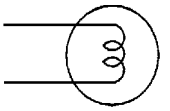
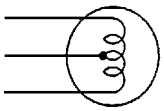
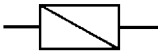
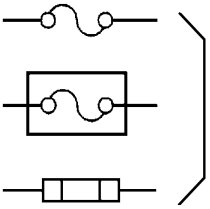
ELECTRICAL SYMBOLS


single filament bulb

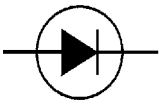

dual filament bulb


fuse

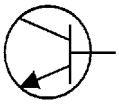

fusible link


(old symbols)

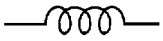

diode


light emitting diode (LED)

motor

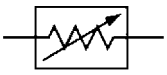

transistor


resistor

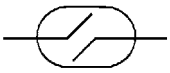

coil


battery
(each set of line = 1 cell)

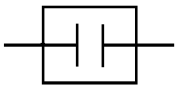
TEL001

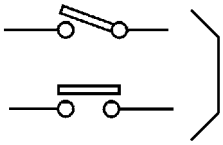

variable resistor

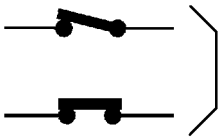

thermistor


reed switch


circuit breaker


condenser


switch
(normally open)


switch
(normally closed)


ground


no connection
between wires


connection
between wires


branch circuit

TEL002

INTRODUCTION TO ELECTRICITY

Nissan vehicle use electricity to control and operate many standard features such as headlights, windshield wipers and rear window defoggers. More recently, Nissan's Anti-lock Braking System (ABS) and Sonar Suspension have been possible because of advances in electronic technology. While these represent some of the more sophisticated uses of electricity and electronics on vehicles today, the trouble-shooting and repair techniques are relatively simple.

You will need to be able to troubleshoot and repair electrical and electronic circuits used on Nissan Diesel vehicles. You do not need to know how to design the systems! This course will provide you with the skills necessary to:

Verify symptoms by attempting to operate circuits, and find out what is working and what is not working.

Isolate causes of problems by
- tracing current flow paths using Wiring Diagrams.
- locating harness connectors using Harness Layout Diagrams.
- testing electrical circuits using a multimeter.

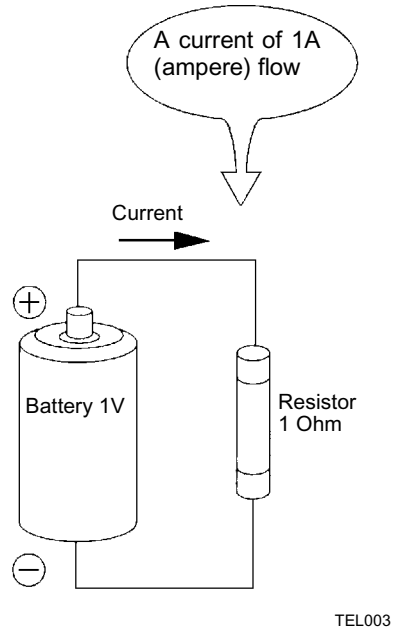
Repair electrical problems by
- fixing broken wires and poor connections.
- replacing broken components
- adjusting a switch or sensor.

Recheck that the symptom has been fixed, and duplicating the conditions that caused the problem to be sure no new problems have been caused.

1. BASIC ELECTRICAL

1) OHMS LAW

The electrical properties described thus far, voltage, current, and resistance, have the following relationship. This relationship was discovered by the German physicist Ohm, and is therefore called Ohm's Law. It describes one of the most fundamental relationship in the field of electricity.



Ohm's Law

The current which flows in an electric circuit is proportional to amount of applied voltage and inversely proportional to the resistance.
In other words, the amount of current flowing in a circuit is doubled if the applied voltage is doubled, and cut in half if the resistance is doubled.
If, in the circuit in figure at right, the current is expressed as 1 (A), voltage as E (V), and resistance R (Ω), then Ohm's Law is given by the following equation:

$$I = V / R \ [A]$$

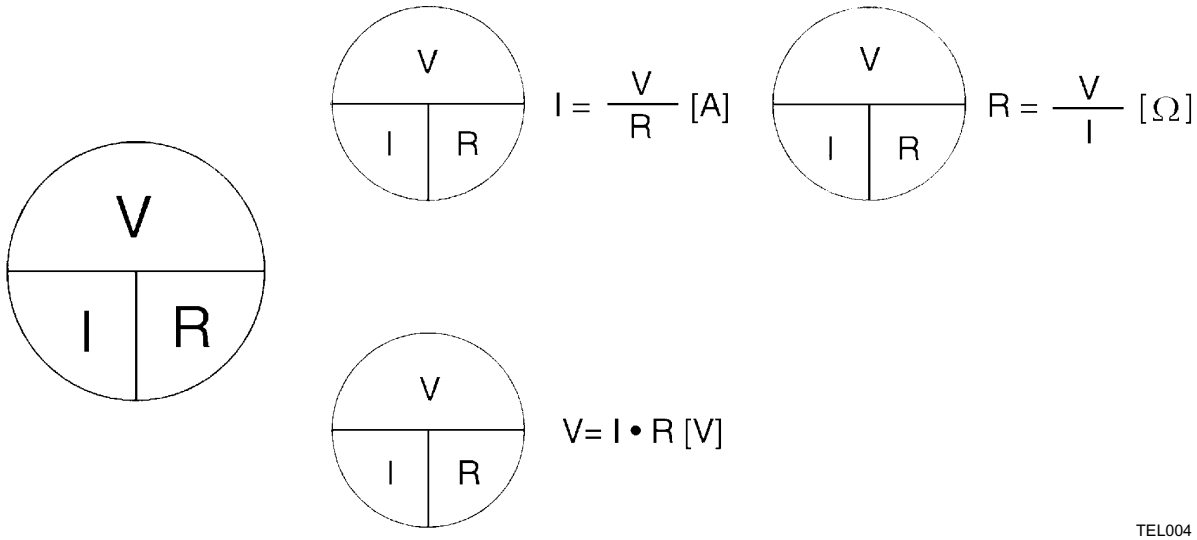
$R = V / I \ [\Omega]$

$V = I \times R \ [V]$

Where: I --- Current
V --- Voltage
R --- Resistance

AN IDEA HELPFUL IN MEMORIZING OHM'S LAW

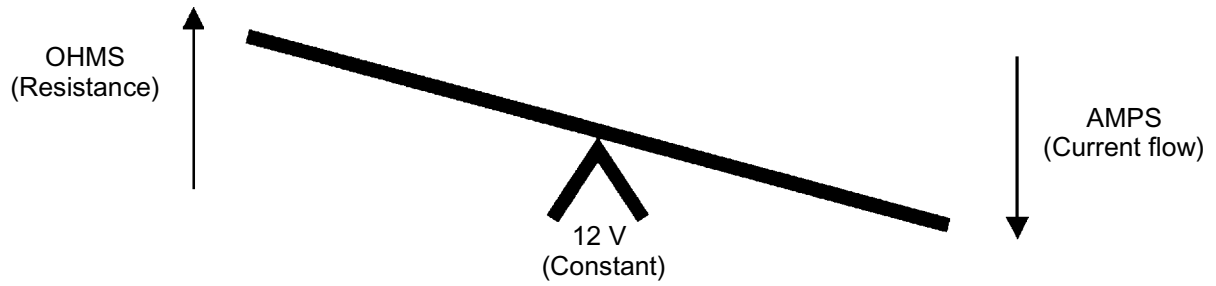
Just picture a circle which is divided into three. The positions of V.1.R. are important. V actually represents "Volt" but why not think of it as Victory as it is above 1 and R.



TEL004

In the 1800s, a German physicist named George Ohm worked out a relationship between voltage, resistance and amperage in a circuit. The key to this relationship can be summarized in the following statements:

IF VOLTAGE (VOLTS) STAYS CONSTANT AND CIRCUIT RESISTANCE (OHMS) INCREASES, CURRENT FLOW (AMPS) WILL DECREASE.

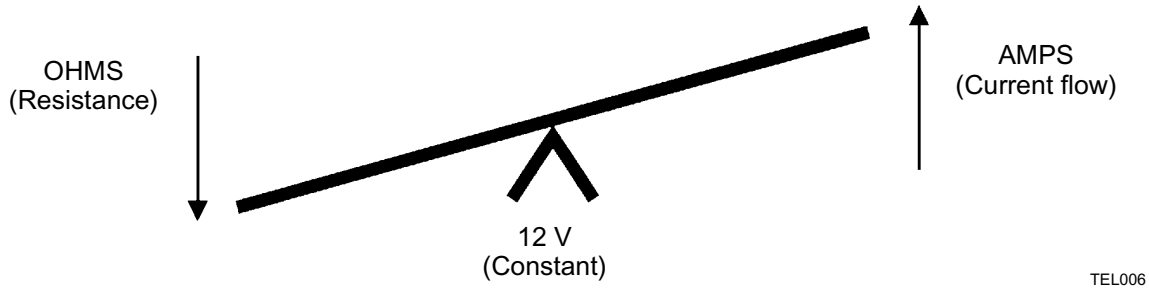


TEL005

For example, in a circuit with corrosion at one of the wire connections, INCREASED resistance will DECREASE the current flow. High resistance will result in light bulbs that are dim, relays that do not engage, and motors that turn too slowly.

Secondly, Ohm's Law states:

IF VOLTAGE STAYS CONSTANT AND CIRCUIT RESISTANCE DECREASES, CURRENT FLOW WILL INCREASE.



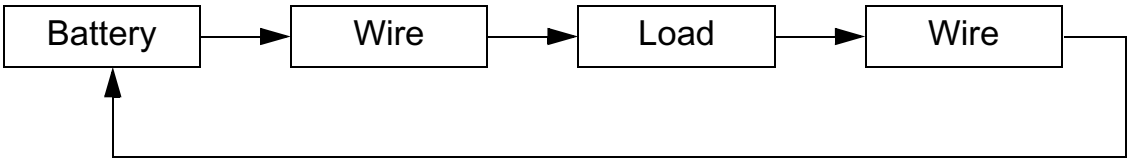
This means. for example, that if the insulation on the **POWER** wire is nicked or cut and the wire makes a **SHORT** circuit to ground, the resistance built into the circuit is bypassed. As a result, current flow in the circuit increases, and the fuse will blow. In an unprotected circuit, the wire will get hot and melt the insulation!

In summary:

IF RESISTANCE (OHMS) IN A CIRCUIT GO UP, CURRENT FLOW (AMPS) GO DOWN DIM BULB
IF RESISTANCE (OHMS) IN A CIRCUIT GO DOWN, CURRENT FLOW (AMPS) GO UP BLOWN FUSE

2) CIRCUIT REQUIREMENTS

The basis for discussing electricity in Nissan vehicles is the CIRCUIT. A circuit is a complete path for electricity to flow. Electrical circuits consist of wires, wire connectors, switches, relays or other electrical and, electronic components.

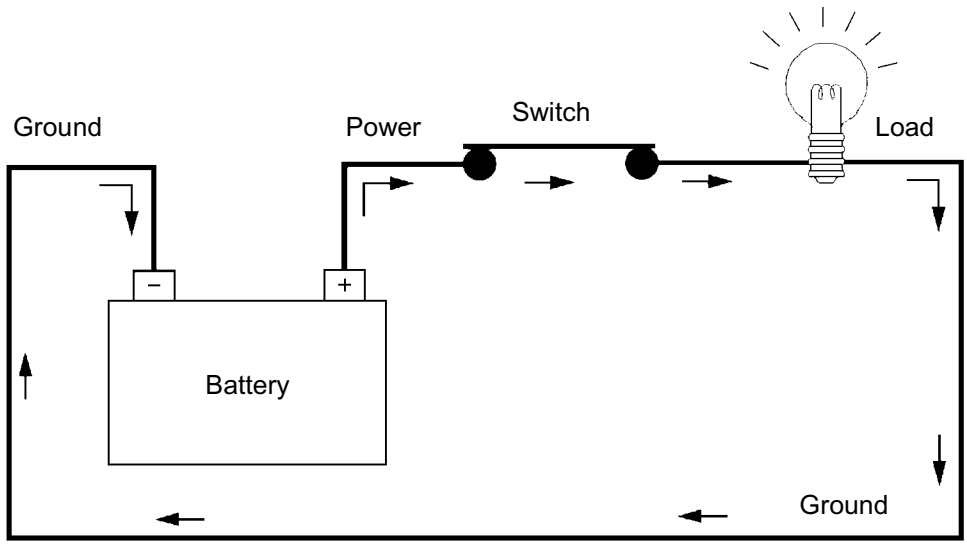


Regardless of the complexity of the circuit, or the number of parts in the circuit, there are three essential elements that ALL CIRCUITS must have in order to operate. They are:

POWER (SOURCE) The battery AND the electrical path from the battery to the load. This is the positive (+) side of the circuit.

LOAD Any electrical component that lights, heats or produces motion in a circuit.

GROUND The electrical path from the LOAD back to the battery. This is the negative (-) side of the circuit.



TEL007

3) VOLTAGE, AMPERAGE AND RESISTANCE

In addition to the requirement that a circuit have a POWER source, a LOAD for the electrons to pass through, and a GROUND or way for the current to return to the POWER source, there are three other factors that determine the operation of the circuit. They are:

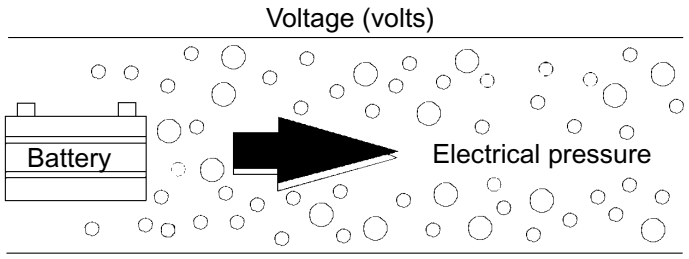
VOLTAGE The electrical force in a circuit that pushes electrons through the conductors

AMPERAGE The amount of electrons moving in a circuit

RESISTANCE Opposition to the flow of electrons

VOLTAGE

Electrons will flow through a circuit if they are pushed. Voltage is the amount of electrical pressure that is available to push electrons through a circuit. Nissan vehicles all use 12 VOLT batteries, but when the alternator is charging, circuit voltage will increase to approx. 14 volts.



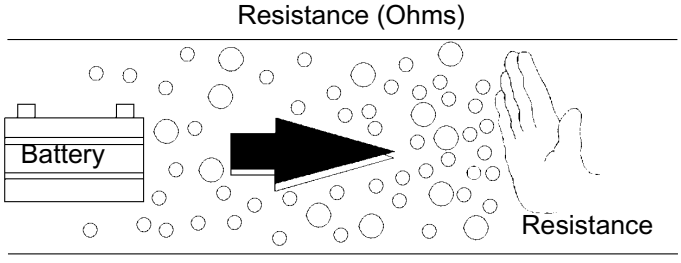
TEL008

AMPERAGE

The measurement of current flow, or electricity in a circuit is called amperage. This represents the flow of electrons through the wires as the circuit operates.
There have been many theories written about electricity (current flow). Research in chemistry and physics has established the electron theory to help explain what electricity is and how it is used.

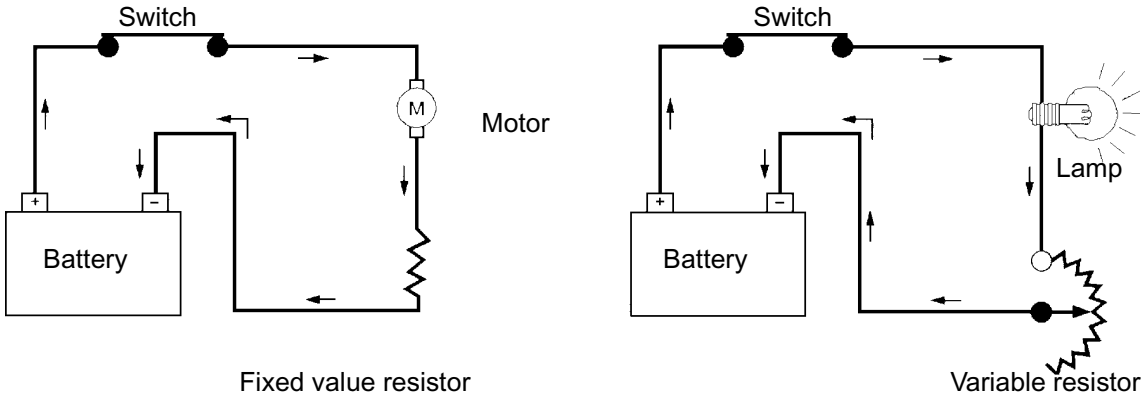
RESISTANCE

Resistance is an essential part of electrical LOADs. Circuits are designed with a specific amount of resistance. Resistance opposes electron flow in a circuit and is measured in OHMS. OHMS are represented by the symbol Ω.



TEL009

Sometimes components called RESISTORS are used to oppose current flow in a circuit. There are two types of resistors used in automotive circuits. A fixed value resistor is used to establish a set resistance in a circuit. A second type of resistor can vary its resistance to control the movement of electrons in a circuit. In the example, a variable resistor is used in the illumination circuit to dim a light bulb. The fixed resistor in the motor circuit will change the speed of the motor.



TEL010

Earlier, we spoke of a circuit's requirements for POWER, LOAD and GROUND. The LOAD is the resistance in the circuit that provides beat, light, or motion. When the resistance of the circuit LOAD is at the correct value, and when POWER and GROUND are correct, the circuit operates as it should. Problems occur when resistance in a circuit increases or decreases.

Increased circuit resistance can be caused by such things as loose connections, corroded wire connectors, or dirty switch contacts. These conditions create UNWANTED resistance. Unwanted resistance opposes the flow of electrons in a circuit, causing bulbs to be dim and motors to turn slowly. These unwanted resistance are the things you are called on to fix!

While high resistance can keep a circuit from working, there are also serious consequences when circuit resistance decreases. A decrease in circuit resistance, caused for example by a partially shorted LOAD, increase the current flow in a circuit. The result is a blown fuse, or even burned wires and connectors. We'll talk more about ways to isolate and repair these unwanted resistances later. For now, look at the following chart for a summary of the elements that determine the operation of a circuit.

TERM	DEFINITION	UNIT OF MEASUREMENT	SYMBOL
Voltage	Electrical Pressure	Volt	V
Amperage	Current Flow	Amp	A
Resistance	Opposition to Current Flow	Ohm	

UNITS

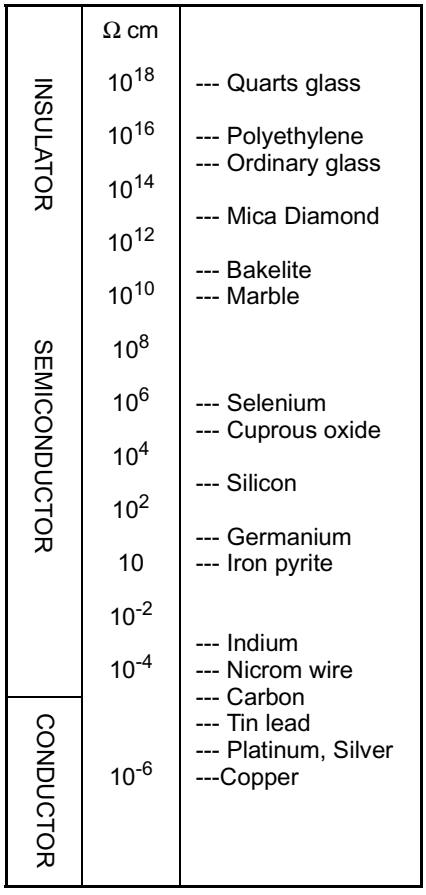
The units generally used in DC (direct current) electrical circuits are the Ampere [A], Ohm
[Q], Volt [M, etc. The following auxiliary units are used depending on the magnitude of the values.

		Value / Unit	x 10^{-6}	x 10^{-3}	x 1	x 10^{3}	x 10^{6}
V	General electric power	[V] Volt	μV (Micro-)	mV (Milli-)	V	kV (Kiro-)	—
I	Electric current	[A] Ampere	μA (Micro-)	mA (Milli-)	A	—	—
R	Electric resistor	[Ω] Ohm	—	—	W	kΩ (Kiro-)	MΩ (Mega-)

SEMICONDUCTORS

WHAT IS A SEMICONDUCTORS

Some substances have many electrons that move freely (= free electrons), while others do not. The former are called conductors, suitable for carrying electricity. The latter are called insulators and do not allow electricity to flow.
The graph on the right shows the specific resistance of various materials. Germanium, silicon, etc., having a specific resistance between that of a conductor and an insulator, are called semiconductors.



Semiconductors are widely used in today's electronic devices such as diodes, transistor, -and other elements. Their superior electrical capabilities result from the following characteristics.

Although a pure substance does not conduct electricity well, substantial electricity can be conducted if a small amount of an impurity is added. The change in electrical resistance of semiconductors with respect to a change in temperature is the opposite of that of metals. For metals, the resistance becomes larger as temperature rises but resistance of semiconductors becomes smaller. (There are some materials which have the reverse characteristic.)

INSULATORS

There is another Category of materials such as wood, glass, rubber and plastic which are made of atoms whose electrons are very tightly bound to the nucleus. The electrons of these materials can not easily move to other atoms. Such materials are called insulators. Insulators are important because in vehicle wiring harnesses, where the wires for many circuits travel together, electrons have to be prevented from moving from one another

CONDUCTORS

Certain materials conduct electricity much better than others. As we said, copper and steel are good conductors because they have large numbers of free electrons that will move from atom to atom. Metals such as gold and silver are even better conductors because they have even more orbiting electrons. Since gold and silver are quite expensive, they are only used' in a few, special applications on Nissan products.

4) CIRCUIT TYPES

All circuits must have POWER, LOAD and GROUND to operate properly. On Nissan vehicles, these elements are arranged in two different ways:

- **SERIES CIRCUITS**
- **PARALLEL CIRCUITS**

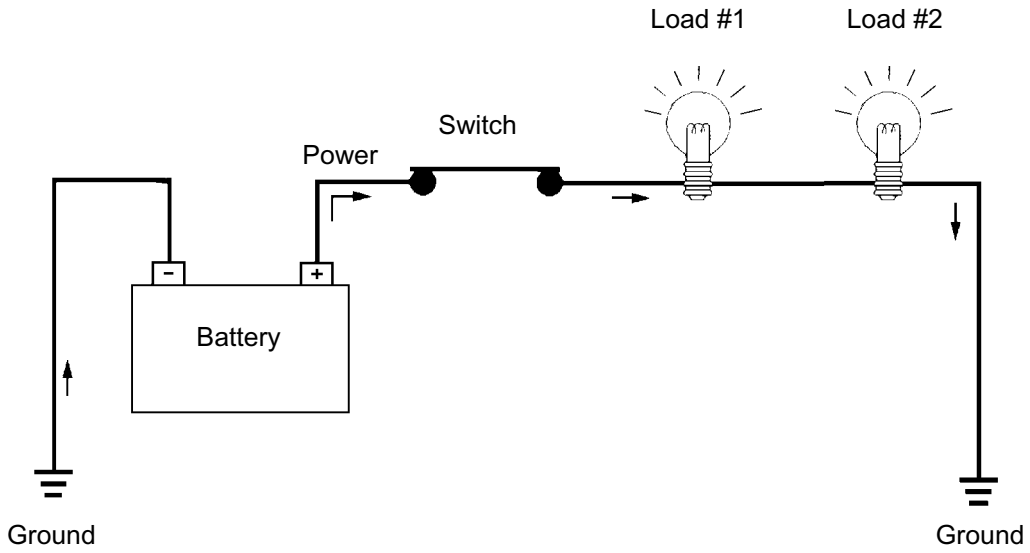
SERIES CIRCUITS

In a series circuit, the POWER, LOAD and GROUND are arranged so that current can take only one path through the circuit. Consequently, current flow (amps) will be the same no matter where it is measured in the circuit. Voltage in a series circuit, however, will gradually decrease because each load uses part of the total voltage available in the circuit.

TROUBLESHOOTING TIP #1

An open at any point in a series circuit will prevent the entire circuit from operating.

A series circuit will operate provided there are no opens in the circuit. In the circuit shown, for example, if the switch fails, creating an open circuit, no current will flow, and neither of the bulbs will light.



TEL011

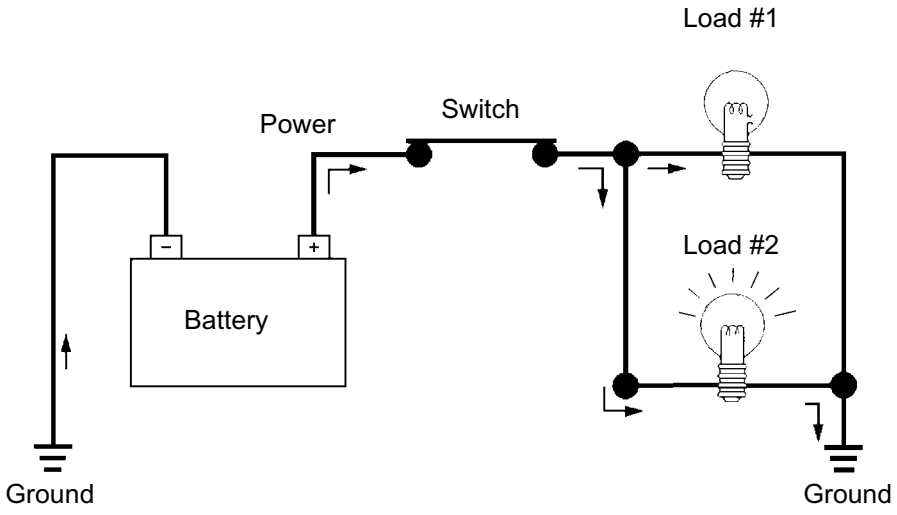
PARALLEL CIRCUITS

In a parallel circuit there are two or more paths for current to flow. Tail light circuits on Nissan vehicles are examples of parallel circuits. If one of the bulbs in a parallel circuit burns out, current will continue to flow through the other paths in the circuit, and the other bulbs will still light.

TROUBLESHOOTING TIP #2

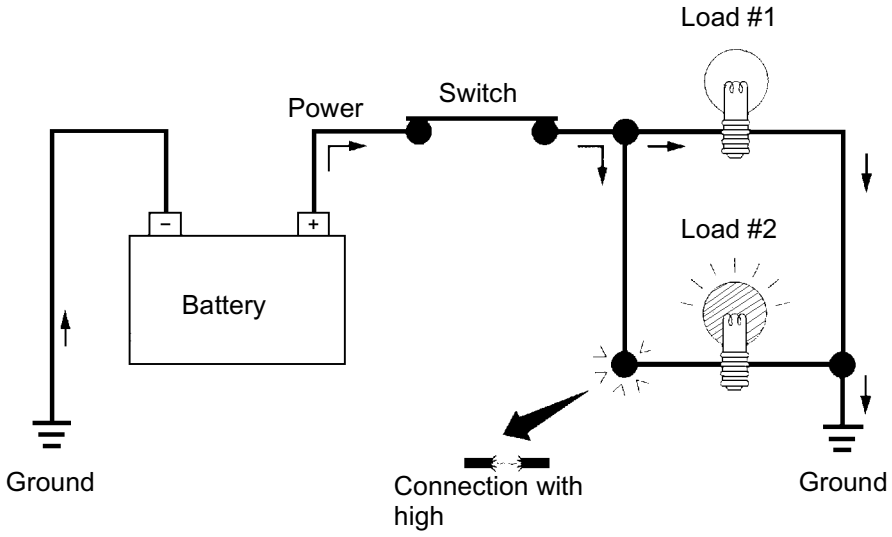
An open in a parallel circuit prevent only the load in the open push from operating.

In the example below, if one of the bulbs in the parallel circuit burns out, current will continue to flow through the other paths in the circuit, and the other bulbs will still light.



TEL012

In a parallel circuit, if the resistance of each bulb is the same, current flow will be the same. If resistance changes in any of the paths, current flow through that path will also change. A bad connection at one of the bulbs will change the resistance for only that one bulb. It will be dim, but the other bulbs will not be affected.



Nissan vehicles generally use parallel circuits when more than one LOAD receives POWER from a common point, such as in the case of a taillight circuit. When diagnosing a parallel circuit, if neither LOAD operates, look for an open circuit before the circuit splits. If one or both LOADs are dim, look for high circuit resistance.

TROUBLESHOOTING TIP #3

If both LOADs in a parallel circuit are not operating, look for the problem to be BEFORE the circuits split.

In addition to series and parallel circuits, there are SERIES /PARALLEL circuits on Nissan vehicles. A series/parallel circuit is a combination of the two types. The parallel part of the series /parallel circuit can be diagnosed as a parallel circuit, while the series part of the circuit is diagnosed the same way as a series circuit.

INTRODUCTION TO ECCS

1. What is ECCS engine?

ECCS engine is a real improvement for reduction of each exhaust gas emission while maintaining driveability by controlling fuel injection, idle engine-speed, fuel pump control by one microcomputer according to every driving condition, to always most suitable condition including improvement of fuel consumption. Control of ECCS engine pre-programs the control module to the most suitable control value in every driving condition beforehand. It detects the state of the engine by sensors and selects the most suitable value among the pre-programmed data that a control module memorizes by an input signal from sensors. It also sends an output signal to the actuator and controls it.

2. Purpose of ECCS development

1) Improved engine performance
2) Improved fuel consumption
3) Reduced air pollution
4) Improved driveability
5) Improved starting in cold weather

3. ECCS Flow System

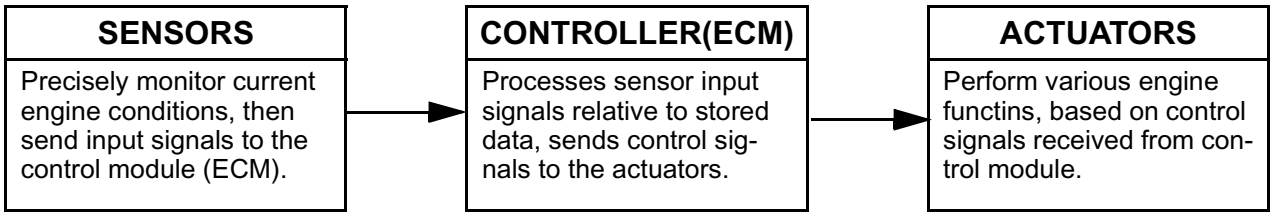
Although particular components vary from model to model, basically the ECCS monitors and controls these 3 primary systems to maintain maximum engine performance.

* FUEL FLOW SYSTEM
* AIR FLOW SYSTEM
* ELECTRONIC FLOW (IGNITION) SYSTEM

Constant adjustments are made to maintain a specified relationship between these systems. Understanding this relationship will allow you to more easily break down the overall engine operations into smaller segments. In doing so, you can more systematically target and/or eliminate them as part of the trouble cause. Brief descriptions of each system are found on the following pages. To maintain the operational relationship described above, the ECCS uses three basic types of components;

*SENSORS *CONTROLLER *ACTUATORS

These components work in relation to each other as shown below:



4. Function of ECCS

SYSTEM CONFIGURATION
ECCS FUNCTION
The ECCS is capable of controlling a number of functions. It is also capable of providing more delicate and more sophisticated control. The functions that can be controlled by ECCS are:

1) FUEL INJECTION CONTROL

Based on the quantity of intake air (air mass), this fuel injection control system determines the fuel injection quantity corresponding to engine conditions. For example, optimum fuel injection quantity is determined by the coolant temperature at the time when the engine is started. After idling, the air-fuel ratio is properly controlled by a learning function.

2) IGNITION TIMING CONTROL

Reads data from the memory in ECM, and determines optimum ignition timing based on engine rpm and intake air quantity.

3) FUEL PUMP CONTROL

Controls source voltage to the fuel pump according to engine rpm and condition, thereby reducing pump noise and power consumption.

4) IDLE SPEED CONTROL

Receives signals from various sensors, and adjusts the engine to optimum idling speed corresponding to the engine condition.

5) PRESSURE REGULATOR CONTROL

Increases the fuel pressure temporarily when starting the engine with high coolant temperature.

6) FAIL-SAFE SYSTEM

When a malfunction occurs in some important sensors, the ECM is able to control the engine in a limited manner so the vehicle may be driven. The ECM itself has such a back up program if it fails to function correctly.

7) ON-BOARD DIAGNOSIS SYSTEM

The ECM is able to monitor major sensor and some actuators, for incorrect signals. If a malfunction occurs due to missing, open or short circuits, the ECM self diagnosis system will record a code which can be retrieved by a service technician at a later.