACC modes.

The LEAF utilizes standard CV axles, so periodic inspection and repair of the boots as necessary will ensure long axle life.

## Brake and Steering Systems

The basics of the LEAF's brakes are what you already know and understand from most other vehicles: disc brakes using hydraulic caliper pistons. However, Nissan introduces an electronically-driven Intelligent Brake Unit (IBU) that integrates the brake control module with the master cylinder and an electronic brake booster.

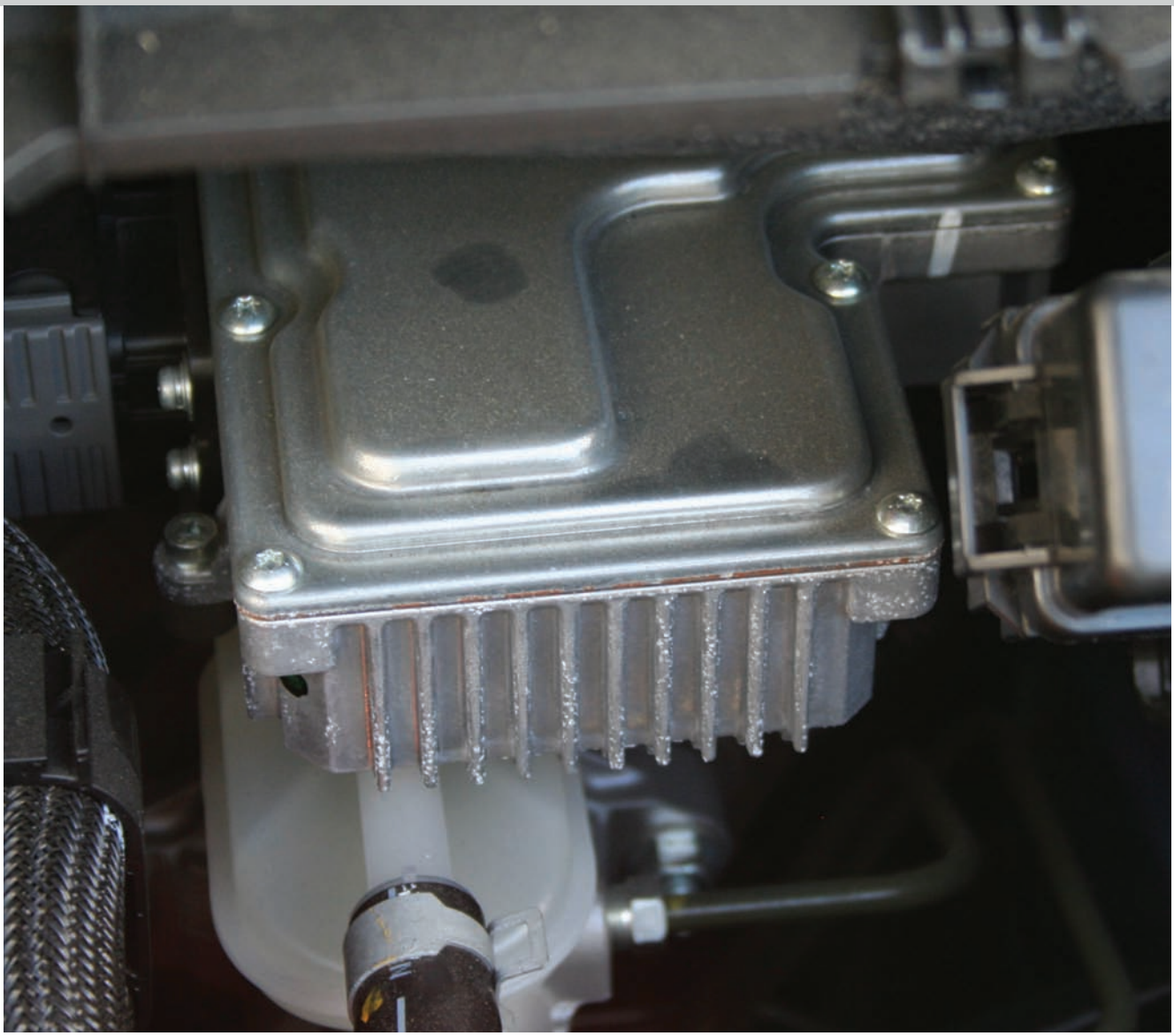
Because the VCM can switch the role of the traction motor into a generator when not accelerating, the LEAF must account for this behavior in braking. When you try to separate two magnets, it requires effort; the same force also occurs during the induction process within the electric motor, effectively slowing the vehicle down. This is called regenerative braking, and it can be used cooperatively with the friction brakes to stop the car. The VCM can measure the exact stopping power of the regeneration process by monitoring the AC generated – simply the inverse of how it calculates target motor speed and torque.




**The RE1F61A reduction gear input gear has 17 teeth, connected to a 31-tooth main gear, which outputs through another 17-tooth gear to the large, 74-tooth final drive gear. The final gear ratio is 7.937. In this diagram, (A) indicates the power input direction and (B) indicates the power output flow.**

Here's how the LEAF comes to a stop. First, the Stroke Sensor in the brake pedal assembly measures the pedal travel (driver input) and gives this information to the IBU control module. From this input, and with data from CAN communications about the vehicle speed, available cooperative regeneration slowing force, and wheel speed sensors, the IBU module commands the brake actuator to develop required hydraulic pressure within the brake master cylinder using the actuator motor to control the master cylinder piston. As the traction motor develops braking energy through regeneration, the VCM will transmit the regenerative force to the IBU using the CAN bus. The IBU will then command the master cylinder actuator to reduce hydraulic pressure in response to traction motor braking. If the lithium-ion battery is fully charged, no regeneration will occur and hydraulic pressure alone is used for braking.

In the event of an emergency power outage, the LEAF can still provide friction braking. The IBU fail-safe feature allows physical master cylinder control with the brake pedal. When the LEAF has no power, solenoids that would otherwise be energized default to a position that allows the pedal to directly interface with the master cylinder. For this reason, it is necessary to power off the LEAF during brake fluid flush maintenance in order to bleed the lines.



**The Intelligent Brake Unit is not independently serviceable, but is monitored completely by the VCM and will report any malfunction using the MIL and dedicated bulb indicators.**

The LEAF's Electronically Controlled Power Steering System (EPS) generates optimal power assist torque based on the load on the front wheels, steering wheel turning torque, and vehicle speed. The EPS unit is attached to the steering column, and its output shaft connects to a standard rack and pinion. During operation, sensors detect the motion and torque of the steering column (driver input) and the EPS module calculates the necessary assistive power using an electric motor within the EPS unit. Therefore, the motor can provide a varying amount of assist based on steering input: the greater the steering input, the greater the amount of current supplied to the EPS motor for assist. Since electricity is only required when assist is needed, the total draw on the 12V battery is reduced. The EPS employs a reduction gear to properly transmit output torque into the rack assembly.

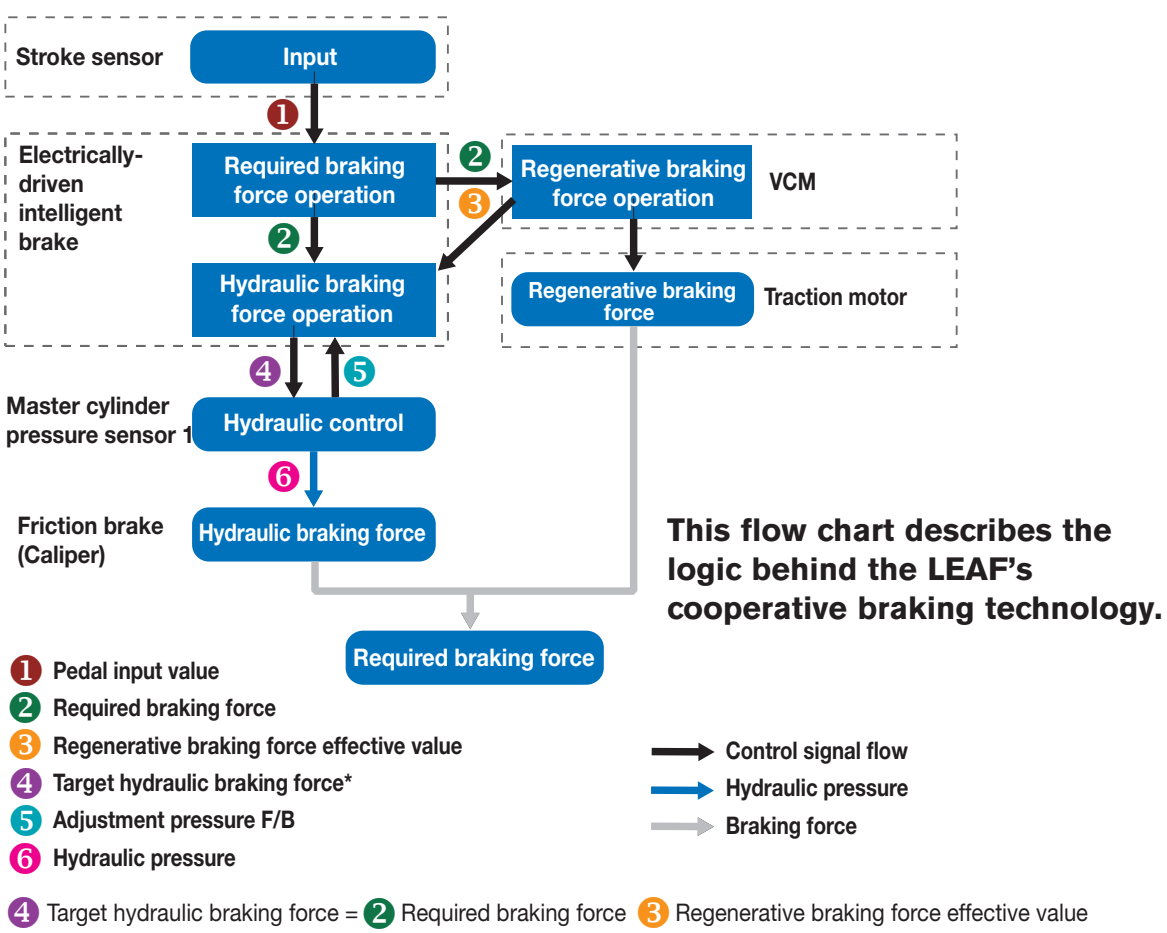
Diagnosis and repair of braking and steering systems must be done with the CONSULT-III plus. After component replacement, it is often necessary to perform certain special service requirements. For example: a zero-point calibration can be performed for the EPS so the return-home position is learned.

## Restraint System and Miscellaneous Accessories

The LEAF is equipped with many of the safety features modern consumers have come to expect: driver, passenger, side, and curtain air bags. The Supplemental Restraint Systems (SRS) are controlled in a conventional fashion, utilizing G-sensors, yaw sensors, and crash sensors to logically determine whether a crash has occurred, from what direction, and with what severity. Repairing the LEAF after a collision requires more diligence than normal due to the presence of high voltage. Follow the service manual guidelines for properly disabling 12V and high voltage prior to working on SRS components.

Air conditioning is controlled electronically by what Nissan terms the "A/C Auto Amp." The electric A/C compressor uses high voltage input to power a three-phase motor in an identical manner to that of the main traction motor. The driver can determine his or her desired level of cooling, and the A/C Auto Amp will electronically control the A/C compressor speed to generate the target output temperature. Because the compressor can be controlled independently of motor speed, the system is inherently more efficient than a belt-driven unit on a conventional car. As the compressor draws power from the high-voltage battery, it will decrease the overall range of the LEAF and should be taken into account when discussing the Battery Usage Report. ECO mode will automatically decrease the power available to the A/C compressor.

An "alternator" is simulated by using an onboard DC to DC charger, which lives in the DC/DC junction box. The



high-voltage battery pack will automatically supply power to charge the on-board 12V battery as necessary. When the vehicle is stored OFF for an extended time, the VCM will periodically charge the 12V battery for five minutes every few days. Nissan cautions LEAF owners not to leave the HV battery SOC above 80% when storing the vehicle as it can affect the longevity of the battery pack.

High-voltage components generate heat. Except for the battery, this heat is handled using an aluminum core radiator and electric fans. Two electric water pumps are controlled by the VCM and set in series to operate together for redundancy. The VCM can control the amount of cooling by directly operating
the water pump duty cycle. Sensors within the DC/DC junction box, traction motor, and on the inverter will report operating temperatures to the VCM. Use only Nissan genuine pre-mixed coolant (blue), and never use stop-leak additives because they can damage the electrical components.

## Maintenance and Driver Conveniences

The LEAF is equipped with cellular telemetry, live updates, and remote control. This system is called CARWINGS. The telematics control unit (TCU) lives under the dash, near the right passenger kick panel. Nissan cautions service personnel who rely on cardiac pacemakers or other life-support systems to be mindful of the interference that the telematics antenna can cause. The LEAF is capable of using both Simple Message System (SMS; colloquially called text messaging) and Internet connectivity to provide drivers with basic status information and bi-directional control of some systems. Once owners have registered their username and password, they can use a supported device such as an iPad to check battery SOC, monitor and control at-home charging, or even begin cabin conditioning using the HVAC.

Due to FCC controls and regulations, a unique VIN and International Mobile Equipment Identifier (IMEI) must be registered to any TCU. Therefore, it is not possible to perform diagnosis or repair with a known-good TCU or a recycled part. Furthermore, a replacement TCU can only be activated using the CONSULT-III plus after any replacement. The work support function provides the necessary registration steps. CARWINGS will allow users to locate nearby charging stations while traveling without having to install GPS update DVDs. The navigation computer is able to display the vehicle's range, and display available stations.


**Communicate with the LEAF remotely using SMS on a cell phone, or the internet and a support device. Shown here is the Apple iPad app.**

A LEAF high-voltage Lithium-Ion battery that is nearly discharged will begin to limit power distribution to the traction motor and A/C systems to increase range. The charge limitation indicator ("turtle light") will turn on to alert the driver that the LEAF will no longer accelerate at the same rate. The Owner's Manual warranty supplement will include emergency contacts for road-side charging or towing. Towing a LEAF must be done with a flat-bed, or with the rear wheels trailing. If a LEAF is towed with the front wheels on the road, the traction motor may generate electricity and cause damage to the EV components.

The LEAF still requires periodic maintenance. Nissan recommends changing the brake fluid and cabin filter every 15K, along with inspections. The high-voltage cooling system should be serviced every 125,000 miles. Details are in the LEAF service manual. Every 12 months regardless of mileage, the EV component warranty requires a Battery Usage Report. This report is generated on a CONSULT-III plus, under the maintenance function.

## Advice for your usage

The recommendations below can help to minimize the ongoing impact on your LEAF Li-ion battery, which can affect your battery's total capacity over its lifetime.

| Item | Cause of gradual loss of capacity 1 | Recommendation 3 | Your score 2 |
|---|---|---|---|
| Charging | Frequent use of Quick charging | Your score is very high and good for your battery |  |
| | Frequent charging when batter state of charge is already high | Your score is very high and good for your battery |  |
| Driving | Too much electric consumption while driving | Your score is very high and good for your battery |  |
| Storage | Long term parking with high state of charge | Your score is very high and good for your battery |  |

**This LEAF driver is gentle on the high voltage battery.**

| Recommendation | Your score |
|---|---|
| Use normal charge equipment (not quick change) when possible |  |
| Select 80% charge limit mode when your daily driving journey is short |  |
| Use the ECO MOCE for a gradual and smoother acceleration and for a reduced drive load |  |
| If your vehicle will not be driven for a long period of time, limit State of Charge to below 80% selecting 80% charge limit mode |  |

**This LEAF driver may be a bit too aggressive in driving or usage habits. The Battery Usage Report can help your customers improve their range.**

The Battery Usage Report is a table designed to illustrate the projected condition of the battery under current usage. In the top graphic, the driver does not stress the high-voltage battery with repeated quick charges, fast acceleration, frequent ACC-only "idling," or continual use of the A/C. Gradual loss of capacity is a normal battery characteristic. Nissan states that the HV battery is expected to perform at approximately 80% of its original performance after five years of average use. However, battery capacity and range can vary depending on a number of factors, including age and usage of the battery, number of passengers and payload, air conditioning/heater usage, high speed or stop-and-go driving, and topography.

## Springtime for Electric Vehicles

The electric vehicle movement is gathering support and momentum, and will require an additional level of expertise. Shops that train and familiarize themselves with hybrid and electric vehicles will be able to retain their customers who eventually shift away from their conventional gasoline vehicles. The Nissan LEAF is very popular, and will show up in your shop. Will you be prepared?

# Automatic Transmission Failure Diagnosis

**Modern automatic transmission failure diagnosis can be daunting. Use these easy methods for testing the suspected component or system, research the specific service information – and apply a little logic – and you'll get the job done faster and more accurately.**

Automatic transmissions existed long before advanced electronic systems were available to control them. What was once a virtually self-contained system has now spread out. While it's still called an "automatic" transmission, it has actually become more of a controlled transmission. Without a lot of external help, modern automatic transmissions are just a single-speed gear reduction.

First, the information necessary to make gear selection choices is now made based mostly on components outside of the transmission housing. The information the throttle pressure cable once provided is now furnished by the ECM, based on input from sensors such as the TPS. Vehicle speed is now also measured via sensors and relayed to the TCM through the ECM. Finally, the "clockwork" that once opened and closed valves and directly controlled shifting has been replaced with externally-controlled solenoid valves.

The decision-making is now done outside the transmission case as well. Mechanical hydraulic systems are not capable of the same level of "intelligent" thinking as an electronic control module, and intelligent shifting choices are necessary to increase efficiency, performance, and drivability. Shift timing and clutch application can now be perfectly matched to driving conditions. The torque converter clutch can be locked in any gear or even partially locked with duty cycle control. The control unit is even able to recognize driving situations, such as a grade, and provide engine braking or prevent overdrive hunting as appropriate. "Programming" a pure mechanical hydraulic system for this level of control would be nearly impossible, and, even if it were, the added weight would be unacceptable.

Thus, the modern transmission has become mostly output. There are a few sensors, and there is still some direct mechanical hydraulic control, but most of the transmission's function is actuation: to put commands into action, not to evaluate or make decisions. Changing gear ratio requires input, logic, and output. Only one third of this system lives within the transmission housing. Therefore, the odds of accurate diagnosis-by-test-drive or replace-based-on-symptom are lower than ever before. This is why thorough transmission diagnosis is critical, even if your shop usually replaces rather than repairs.

## Easy as 1- 2 - 3

The fundamentals of transmission diagnosis are much the same as the fundamentals of diagnosing any computer-controlled system. Just answer the following questions:

1. ***How was the system designed to work? Computer control is all about logic – "if this, then that." Find out what the transmission should be doing, then see if it is doing it.***
2. ***What are the relevant sensor inputs, and do they match actual conditions? If not, why?***
3. ***What are the outputs, and do the output commands match the actual output. If not, why?***

Research is the first step, but in order to research efficiently, you must have a direction to pursue; an idea of where to focus the enquiry. So, without spending too much time, carefully read the symptom description on the repair order, test drive the car, and check for trouble codes. However, it's important not to get sucked into trying to perform diagnosis before understanding how the system should work, so as soon as you've found a direction, leave the car and head for your laptop.

There are several very useful areas in the service manual. If you have a trouble code (DTC) to work with, the section that covers On Board Diagnosis Logic is extremely useful. It's possible to "get inside the mind" of the TCM and know what it's going to do (or at least what it should do). If you know how the TCM is testing the system, and how it will interpret the results, you'll be able to set up your own testing; drive under appropriate conditions, monitor the sensors the TCM uses to test, and apply the logic the TCM applies. A little research, observation, logic, some simple math and you'll be in a position to evaluate what's happening, just like the TCM, but with a lot more processing power and flexibility of thought.

## Divide and Conquer

"Divide and conquer" is a term adapted to a network diagnostic technique that works wonderfully for almost any diagnostic situation. In essence, the idea is to test the system from as close to the middle as possible,

decide which side has the problem, then divide that side in the middle as well, decide which side has the problem, and continue to divide and decide until the problem is isolated.

The "center" of the system is the TCM. Inputs and outputs are all on display from the comfort of the driver's seat using the CONSULT III PLUS. The CONSULT III PLUS allows the technician to view the system from the middle. You'll be able to see what the TCM sees and how it responds; the relevant input signals and the output commands.

Often, the "Service Engine Soon" (MIL) and "AT Check" light will come on when there is a problem with shifting. Sometimes this will happen before the driver even notices any other symptoms. When a DTC is present, it's almost always best to start with trouble code diagnosis before trying to diagnose by symptom, but in the end, every situation is different, so do what makes the most sense based on the situation.

## Diagnostic Trouble Code Diagnosis

Start by looking at Freeze Frame Data (FFD). Perhaps "looking at" is not a good way to say it; FFD should really be "examined," or "analyzed." Look carefully at all of the PIDs. Are they related to the DTC detection logic contained within the FFD? If so, can you see why the code set? Are any of the PIDs obviously impossible? The TCM uses rational comparison of inputs, and so can you. Also, note all of the conditions related to the conditions when the code set so that you can duplicate them on a test drive for diagnostic and repair confirmation purposes.

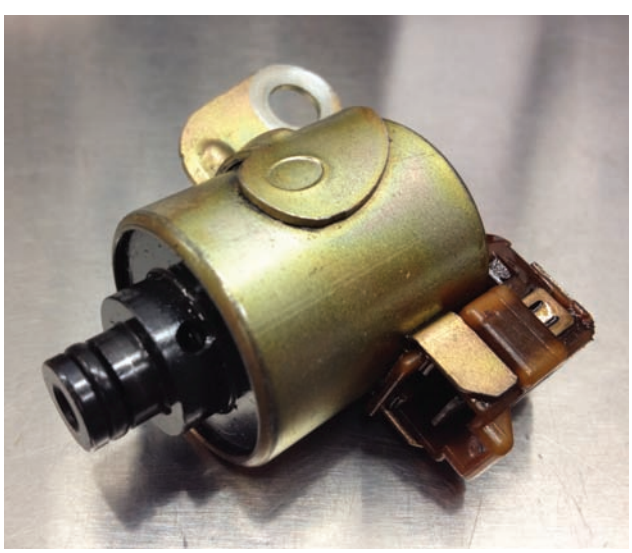
When a transmission-related DTC is found, or you suspect a condition exists that might cause a code with a little more duration, try the DTC WORK SUPPORT feature in CONSULT III PLUS. It's a very handy tool to determine if a problem is currently occurring. DTC WORK SUPPORT for AT codes can be found by selecting AT>DTC WORK SUPPORT, then choosing the appropriate test for the DTC or symptoms. In order to run the DTC WORK SUPPORT test, the driving conditions must match the test criteria. In other words, if you're testing for 1st gear function, you'll need to drive the car under conditions that allow the TCM to test the function of 1st gear. Instructions for doing this can be easily found in the service manual. Still using the 1st gear function as an example, look under the diagnosis section for P0731 (1st gear function) and use the Diagnostic Trouble Code Confirmation Procedure found there.

The guided testing of DTC WORK SUPPORT is not the only method of diagnosis, albeit a convenient one. When all else fails, it's possible to use logic to diagnose the problem. However, in order for logic to work, you must have true statements to work with, and the best place to find the true statements is in the service manual.

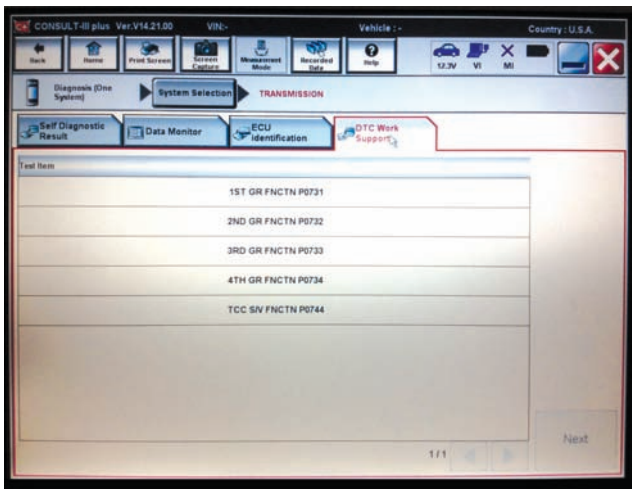
It's important to note that the presence of a DTC may alter the logic of the transmission. For instance, if the transmission is slipping badly in 1st gear and a P0731 is set, the TCM could decide not to use 1st gear and start off in 2nd. If you want to confirm the original symptom on a test drive, you may need to clear any DTCs first.

## Inputs

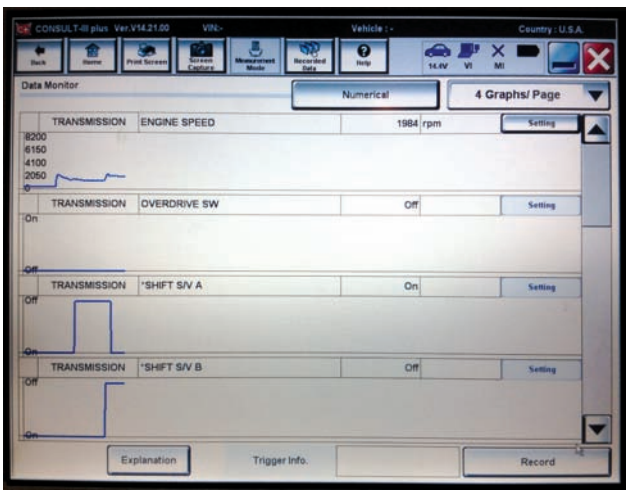
It makes sense to start by looking at the inputs, as output is based on it. Let's say a vehicle is in the shop with the complaint of no overdrive. After checking the



**Solenoids can fail electrically (an open or short in the windings), or become stuck. Sticking is usually caused by fluid contamination. Fluid should be replaced if a stuck solenoid is found. However, if a transmission is worn and continues to dump debris into the fluid, a replacement solenoid may only be a short-term solution.**




**The DTC WORK SUPPORT feature on the CONSULT III PLUS can determine if a problem is currently occurring.**




**Test driving the car using the DTC WORK SUPPORT will allow the CONSULT III PLUS to check each transmission function.**

system description you know that the overdrive cancel button must not be pressed, the transmission fluid must be up to normal operating temperature, and the vehicle speed and load conditions must be suitable for overdrive gearing.

What inputs should be checked? Probably the Throttle Position Sensor (TPS), Transmission Fluid Temperature Sensor (AT Temp), the O/D lockout switch (3rd gear switch), and vehicle speed inputs like the Vehicle Speed Sensor (VSS) and Output Shaft Speed Sensor (AT REV). These are the inputs the TCM will examine to make the decision. In order to decide whether the problem is with input, logic, or control, you should monitor relevant input, research the logic descriptions, and verify desired output. If the 3rd gear switch PID is ON, then the logic and output are as designed, so focus on why the 3rd gear PID switch is on.

## Logic

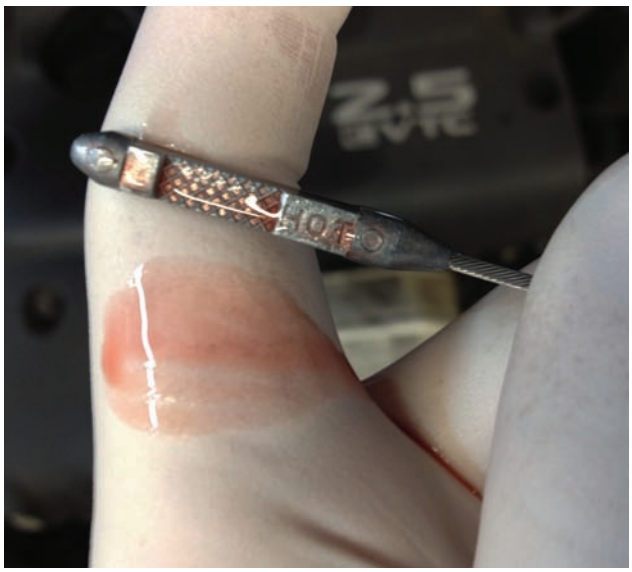
Once input conditions are met for a particular output, the next question is: Is the TCM output in agreement with the description in the service manual? It's rare to see a logic failure, so if you think you've found one, suspect a manual error. Compare it against an identical vehicle before ordering a TCM. However, there are often updates available to improve transmission performance and longevity, so always check for TSBs.

## Output

The output PIDs indicate what the transmission "thinks" it's doing. If the transmission is not doing as commanded, it's time to find out why. This can be broken into five questions:

1. ***Is the solenoid output signal leaving the TCM?***
2. ***Is the solenoid output signal reaching the transmission?***
3. ***Is the solenoid operative?***
4. ***Does the output have the support it requires (fluid pressure)?***
5. ***Is the actuator the solenoid controls receiving the desired output?***

As stated earlier, start in the middle; is the solenoid operative? There's usually no need to remove the suspect solenoid from the transmission for resistance testing or power testing. If the solenoid can be heard clicking, it's likely the TCM output, wires, and solenoid are all okay. If there is an active test available for the solenoid, use it to cycle the solenoid. If not, it may be possible to operate the solenoid with the KOEO in gear (depending on which solenoid and which car). Finally, the solenoid can be activated using the instructions in



**Transmission fluid should be translucent and free of floating debris. Most fluid is dyed red, but some fluids, like NS2, may have a different tint. Some types of fluid have a sweet odor when in good condition, but others can smell a little "sharp" even when new. Don't rely on odor as a gauge of condition unless you are familiar with what "normal" smells like.**

the manual while listening for clicking. A fuel injector balance tester is a handy tool for this method.

## Mechanical and Hydraulic Problems

Once problems with transmission control systems and solenoids have been examined, there are still plenty of things that can go wrong inside the transmission case. The most common causes of failure can be put into three categories:

1. ***Mechanical wear causing noise/vibration. The debris from the failing parts may also jam solenoid valves.***

2. ***Clutch wear causing excessive clutch pack clearance and slipping. This too may cause solenoid valves to get stuck.***

3. ***Inadequate fluid pressure caused by either poor pump output or internal leaks.***

**Transmission fluid becomes opaque and brown as it degrades. An acrid burnt odor and floating bits of clutch, bushing, and steel shavings are signs of trouble.**


**Fluid pressure does most of the work in the transmission. Use a pressure gauge to find out whether fluid pressure is adequate and if it's being directed properly.**

Mechanical wear is best diagnosed by examining the fluid and the inside of the transmission pan. Clutch wear is usually diagnosed through a combination of test driving and fluid/pan examination. Fluid pressure issues should be diagnosed using a pressure gauge and the tests outlined in the service manual.


**Because a CVT operates on principles far different from those of regular automatics, NS-2 fluid is an absolute requirement. That doesn't mean, however, that other Nissan transmissions should be filled with generic ATF. Using only genuine Nissan O.E. fluid will help assure that your customers avoid expensive repairs.**

It's been said that "It's better to miss a fluid change than to use cheap ATF." Amen. There are numerous aftermarket companies out there that push the "one size fits all" idea where ATF is concerned, and use the dubious phrase "meets OEM standards" to promote their products. We beg to differ. If you want to save your customers from expensive trans damage and differentiate your maintenance services, use only OE fluid from your local Nissan/Infinity dealer's parts department for your flush and refill jobs. Buying in bulk will make it economical.

Also, one of the first steps in a transmission/transaxle diagnosis should be to determine what's in there, perhaps by quizzing the car's owner. Especially where harsh engagement, shudder, and delay are concerned, just a switch to the right stuff (read the dipstick, owner's manual, and fluid requirements at www.nissan-techinfo.com) may actually cure the problem. Chances are, however, that the damage has already begun, so explain to your patrons that since transmission repairs are a multi-thousand-dollar proposition these days, it's only sensible to keep Genuine Nissan ATF in those technological marvels always.

Of course, you are aware by now that using anything but NS-2 in a CVT will ruin it in short order.

# It's not just Glue and Stick

# Are you repair-ready for chemical bonding?


**Collision professionals must remain current in the four key resource areas shown above. Only then can they be fully competent to perform complete, safe repairs for customers (courtesy ManicMedia LLC).**

Hot on the heels of advanced high-strength steels and alloys, vehicle structures are now incorporating more thermoplastic, carbon fiber and other composite materials. The ongoing quest for lighter vehicle weight, performance without compromise, improved safety and lower manufacturing costs is driving the shift to these new materials. Nissan customers are already driving vehicles made in part from these new materials and more are on their way. Consequently, chemical bonding using structural adhesives is often the preferred and recommended joining method, rather than welding or riveting.

Professionals must ensure they are up-to-date with the latest service and repair information, invest in the required tooling, and seek effective training to learn and assimilate modern bonding-related repairs. Keeping competencies current is not only the difference between a cosmetic versus a complete repair, it's also driving opportunity to properly-prepared collision facilities.

## Bonding is the "New Normal"

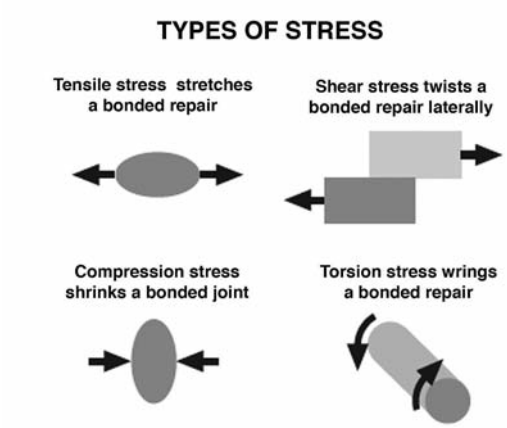
Bonding with adhesives is a more complicated process than in the past. No longer is it a matter of just slathering on some glue and clamping the parts together. While structural adhesives have been used for more than 25 years in the automobile industry, early adhesives were predominantly single-component varieties, which at that time were sufficient for some repairs involving conventional mild strength steels.

The transition to repairing newer materials necessitated a shift to two-component (a resin and a catalyst) adhesive formulations that provided improved bonding properties and allowed more working time during repair.

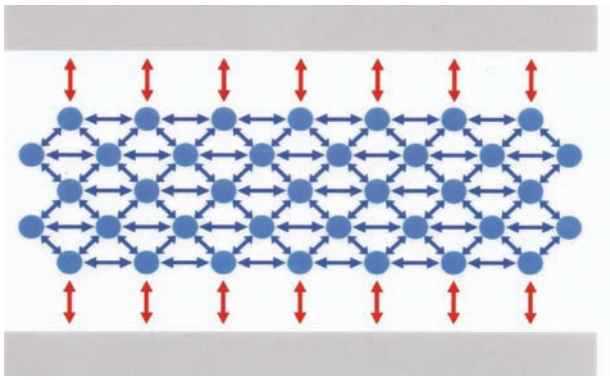
When combined during a repair, the catalyst initiates a chemical reaction in the resin. Expect to feel the bonded parts heating up as the resin develops its bonding properties as the mixture cures. Note that the curing ability that is built into an adhesive can vary from minutes to days, which affects a technician's working time. In addition, baking, ultraviolet light, hot air welding, or other procedures involving applied heat may be required.

Managing the types of stresses that a vehicle will encounter post-repair is also essential. This requires matching the right adhesive to the expected stresses and following more intricate bonding procedures. It's the new normal.

For example, bonding with structural adhesives is particularly effective in instances where the primary stress forces are either compression, or shear – where




**Chemical bonding, alone or in conjunction with other techniques, is an effective joining process for managing the above types of stress** (courtesy Dow Automotive Systems).



**Adhesion and cohesion are the two fundamental properties of adhesives used in bonding materials. Adhesion (red arrows) is the attraction between the materials being bonded and the adhesive. Cohesion (blue arrows) is the attraction between the molecules of the adhesive itself, which occurs as the adhesive cures** (courtesy 3M)**.**

the force tries to slide the joined surfaces against one another, like pressing your hands together and trying to slide them apart. Conversely, bonding is not as effective in locations where tensile or torsion stress forces are in play. In cases where the tensile stress acting on the joint would pull the two pieces apart (peeling),or the torsion stress could bend or twist the joint, collision repair procedures often specify that adhesives be used together with rivets (rivet-bonding), or in conjunction with certain techniques, such as spot-welding.

The two-stage structural adhesives in use today include polyurethane epoxies, glassy matrix epoxies, which have glass beads embedded in the resin, and rubber-based epoxies. Glassy matrix epoxies, for example, are extremely strong and rigid, and they resist shearing stress at very high force levels. Polyurethane epoxies are more flexible and provide a better fit for some components, but they break under shearing forces at much lower force levels than glassy matrix epoxies. Newer rubber-based adhesives contain additives that allow synergistic rubber toughening of adhesives to provide high-strength epoxies with greater flexibility – a hybrid of the earlier formulations.

## Chemical Bonding Offers Significant Advantages

Similar to higher-strength metals, newer plastics and other inbound composites come in different grades, which impacts how each material performs under various stresses during normal operation and during a collision.

Adhesive manufacturers 3M and Dow Automotive Systems say that the proper use of modern adhesives in bonding repairs:

- Provides more durable and stronger repairs with less corrosion risk than just welds. In fact, adhesives usually form a bond stronger than the materials they're bonding together.

- Reduces the number of welds that would have otherwise been required. For example, OEM rivets and OEM structural adhesive are used in areas that squeeze-type resistance spot welding (STRSW) arms cannot access.

- Helps resolve problems with cracks around spot welds occurring as a result of fatigue loads. In addition, adhesives also enable hybrid sandwich construction to be employed in manufacturing.

- Optimizes the energy flow of the various stresses during normal vehicle operation, or a collision. These forces can be more evenly distributed across a region that is joined with adhesives, when compared to those joined only by welds, rivets, or other joining methods.

**In some cases, Nissan requires procedures where adhesives are used along with other fastening methods. For example, proper repair of the GT-R requires the use of adhesives in the bonded and bolted joint where the aluminum rail attaches to the front steel structure, and also where the aluminum bulkhead attaches to the rear bulkhead. Adhesives are also used on the wheelhouse-to-quarter panel hem-flange joint** (courtesy I-CAR).

**Consult TECH-MATE for Nissan-approved equipment, tools and supplies required to perform chemical bonding repairs. Examples include the fixture equipment and rivet bonding guns** (courtesy I-CAR).

▪ Improves noise, vibration, and harshness (NVH) by dampening airborne noise distribution and minimizing body vibrations.

▪ Increases structural integrity and acts as an isolator between the dissimilar metals, preventing galvanic corrosion.

▪ Empowers the future introduction of lighter weight carbon fiber roofs and other non-steel and non-alloy components without compromising strength, performance, safety or durability.

Because different bonding adhesives have unique properties to provide acceptable or improved elasticity and flexibility, in addition to better stress management for the materials being bonded, collision repair facilities and technicians must be vigilant. The use of the wrong adhesive and/or incorrect bonding repair procedure – whether from ignorance or negligence – compromises everyone.

## Rivet-Bonding is on the Rise

New vehicle construction techniques mean new procedures in collision repair are needed to maintain the integrity of a vehicle in the case of any following accidents. Consider the Nissan GT-R that uses a multi-material design of high-strength steels, aluminum, and carbon fiber.

While high-strength steel is used for most of the GT-R structure, cast aluminum is used for the GT-R front strut towers, door shells, and rear bulkhead. The front strut towers and rear bulkhead are attached to the steel structure using an adhesive, which increases structural integrity and acts as an anti-corrosive isolator. Carbon fiber panels, along with plastic and sheet-molded compound panels, are used to completely close out the GT-R underbody.

Attaching vehicle parts that are of two different types of materials should only be done by following the repair procedures approved by Nissan. Standard welding methods cannot be used to join these many new metals, because welding could deform them, and the interaction between the metals may lead to premature corrosion beneath repainted finishes. Likewise, welding would destroy newer nonmetallic materials. In these instances, chemical bonding may provide a viable alternative.

Some repairs to Nissan vehicles may only require a two-stage adhesive. Others may require the use of adhesives in conjunction with other fastening methods, such as bolts or rivets. Others may even require the addition of specialized welding procedures.

Should rivet-bonding be required, here are several key considerations that will help conserve limited working time and perform a complete, safe repair:

▪ Technicians must know the composition of what they are going to cut into beforehand.

▪ Before using an adhesive, application instructions and repair procedures must be understood.

▪ The use of approved parts, tools, fasteners and adhesives is essential. In particular, this new method requires the use of a punch riveting tool.

**Nissan has partnered with I-CAR and DuPont Performance Coatings to qualify and provide training to collision facilities so that they can become part of the Nissan Certified Collision Repair Network. Look for an upcoming Nissan Infiniti Tech News article for more details** (courtesty I-CAR).

▪ Avoid cross-contamination by working on the separate metals in different areas and with different tools.

▪ Clean surfaces are required for proper bonding. It is also important that bare metal be bonded to bare metal and not to painted surfaces.

▪ When rivet-bonding, be sure to bevel the drill holes so that panels can be compressed snugly together. Technicians should also note if rivets are involved, repairs involving aluminum should use aluminum rivets, while those involving steel should use steel rivets. A coating of zinc dust to prevent corrosion may also be required.

▪ During the final assembly, ensure that the new panel aligns properly to where it will be attached and check for gaps. A specified reinforcement plate may be required.

## Following Nissan Requirements and Recommendations is Essential

Nissan provides a number of resources for making complete, safe repairs for new lightweight materials. For example:

▪ As a starting point, consult the Nissan or Infiniti service information websites (www.nissan-techinfo.com or www.infiniti-techinfo.com). In addition to other data, these sites provide critical information regarding the location of various construction materials within a vehicle.

▪ Then visit the Nissan TECH-MATE website (www.nissantechmate.com) for lists of required or approved tools, equipment and supplies. For example, Nissan requires Celette frame racks and fixture equipment, as well as certain adhesives, such as 3M DP420 or 3M 8115.

▪ Nissan has partnered with I-CAR for collision training. "Currently, collision program training for Nissan certified collision facilities is an I-CAR focused training program," advises Mark Zoba, Nissan manager for Collision Parts, Service Sales and Marketing. " To be a Nissan certified, facilities must attain I-Car Gold status. Full requirements to acquire Gold status can be found at the I-CAR website (www.i-car.com). We've already developed a GT-R course and are looking at adding additional Infiniti and Nissan specific courses in the future."

Chemical bonding adhesives have proven to be ideally suited to modern vehicle bodywork repairs when high-strength metals, plastics, carbon fiber and emerging composites are present. Compared to more traditional joining technologies for new lightweight materials, modern two-component adhesive formulations and chemical bonding repair procedures allow all the properties of the repaired components to be more closely returned to their original state.

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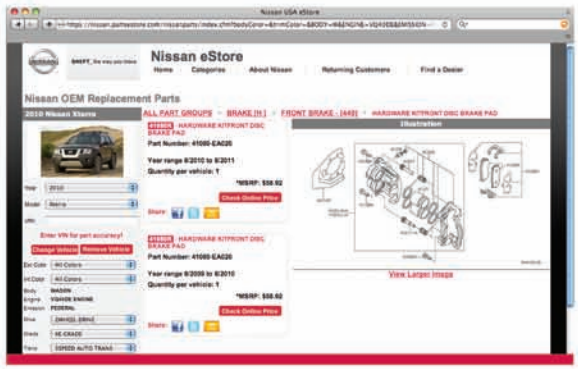
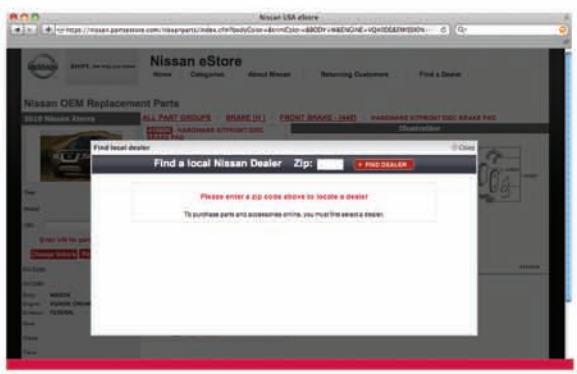


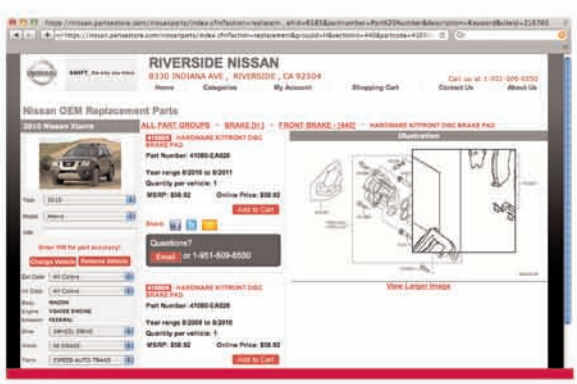

## Ready.

Enter your vehicle model and year. Select the specific category for the part you need. This is also a great time to identify other possible components you may need to properly complete the job. Choose your specific parts required. Add these parts to your shopping cart.




## Set.

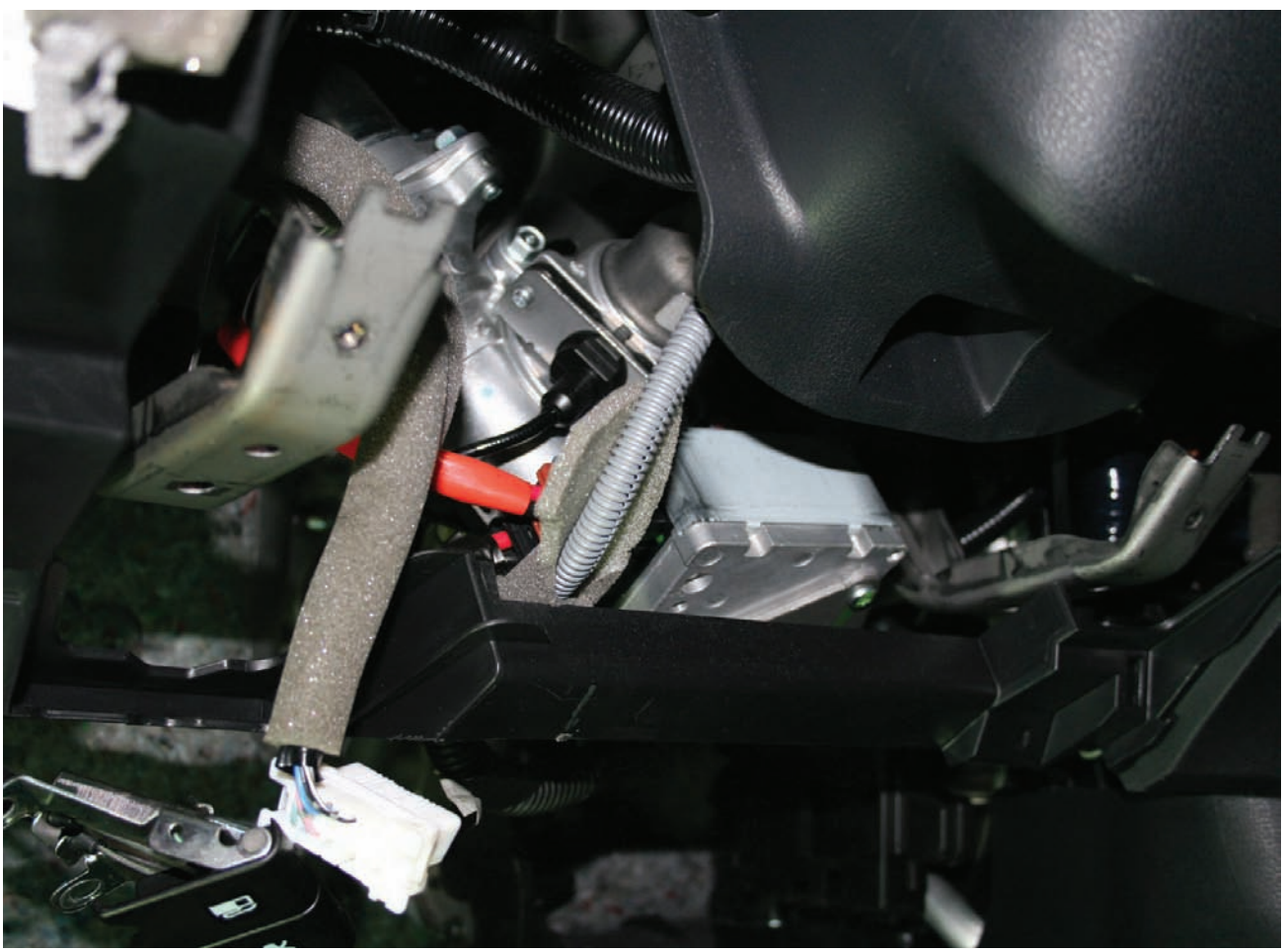
If you are new customer, enter your Zip code to see the closest dealers to you. Choose a dealer, submit your account information, then the dealer will set custom pricing for your shop and e-mail you a confirmation. As a returning customer you'll be able to immediately access your dealer specific webpage and custom pricing.




## Click.

Once you're logged in, the chosen part(s) are still in your in box, but now the custom pricing of that dealer is shown. Once added to the shopping cart you can continue to checkout.

# Nissan Electronic Power Assist



**Electronic power steering systems (EPS) are now more common than ever on newer Nissan vehicles. This article covers the three types Nissan uses for its EPS, a discussion of its advantages, and tips for diagnosis and repair.**

Electronic Power Assist Systems (EPS) are starting to see wider implementation due to the advantages they bring for fuel economy and manufacturing savings. American consumers expect power steering as a standard feature. Nissan works to meet that expectation by going beyond the conventional hydraulic power assist methods to create vehicles that utilize modern electronic controls for improved efficiency. With any new technology comes the need for more training. Here, we'll help clarify the reasons for using EPS and describe system components, their function, and how to diagnose and repair each design.

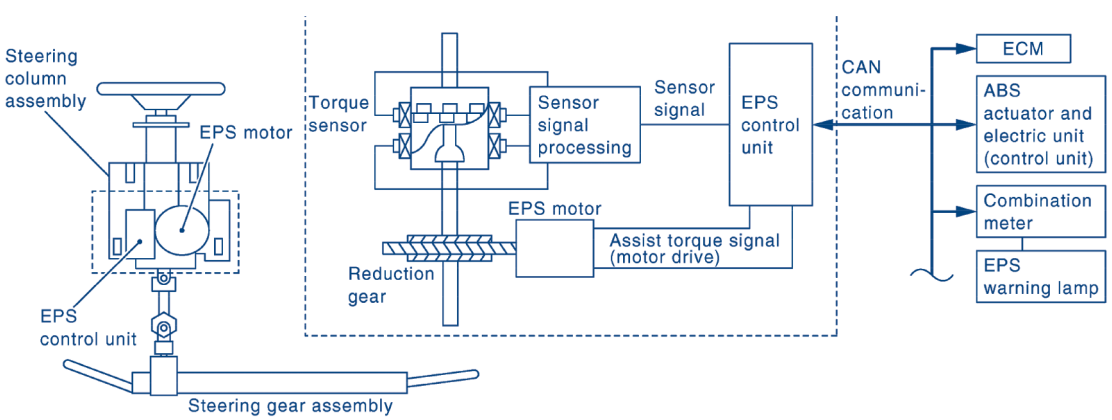
## The Advantages of EPS

It's often tempting to dismiss some new automotive inventions as niche market or luxury-car-only developments. EPS is here to stay, and it will become more common. When compared to conventional hydraulic assist, EPS is cheaper to make, malfunctions or breaks down less often, and reduces the load on the engine for performance gains and greater fuel efficiency. You'll find EPS installed in the newest Nissan Juke, Sentra, Versa, Rogue, LEAF, Altima, and Infiniti M-Series hybrids, and likely more models in the coming generations. This is a wide-scale shift in the manufacturing process, and it is our responsibility as technicians to stay informed about the details of function, diagnosis, and repair.

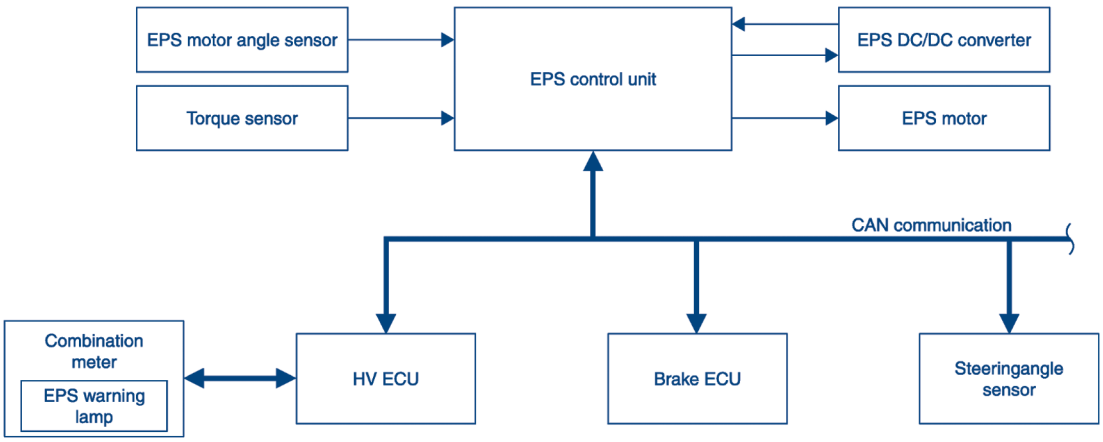
Let's discuss how Electronic Power Steering achieves these benefits before we launch into the different designs that Nissan uses. First and foremost, power assist is generated with a DC electric motor instead of a pump connected to the crankshaft. Motor speed can be directly controlled to produce the necessary assist pressures based on sensor input.

Conventional power assist is dependent on engine rpm, and requires idle-up signals for slow-speed parking to prevent engine stalling, and to provide adequate rpm for the necessary fluid pressure. Furthermore, conventional power steering pumps are always generating fluid pressure even when the steering wheel is in the straight-ahead position, simply because it's attached to the crank, and it must be available when requested. EPS is "smart enough" to know if the driver is turning the wheel, and can determine how much assist is needed. Most driving is going straight ahead, so it is a logical improvement for efficiency to only use engine power (as consumed by the alternator) when necessary.

EPS also requires fewer individual components, reducing the costs of manufacturing and maintenance. Some technicians may groan at the loss of "broken things to fix," but EPS still relies on sensor




**Column-mounted EPS design.**




**Rack-mounted EPS design.**

input and control modules, all of which may need diagnosis and repair. On the bright side, cars will be less messy to work on without power steering fluid leaks! Modern vehicles are shifting the role of the technician toward computer system diagnosis; EPS just confirms the transition.

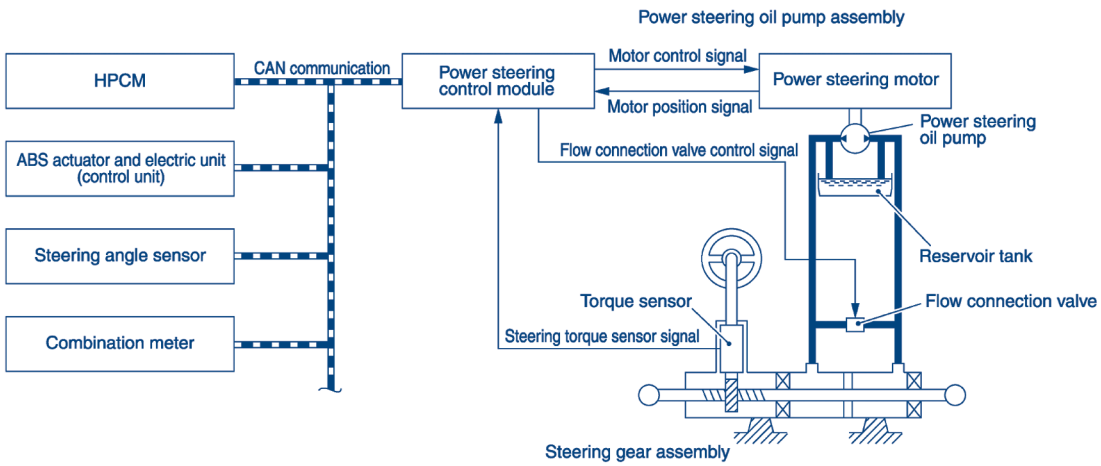
## Different EPS Designs

Let's explore the three different ways that Nissan implements EPS in its vehicles. Most common is the steering column-mounted EPS, in which the motor, control module, steering wheel torque sensor, and reduction gear are located under the dashboard in one large group. This EPS design simply boosts the driver's steering wheel input torque, rotating the steering shaft and causing the steering gear to move. That's really the entire setup! It eliminates the need for engine bay design to accommodate a pump, pressure and return hoses, reservoir, and a heavy power assist rack. We will explore the components in depth later.

Another EPS design has the motor mounted directly on the power steering rack. The EPS rack assembly contains the DC motor, motor angle sensor, and steering torque sensor. In the Altima hybrid, high voltage from the battery is stepped down to 42V for the EPS motor within a DC/DC converter that is on top of the battery pack. The steering angle sensor is mounted within the steering column. All EPS sensor input is collected by the EPS control unit, which is located under the hood, by the left strut top mount. This design is comparatively more complicated than the above-mentioned steering column EPS. Nevertheless, rack-mounted EPS is more elegant and less spread out than a bunch of hydraulic components strewn about the engine bay.

The last design is a combined, electronic-hydraulic power assist system. Quite simply, the crank-driven power steering pump is replaced by an electronically-controlled DC motor-driven pump that generates the necessary fluid pressure. Nissan calls this hybrid EPS. The hybrid EPS control module calculates pressure based on input from the steering angle sensor on the column and the steering torque sensor in the steering gear. The pump, motor, and control unit are combined into one hybrid EPS unit located under hood. Fluid pressure is transmitted conventionally into a hydraulic power steering rack that works on the steering linkage. This system retains the primary efficiency advantage of being able to control the running time of the power steering pump.

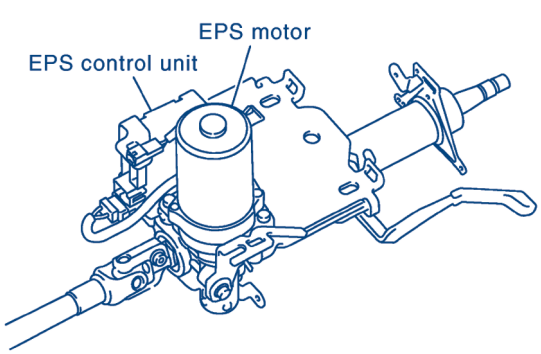
All EPS control modules use CAN



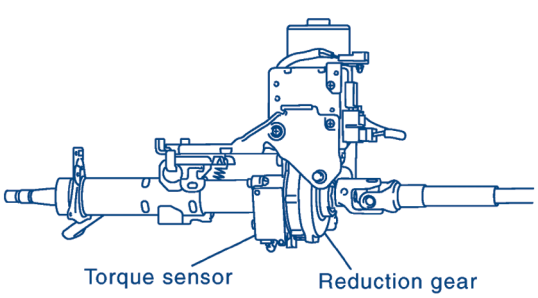

## Hybrid Electronic-Hydraulic EPS design

communication to get the vehicle speed from the primary ECU or ABS computer. Vehicle speed will affect output torque signals because low-speed steering will require greater assist than high-speed driving.

Any electronic power steering has fail-safe modes designed to protect the DC motor from over-running or the driver from losing steering control in case of emergency. In most instances, if electric assist is impossible, the steering wheel input will still move the steering gear or rack requiring increased driver effort. A warning indicator will illuminate on the gauge cluster, and DTC information is stored that can be retrieved using a CONSULT III PLUS. In the case of the hybrid-electric EPS, the steering rack will fail-safe to having equal fluid pressures on either side of the internal rack piston, and open the flow connection valve to alleviate resistance. In the case of prolonged assist demands, the EPS motor will reduce output gradually. This protection function also works in the event the motor is shorted or otherwise powered incorrectly and does not rely on prolonged steering input.




**Seen from above, the EPS motor and control unit on an EPS steering column.**



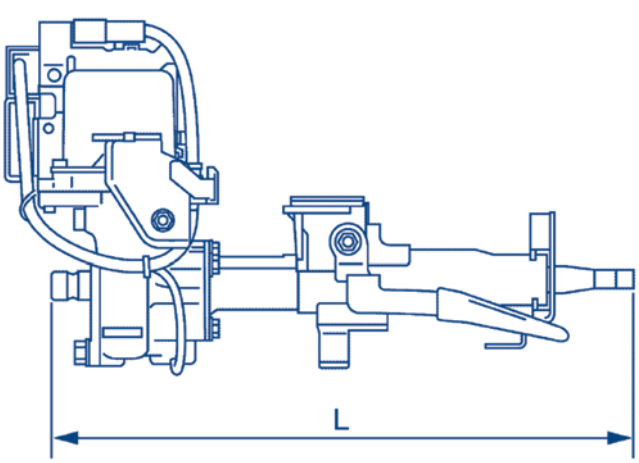

**Seen from the side, the torque sensor and reduction gear. You can get a sense of the additional height and size a steering column will require under the dash to add EPS.**

## A Closer Look at the Steering Column EPS

The steering column EPS is the most common system, and also the most simple in design. Until the driver moves the steering wheel, the system does nothing and remains in standby. If the steering wheel is moved, the torque sensor within the column will report the value to the EPS control unit. At that time, the control module will get vehicle speed information from CAN and perform a calculation to determine the assist torque signal. Depending on whether the driver is turning left or right, the torque signal will be a positive (right) or negative (left) value. The signal is interpreted by the EPS motor, which draws enough current to match the determined output torque. Like a window motor, the EPS motor turns clockwise or counterclockwise based on the path of the current determined by the control unit. The EPS motor rotates a reduction gear that will move the steering shaft and change the final drive torque that actually works on the steering gear pinion.

Because the steering shaft receives more torque directly applied to it, the U-joints are strengthened to accommodate the design. The dashboard and chassis have to be designed to allow for a larger steering column, as the EPS set-up is quite a bit larger than a normal column.

In the event of collision where damage to the steering column is a possibility, it may be necessary to replace the complete column and EPS assembly. With the column out of the vehicle, measure the length between the input of the steering wheel to the output of the EPS motor and compare with the specification in the service manual. Also, check the steering column rotating torque with a preload gauge (SST: ST3127S000) to determine whether the column is bent or there is an internal problem. Increased column rotating torque at certain points of travel may cause erratic power assist.




**Make sure the column is the specified length in the case of accident repair. A small amount of compression can create a lot of problems.**

## Components of the Rack-Mounted EPS Design

Control of the electric steering rack design is functionally identical to the steering column-mounted EPS. Steering wheel torque input is processed by the EPS control unit, which then determines the necessary amount of motor assist to provide. The control unit requests and distributes power from the DC/DC converter to step down the high voltage into the maximum 42V needed by the EPS motor. CAN communications provide the steering angle and vehicle speed data. The electric motor moves a worm gear, and a sensor reports its rotation angle to the EPS control module. Consult the service manual to determine the precise locations of every component within a rack-mounted EPS design. The motor and torque sensor are part of the EPS rack, but the control module and DC/DC converter will be located elsewhere.

## The Hydraulic-Electric Hybrid EPS

The layout and design of a hydraulic-electric hybrid EPS setup will look similar to conventional

systems. In fact, it may actually fool you at first glance as the design requires pressure lines, a fluid reservoir, and hydraulic rack and pinion. The EPS motor is also the pump, reservoir, and control unit, so it is more or less self-contained like the steering column-mounted EPS. The hybrid EPS works just like conventional power steering, but with the exception that the pump motor is controlled identically to the above-mentioned EPS designs. Based on steering torque and vehicle speed, the hybrid EPS control unit determines the necessary amount of fluid pressure, and rotates the vanes of the pump in the appropriate direction to provide assist pressure to the correct side of the steering rack. In other words, it's an on-demand power steering pump that only works when the steering wheel is turned. Just like conventional hydraulic systems, fluid leaks can develop; plus, any EPS component control may require diagnosis and repair.

## EPS Maintenance and Repair

The non-hybrid EPS designs do not require any periodic maintenance. In the event of a malfunction, the customer will complain of noises, steering feedback sensations (vibration, pulsation, judder, etc.), or the "EP" indicator on the gauge cluster may illuminate. The CONSULT III PLUS is necessary for diagnosis. It is possible that low battery voltage can cause loss of important information within the EPS control module.

If a primary EPS component requires replacement, it will be necessary to adjust the neutral position of the steering angle sensor, and/or calibrate the steering torque sensor. This is sometimes referred to as a zero-point calibration. Basically, the EPS needs to be told what things look like when the wheels are pointed straight ahead, and the steering wheel is centered without being actively turned. To set the zero-point for the steering angle sensor, you must use the CONSULT III PLUS and navigate to the ABS ECU work support section to choose ST ANGLE SENSOR ADJUSTMENT.

When performing alignments, the steering angle is not adjustable at the steering gear itself. It is necessary to finish the physical alignment process with adjusting the neutral position of the steering angle sensor as noted above. Forgetting this step may cause the customer to literally have to fight the power steering system to drive straight.

## Some Debate

It has been argued that electronically-controlled steering assist may not be as safe as conventional systems, but this is simply not supported by the facts. EPS failures that result in loss of power assist are cited as the primary risk for crash, yet how is this any different from a hydraulic system that loses pressure from a slipping or broken belt, or fluid volume due to a leak? More often, motor assist remains ON despite having completed a turn, which means driver input is required to return the wheels forward. This is more annoying than dangerous. Sensationalism would have us believe the EPS motor gets stuck on and drives the car off the road. How often does a power window get stuck on indefinitely? Nissan is convinced that the future of efficient vehicles will involve EPS, and extensive quality control is involved in guaranteeing the safety of steering control systems.

## What Will Happen to the Drive Belt?

Electronic accessories are gaining momentum and support as vehicle inter-system communications and processing power improve. The ultimate goal is to remove the yoke of pulley-driven accessories from under the hood. Electric A/C compressors, EPS, and possibly a replacement for the alternator will reduce the energy wasted on accessories, freeing up the engine for better performance and economy. Stay up to date on new Nissan technology with a subscription to www.nissan-techinfo.com for online training materials and new model introductions.

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