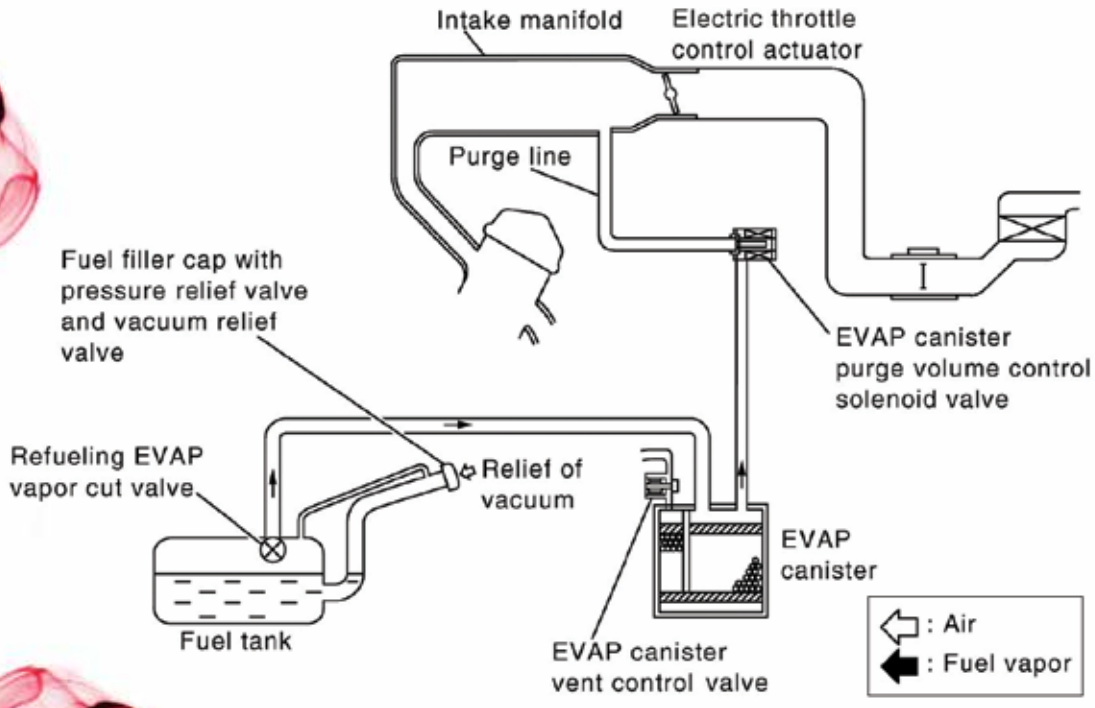
Oh My, I think I've Got the Vapors!

How to deal with EVAP problems without developing indigestion.



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

A Quick Overview of the EVAP System

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

The Charcoal Canister

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

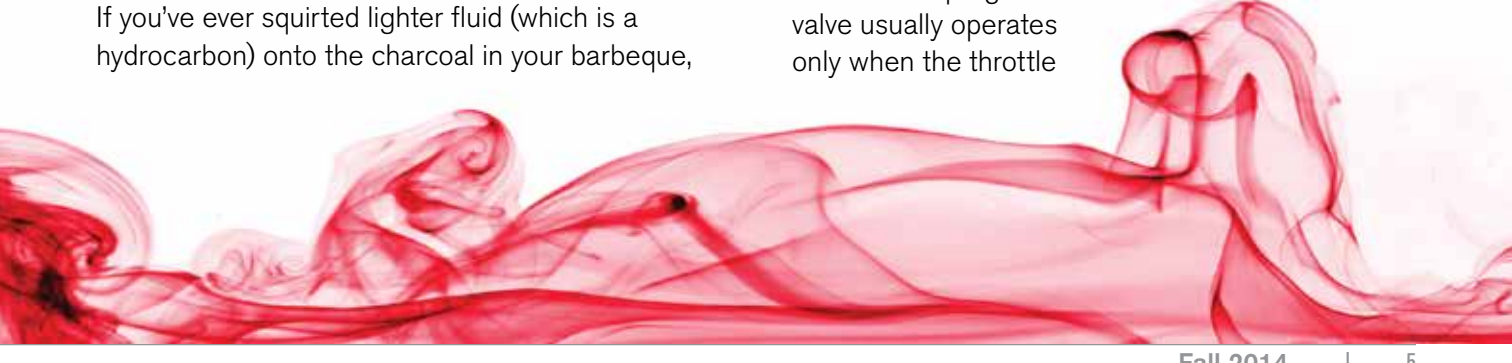
- A torn filter
- Water saturation
- Fuel saturation

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

Purge Volume Control Solenoid Valve

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

The ECM is able to control the volume of flow from the canister by changing its duty cycle. If the valve is ON 50% of the time and OFF 50% of the time, it would flow roughly 50% of its maximum volume. If the ECM changes to 75% ON and 25% OFF, it would flow about 75% of its maximum volume. The purge valve usually operates only when the throttle



is open and the engine is warm. The purge valve should always be fully closed during deceleration, otherwise the flow of fuel vapors could cause backfires. The most common causes of failure are:

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

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

Canister Vent Control Valve

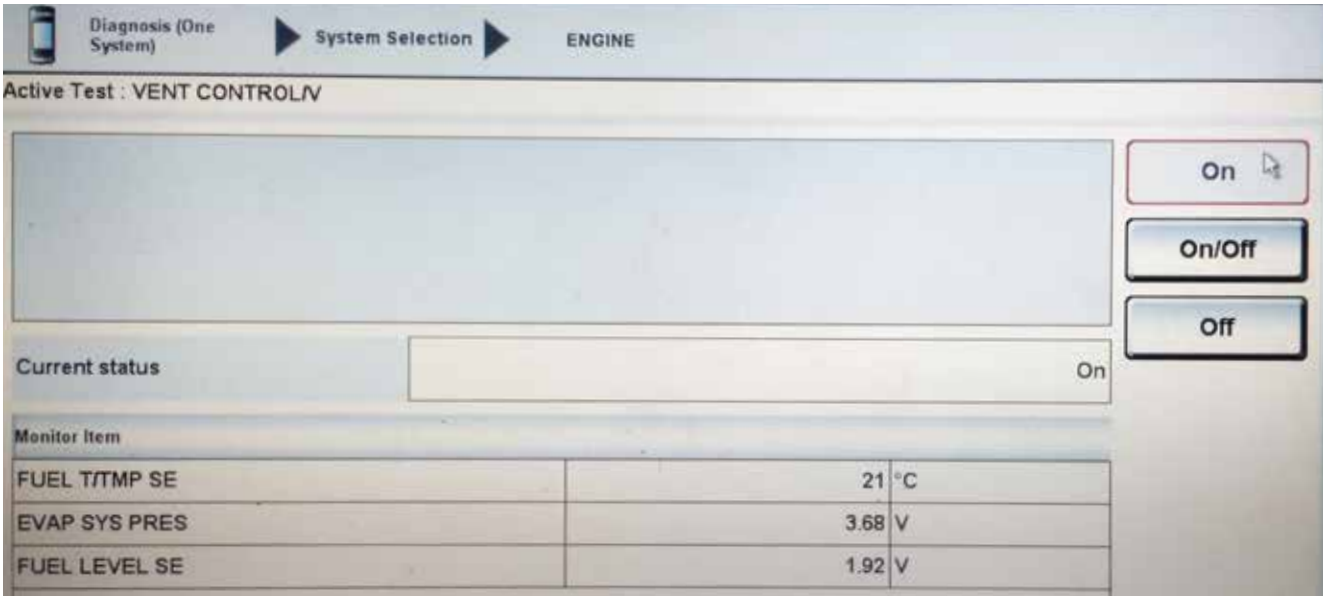
Let's call the CVCV the "vent valve" to save words. The vent valve is a component added for self-diagnostic function only. Its job is to seal the tank from the atmosphere to allow vacuum testing to verify there are no leaks in the system. The vent valve is normally open; the opposite of the purge valve.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

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

EVAP Control System Pressure Sensor

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

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



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

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

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

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

Fuel Tank Temperature Sensor

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

Fuel Level Sensor

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

Diagnosis

So you've found an EVAP code. It's best to start with a visual inspection: eyes only, no touching. Resist the temptation to twist the gas cap! If you tighten it and it seems to move a little, how sure will you be that the car is fixed? It's a good idea to look at the purge line under-hood, and make sure the gas cap is in place, and maybe do a little sniffing

for fuel odor, but don't mess with anything until you've confirmed the problem and have a way to confirm the repair.

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

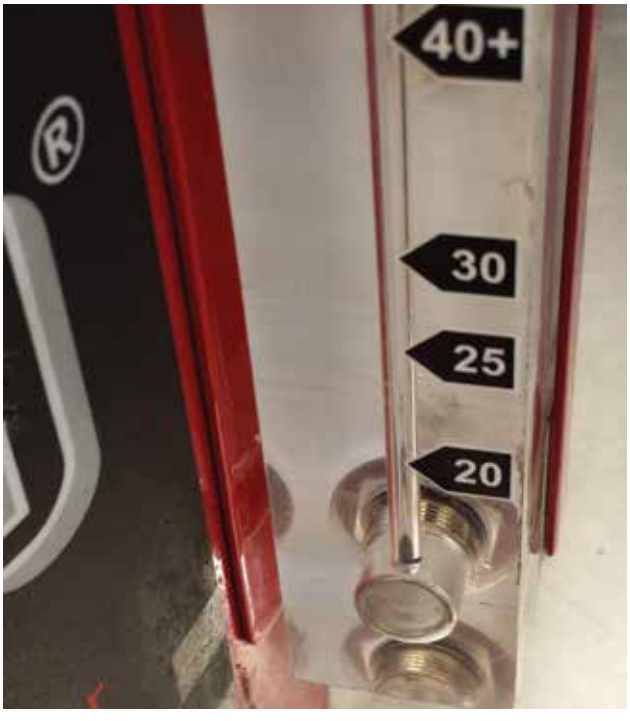
EVAP Leak Check

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

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

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

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



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

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

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

Trouble Code Examples

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

P0441: incorrect purge flow

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

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

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

P0456*: very small leak detected

P0442: small leak detected

P0455: very large leak detected

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

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

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

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

P0443: purge valve

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

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

commanded. For example:

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

P0444: very small leak detected

P0445: short in purge valve

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

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

P0447: vent valve

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

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

P0448: stuck closed vent valve

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

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

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

P0451: pressure sensor output is abnormal

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

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

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

P0452: pressure sensor output low

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

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

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

P0453: pressure sensor output high

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

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

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

P0181: fuel tank temperature sensor rationality check

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

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

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

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

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

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

P0460:	fuel level sensor noise

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

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

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

P0461:	fuel level sensor stays fixed

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

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

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

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

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

Drawing a Blank

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

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

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

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

After the new ECM is installed, select:

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

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

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

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

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