



MEASUREMENT IN TROUBLE DIAGNOSIS

April 2008

Foreword

The information in this Training Manual should not be interpreted as a basis for warranty or goodwill claims against Nissan Motor Co. (Australia) Pty. Ltd. (NMA) unless so designated.

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Before quoting any specifications be sure to check the relevant Service Manual and Technical Bulletins.

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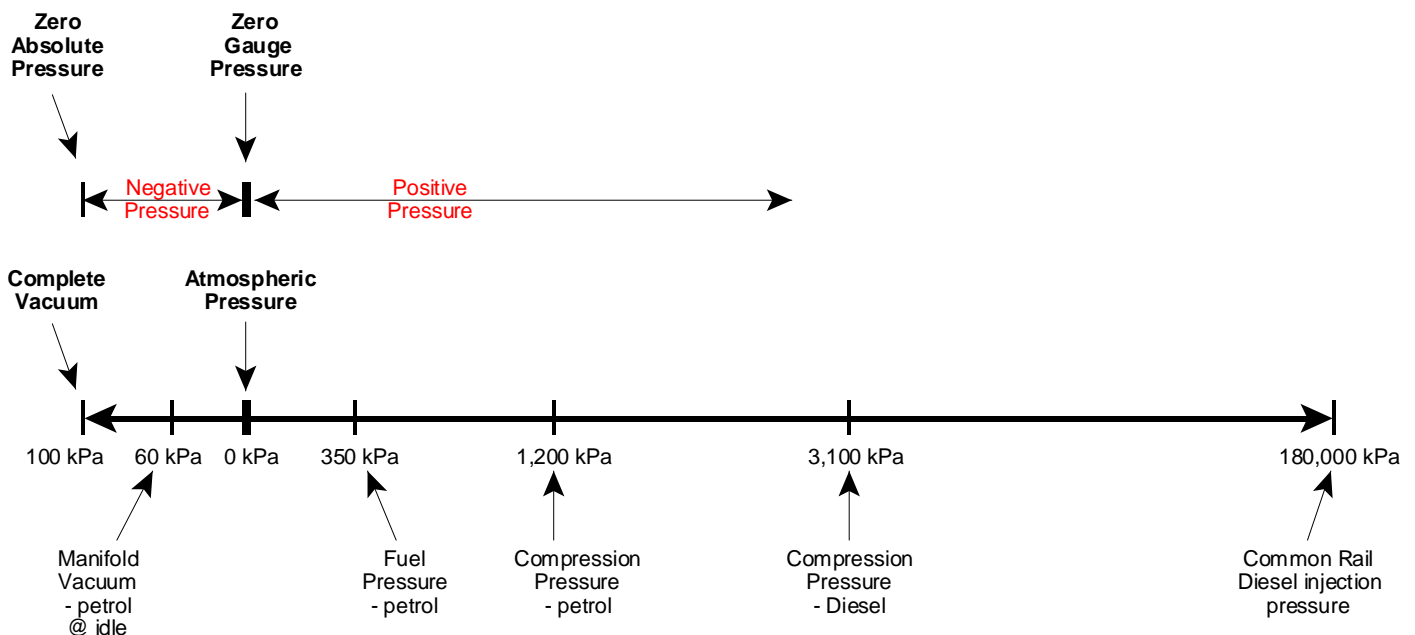
Ref: Technical Training Department.

MEASUREMENT IN DIAGNOSIS

Measurement of Pressure for Trouble Diagnosis

When diagnosing vehicle concerns, various measurements of pressure are often taken. There are two types of pressure that we commonly refer to:

- Gauge pressure (ranging from atmospheric pressure upwards)
- Absolute pressure (ranging from a complete vacuum upwards).



Note: Not to scale

Gauge Pressure

This is relative to atmospheric pressure and is most commonly used in system diagnosis.

Absolute Pressure

This is measured from a perfect vacuum through to positive pressures. This is less commonly used except for example when measuring intake manifold vacuum.

Vacuum

A pressure of 0 kPa G (Gauge) is equal to 100 kPa A (Absolute).

However, when referring to vacuum (from atmospheric pressure), the readings increase in kPa to 100 kPa at a perfect vacuum. This is actually a negative pressure (- kPa) but is usually just expressed as kPa of vacuum.

MEASUREMENT IN DIAGNOSIS

Fuel Pressure Test on Return-less Systems

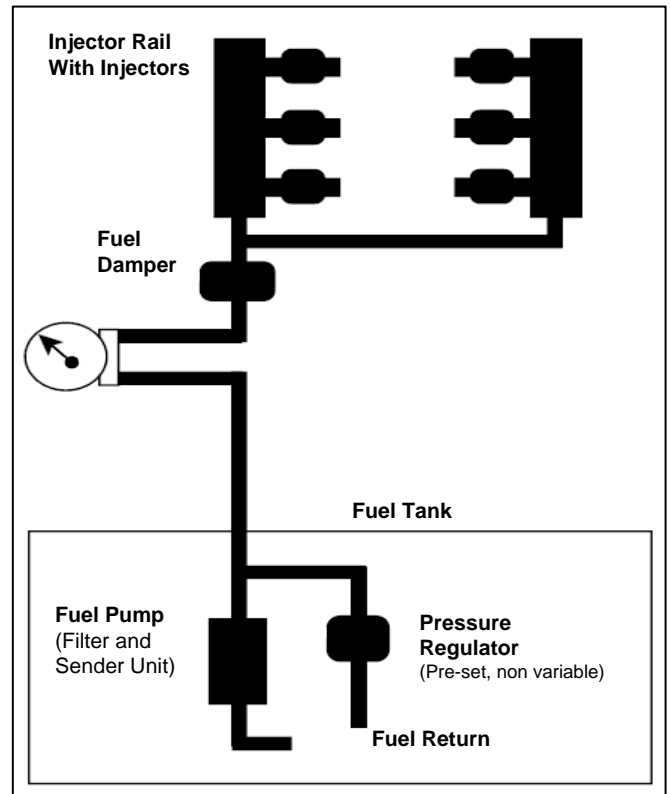
1. Install the Fuel Pressure gauge on the engine. Refer to Section EC – “Basic Service” in the Service Manual
2. Switch Ignition ON. Ensure Fuel Pump activates & then stops after a few seconds. Check for fuel leaks.
3. Start engine and read fuel pressure. Compare to specifications in the Service Manual.

Check the following items if fuel pressure is too LOW:

- Blocked filter or fuel pump pick up
- Restricted fuel lines
- Faulty pressure regulator.

Note:

- **DO NOT SQUEEZE OR CRIMP FUEL LINES!**
- If fuel pressure is too HIGH, replace the pressure regulator which is located in the fuel tank.




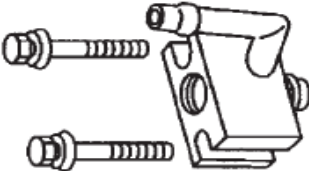
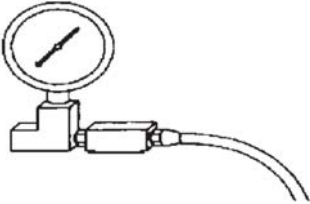

Residual Pressure Retention (Both types of Fuel Systems)

Ensure that when the engine & fuel pump is switched OFF, fuel pressure is retained in the lines for the specified period. Typically this should be no more than a 10% drop over 10 seconds.

If pressure is dropping away excessively, consideration needs to be given to the following items:

- Leakage in the reverse direction back to the tank.
- Leakage in the forward direction through leaking injectors (or fuel pressure regulator on Return Systems only). If this is the case, the engine will be difficult to start & black smoke will be emitted from the exhaust.

Typical SST requirements for Fuel Pressure Testing

Adapter KV 101118400		Adapter KV 10117600 AUS	
Gauge and Adapter 7211 and 7273		Fuel Line Removal Tool 16441 6N210	

MEASUREMENT IN DIAGNOSIS

Measurement of Compression in the Cylinder Chamber

As part of an Engine no / poor running diagnosis, the Cylinder Compression is an important measurement to record in order to narrow down the cause of a fault. Correct engine compression is a critical factor in good engine operation, good fuel consumption and providing clean emissions.

Actual compression pressures will vary depending on the type and condition of the engine.

Typical range of compression pressures:

Engine	Compression kPa		Max variation between cyls.	Cranking RPM
	Std	Minimum		
Petrol – VQ40	1,275	981	98	300
Diesel Indirect Injection – TD42	2,942	2,452	294	200
Diesel Direct Injection – ZD30	2,942	2,452	294	200
Diesel Direct Injection – YD25	3,100	2,500	490	200

Compression Test Procedure

(All engine types)

Engine MUST be at operating temperature.

Ensure battery condition will enable correct cranking speed (monitor with CONSULT II). Use jumper battery if necessary.

If the compression is below specifications:

- Check valve clearances
- Conduct wet-test (small qty. of oil added to Low cylinder):
 - If compression increases, suspect rings/piston problem
 - If compression remains same, suspect valves/cylinder head.
 - If two adjacent cylinders remain Low, suspect head/gasket problem.

Petrol Engines

1. Remove fuel pump fuse, crank engine a few times to ensure engine won't start
2. Remove; manifold collector (if required), ignition coils and spark plugs
3. Insert compression gauge
4. Switch ignition ON and depress accelerator pedal fully

NOTE: The Electronic Throttle (if fitted) will open with ignition switched ON.

5. Crank engine and after gauge stabilises, RECORD compression readings for each cylinder.

MEASUREMENT IN DIAGNOSIS

Diesel Engines

1. Ensure engine is warmed thoroughly & then switch engine OFF.
2. Refer to section EM or EC of the Service Manual for correct pump or fuel system disabling procedure.
NOTE: On YD25 engines - remove injector connectors and carefully isolate with insulation tape. (Refer to Service Manual Update Bulletin EM06-001).
3. Remove Glow Plugs (ensure dirt cannot enter engine and glow plugs are not knocked around)
4. Insert correct compression gauge adaptor for the engine.
NOTE: Engine can be permanently damaged if incorrect compression gauge adaptor is used.
5. Crank engine and after gauge stabilises, RECORD compression readings for each cylinder.

Diesel Engine SST's for checking Compression

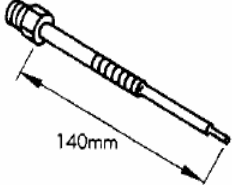
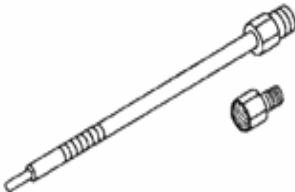
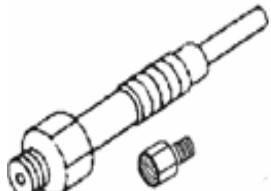
Refer to the right for the different glow plug hole adapter tools required for measuring compression on diesel engines.

NOTE:

Take care not to use the wrong adapter. Otherwise severe engine damage will result.

Petrol Engines

Use any commercially available tools for checking compression on petrol engines.

<p>YD25 Engine ED19600610</p>	
<p>ZD30 Engine ED19600620AUS</p> <p>(DO NOT use in YD engine or severe damage will result)</p>	
<p>TD Engines ED19600600</p>	

MEASUREMENT IN DIAGNOSIS

Measurement of Oxygen Content after Combustion

All modern petrol engines have Oxygen Sensors installed in the exhaust manifold. These sensors generate a voltage signal & sends this voltage back to the ECM.

A varying amount of Oxygen seen by the sensor will create a varying voltage signal. The ECM sees this varying voltage & then it **MAKES AN ASSUMPTION ON HOW MUCH FUEL ENTERED THE COMBUSTION CHAMBER.**

If the Oxygen Sensor (O2S) measures a HIGH level of Oxygen;

This will tell the ECM the A/F Ratio was **LEAN**. Therefore on the engines next cycle the ECM will add **MORE** Fuel.

If the Oxygen Sensor (O2S) measures a LOW level of Oxygen;

This will tell the ECM the A/F Ratio was **RICH**. Therefore on the engines next cycle the ECM will add **LESS** Fuel.

Small Amount of Fuel (LEAN)

This condition will create a situation where the A/F mix will have a short burn time. There is not enough fuel to make a long burn time. Since the small quantity of fuel has quickly burnt up, the burning will stop & there will be a certain amount of Oxygen remaining amongst the exhaust gases.

These gases are expelled out the exhaust valve, the O2 Sensor samples these spent gases & there it will see this remaining O2 content. This will create a voltage signal which indicates to the ECM that the amount of fuel that was sprayed out of the injector was a small amount, therefore next cycle it will increase the injection rate.

Large Amount of Fuel (RICH)

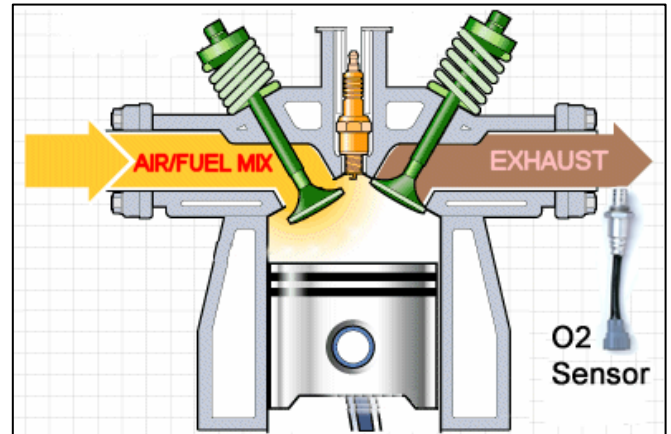
This condition will create a situation where the A/F mix will have a long burn time. There is now more fuel to make a longer burn time. Since the larger quantity of fuel makes a longer burn time, nearly the entire O2 content will burn.

The spent gases left over in the combustion chamber will contain very little if any O2 content. These gases are expelled out the exhaust valve, the O2 Sensor samples these spent gases & there it will see that there is hardly any remaining O2 content. This will create a voltage signal which indicates to the ECM that the amount of fuel that was sprayed out of the injector was a large amount, therefore next cycle it will decrease the injection rate.

MEASUREMENT IN DIAGNOSIS

Ideal Air Fuel Mix (14.7:1)

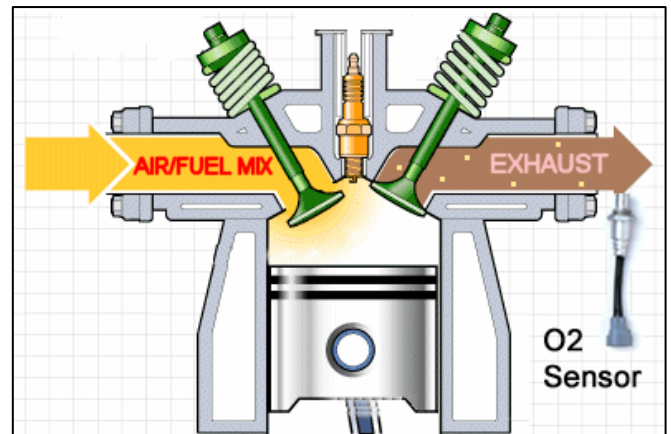
The right amount of Air to Fuel will result in an ideal burn.



IDEAL 14.7:1

LEAN by Short Injection Duration (Excess of Air to Fuel)

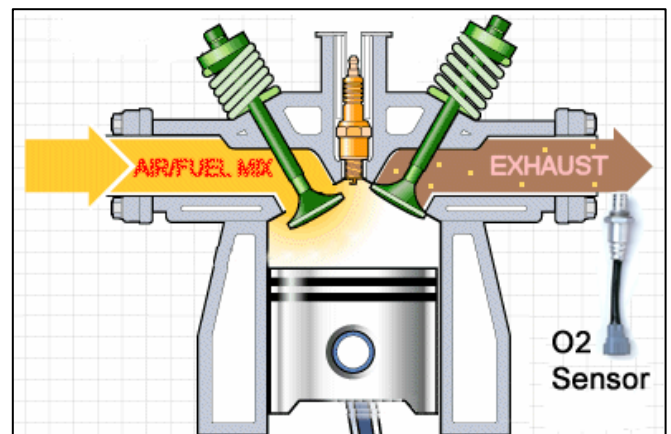
The injector is opened for a short period of time by the ECM. Only a small amount of fuel enters the combustion chamber. This results in a short burn time, therefore some O₂ content will be left over after the burning has stopped. This left over content of O₂ is expelled & then seen by the O₂ sensor. This signals to the ECM that the mix was lean, therefore will result in an increased rate of injection (more fuel) for the next cycle.



SMALL INJECTION QUANTITY

LEAN by Fuel Starvation (Injection Duration OK) (Excess of Air to Fuel)

Due to low fuel pressure / blocked filter / blocked injectors etc, this results in a short burn time due to the lack of fuel. This again results in some O₂ content being left over. This left over content of O₂ is expelled & then seen by the O₂ sensor. This signals to the ECM that the mix was lean, therefore will result in an abnormal increase in the rate of injection for the next cycle in order to compensate for the "lack of fuel" condition.



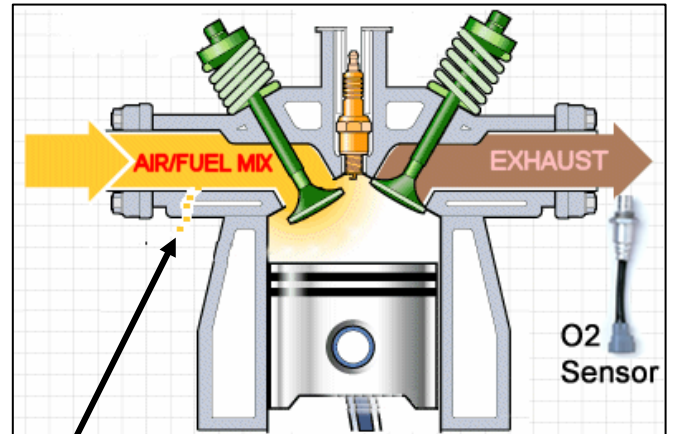
FUEL STARVATION PROBLEM

MEASUREMENT IN DIAGNOSIS

LEAN by Intake Air Leak (un-metered air) (Injection Duration OK - Excess of Air to Fuel)

Due to an air leak on the intake (leaking intake manifold gasket, hole in air intake tube etc.) the MAFS sensor only measures a certain amount of air. This signal is sent to the ECM, therefore the ECM adds a specific amount of fuel which is relevant to the amount of air measured.

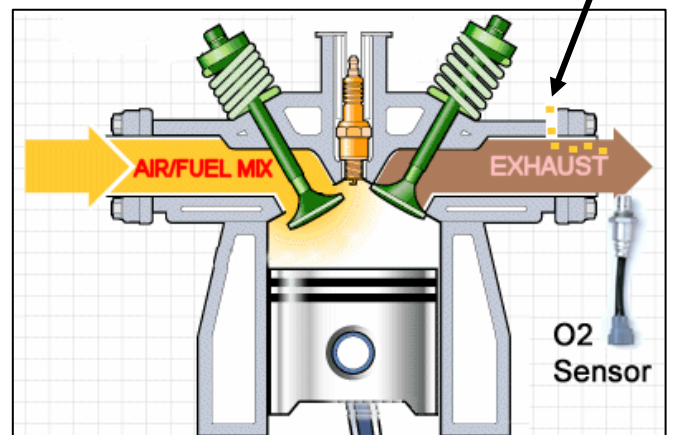
Air which is leaking through a hole or a leaky gasket is added to the combustion chamber with an insufficient amount of fuel. Combustion takes place but there is left over O₂ in the exhaust gases & therefore is seen by the O₂ sensor. This signals the ECM to increase the injection rate above what it thinks is normal.



INTAKE AIR LEAK

False LEAN Signal due to Exhaust Leak (Injection Duration OK. Air/Fuel Ratio normal)

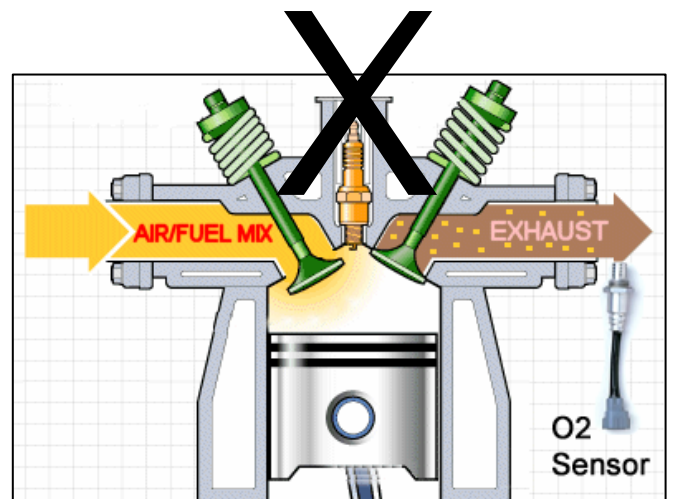
REMEMBER! If the O₂ sensor sees Oxygen, it means LEAN! Therefore if O₂ leaks into an exhaust manifold due to a cracked exhaust manifold or a leaking exhaust manifold gasket, the false O₂ content will make the ECM increase the injection rate – EVEN IF THE INJECTION RATE WAS PERFECT!



EXHAUST MANIFOLD LEAK

False LEAN Signal due to Spark Missfire (Injection Duration OK. Air/Fuel Ratio normal)

REMEMBER! NO spark means NO burn. Even if TOO MUCH fuel entered the combustion chamber, if it doesn't burn, neither does the O₂ content. Unburnt O₂ means LEAN! As a result the ECM increases the injection rate to add more fuel to an engine that doesn't need anymore fuel.



NO SPARK

NISSAN Learning Academy

Measurement in Trouble Diagnosis.

Nissan Australia April 2008

MEASUREMENT IN DIAGNOSIS

RICH

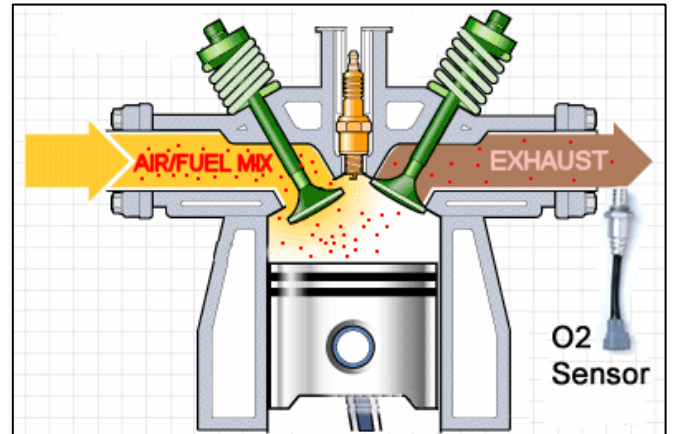
(Normal Air Quantity with Excess Fuel)

If there is an excess amount of fuel added (leaking injectors or excessive injection duration etc.), not all of the fuel will burn because in this case the burning will stop due to all the oxygen being burnt up. RAW FUEL WITHOUT OXYGEN WILL NOT BURN ON IT'S OWN.

The excess fuel will be expelled out of the exhaust valve, however the reason why the O2 sensor will indicate RICH is because it cannot sense any O2 in the expelled exhaust gases. NOT because of the raw fuel left over.

AN OXYGEN SENSOR CAN ONLY SEE OXYGEN.

It cannot see raw fuel.

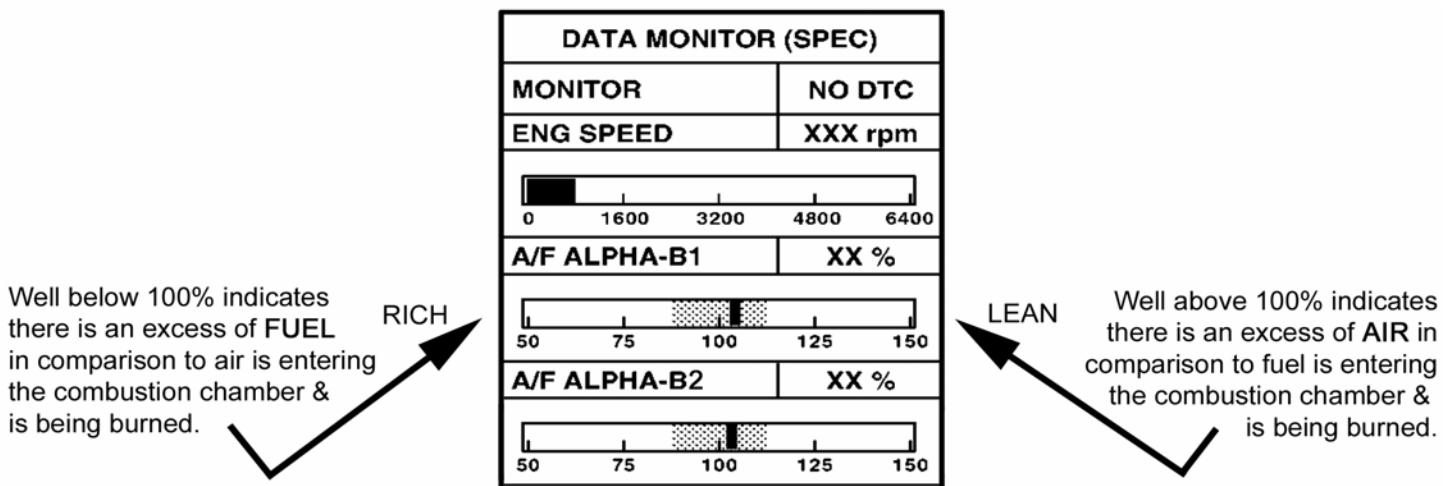


RUNNING RICH / FLOODING

Using Air Fuel Alpha in CONSULT II to indicate measured Oxygen Content

Display A/F ALPHA in DATA MONITOR or DATA MONITOR (SPEC) CONSULT. If the A/F Alpha shows a reading close to 100%, (typically 95% ~ 105%) then the engine is running close to or at it's originally programmed map.

I.e.; The ECM see no problems with the content of left over O2 it's measuring in the exhaust gases. The balance of Fuel Quantity to Air Quantity in the engine is normal.



MEASUREMENT IN DIAGNOSIS

Basic Principles of Electrical

Given that Electricity can't be seen, it can be difficult to determine electrical system faults.

Therefore if Electricity was likened to water flow, it may assist with understanding how to diagnose electrical faults.

1. Normally Operating Circuit

Here the water flows from the tap (**battery**) through a hose (**wiring**). A pressure gauge (**voltmeter**) has been tapped into the hose to measure the line pressure.

The spray nozzle (**light globe**) at the end of hose shows a working circuit.

Due to the restriction (**globe filament**) there is a certain amount of pressure build up in the line. This is measured by the pressure gauge (**voltmeter**). Some of the pressure is seen by the gauge, the remainder of the pressure escapes through the nozzle.

2. No Ground Connection

Here the 2nd diagram shows a circuit which can be likened to having no ground connection (blockage in hose). Therefore the only choice the pressure has is to follow the path offered by the gauge (**voltmeter**).

However the gauge does not allow any pressure to escape, but it does show the full supply pressure.

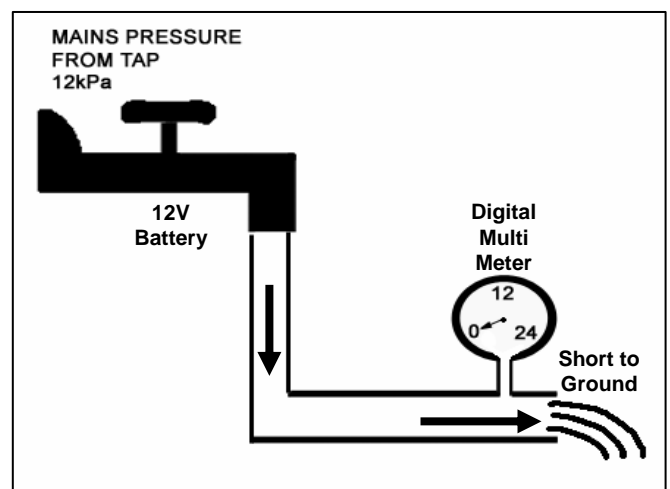
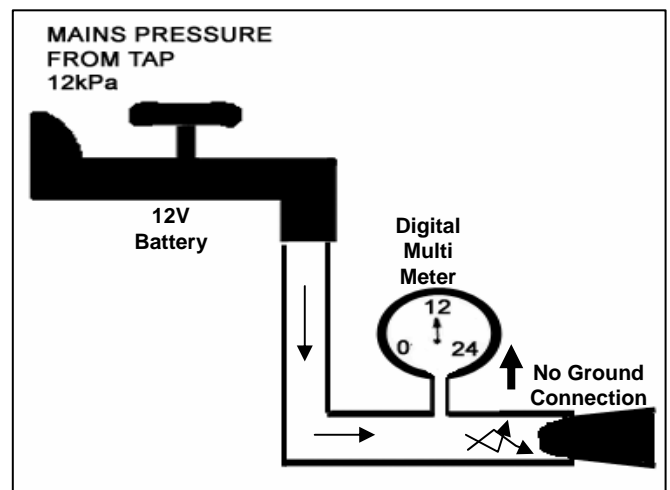
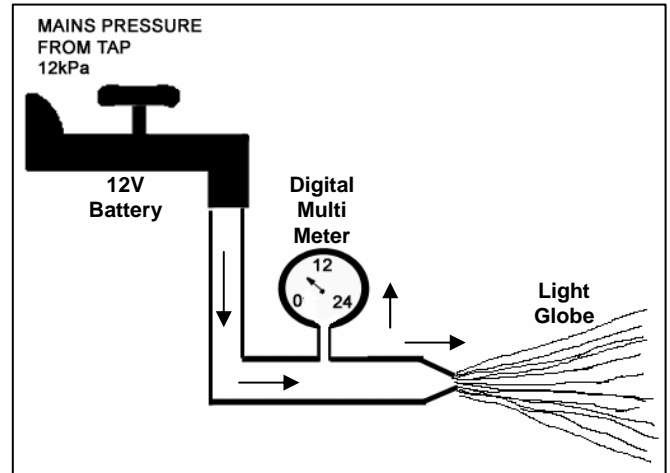
3. Short to Ground

Here the 3rd diagram shows there is no restriction (**load such as a globe filament**) the flow runs out the end of the pipe (**directly from positive back to negative**).

Therefore YES, there is the flow of current present, but it cannot be seen by the pressure gauge (**voltmeter**).

The path offered by the gauge (**voltmeter**) is too restrictive. It's easier for it to fully escape from the end of the hose.

If this was really a flow of electrical current, the fuse would blow & shut down the flow all together.



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Measurement of Voltage

Since electricity can't be seen by the naked eye, technicians need to rely on key electrical concepts to understand how electrical circuits function and assist in locating faults.

Two important concepts that are often misunderstood are:

- Electrical Pressure
- Voltage Drop

1. Electrical Pressure

For current to flow in any circuit, a difference in electrical pressure must exist. A Voltmeter is used to measure the difference in electrical pressure at any two points in a circuit. Remember that Voltage in an electrical circuit is likened to water pressure in a pipe.

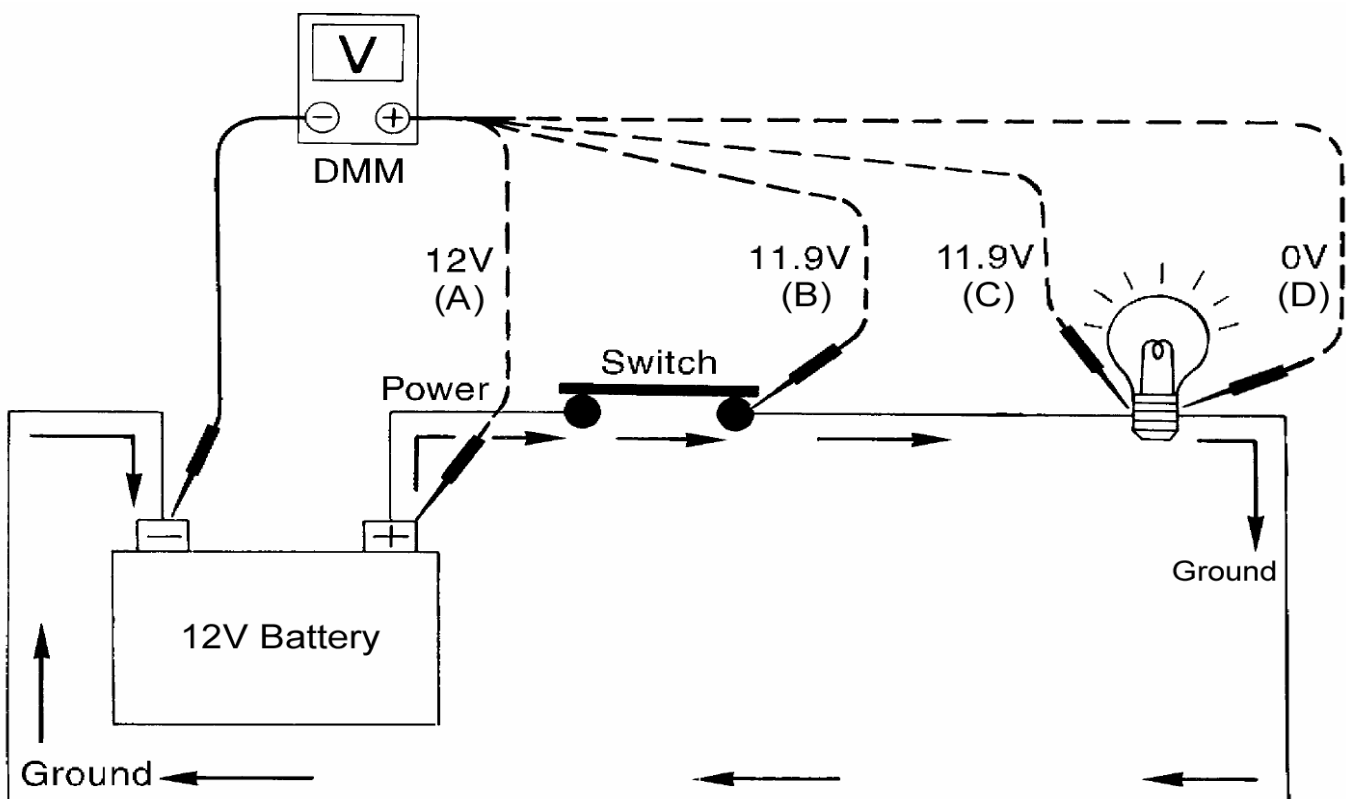
Pressure Difference in a Circuit

For example, in the circuit below the Voltmeter is used to detect the electrical pressure at various points in the circuit.

The Voltmeter's Positive lead is detecting the difference in electrical pressure between the battery Negative terminal, to four other circuit locations.

The electrical pressure difference between the:

- (A) Battery Positive terminal and Battery Negative terminal – 12V
- (B) Switch output terminal and Battery Negative terminal – 11.9 Volts
- (C) Bulb power side and Battery Negative terminal – 11.9 volts
- (D) Bulb ground side and Battery Negative terminal – 0 Volts



Notice that the full battery voltage (or pressure) drops to 0 Volts as the circuit approaches ground.

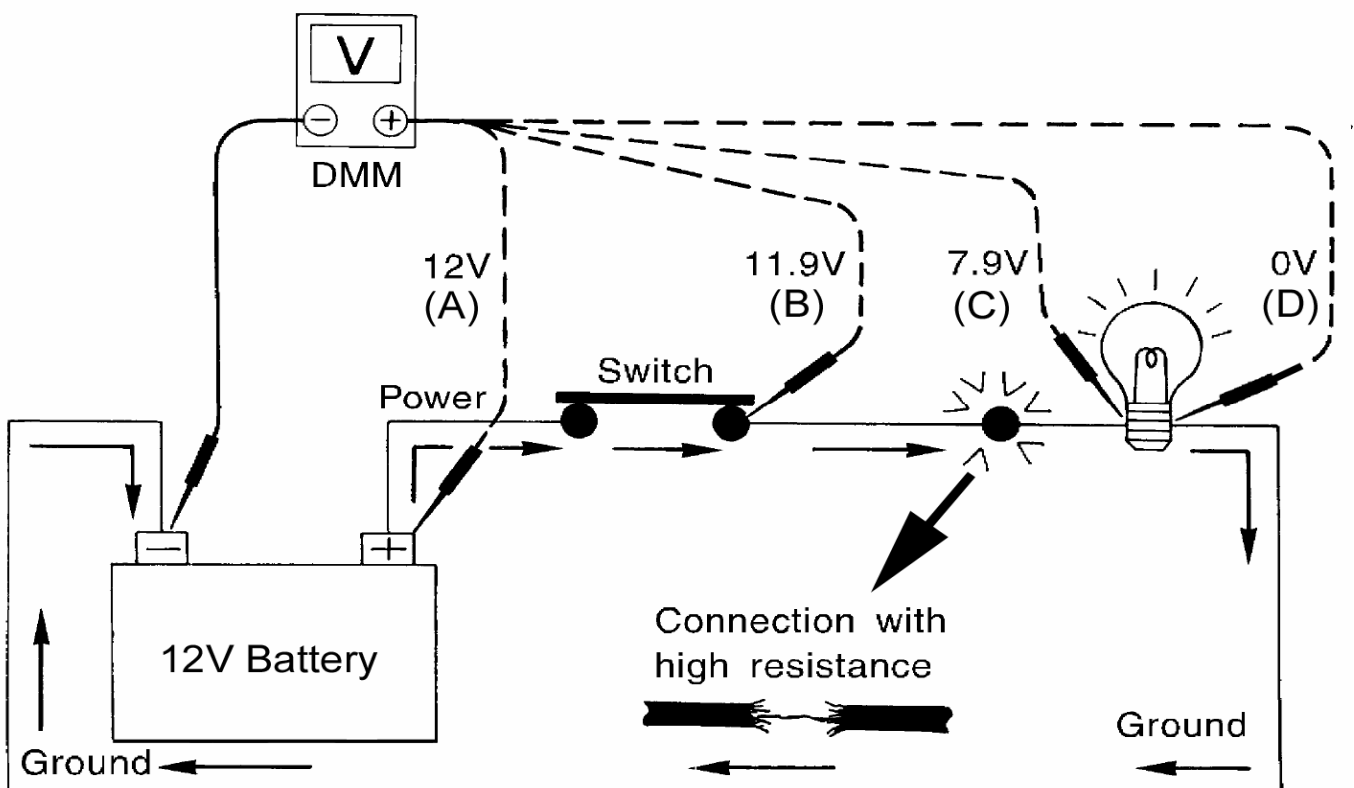
MEASUREMENT IN DIAGNOSIS

1. Electrical Pressure (Cont'd....)

Here is the same electrical circuit with a fault. The wiring is frayed & current has to now make it's way through the resistance which is caused by the frayed / damaged wire.

So now, the electrical pressure difference between the:

- (A) Battery Positive terminal and Battery Negative terminal – 12V
- (B) Switch output terminal and Battery Negative terminal – 11.9 Volts
- (C) **Bulb power side and Battery Negative terminal – 7.9 Volts**
- (D) Bulb ground side and Battery Negative terminal – 0 Volts



MEASUREMENT IN DIAGNOSIS

2. Voltage Drop

As electrical current flows through any circuit or device for work to be done, there must be a Voltage Drop across that circuit. Voltage must be dropped from supply voltage to zero at the ground point.

However there are instances when additional Voltage Drop may be inadvertently built into a circuit through loose or dirty connections, particularly in the ground circuit. Any additional Voltage Drop robs the circuit of energy, reducing its effectiveness.

To do a continuity or resistance test with an Ohmmeter does not confirm the high load performance of a circuit and a Voltage Drop test should be performed.

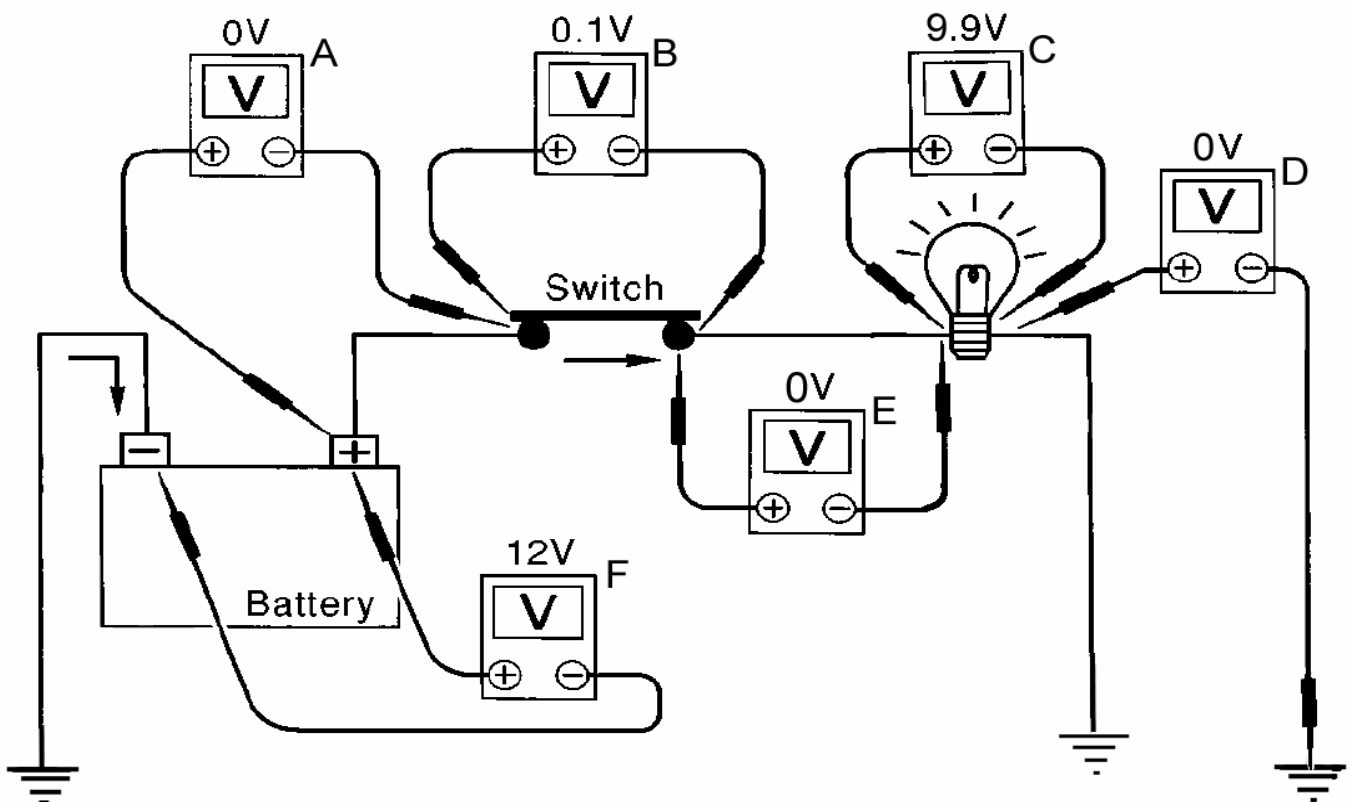
Voltage Drop in a Circuit

For example, in the circuit below the Voltmeter is used to detect the voltage drop across various components in the circuit.

The Voltmeter's leads are detecting the difference in electrical pressure between the two points they are connected to at any one time.

The Voltage Drop across the:

- (A) Battery Positive lead to the Switch Input – 0V
- (B) Switch input & output terminals – 0.1 Volts
- (E) Wire from switch output to bulb input – 0 volts
- (C) Bulb – 9.9 Volts (example only, will always vary dependant on bulb type)
- (D) Ground circuit, from bulb output to Ground – 0 Volts.
- (F) Directly across the battery shows the full difference – 12V



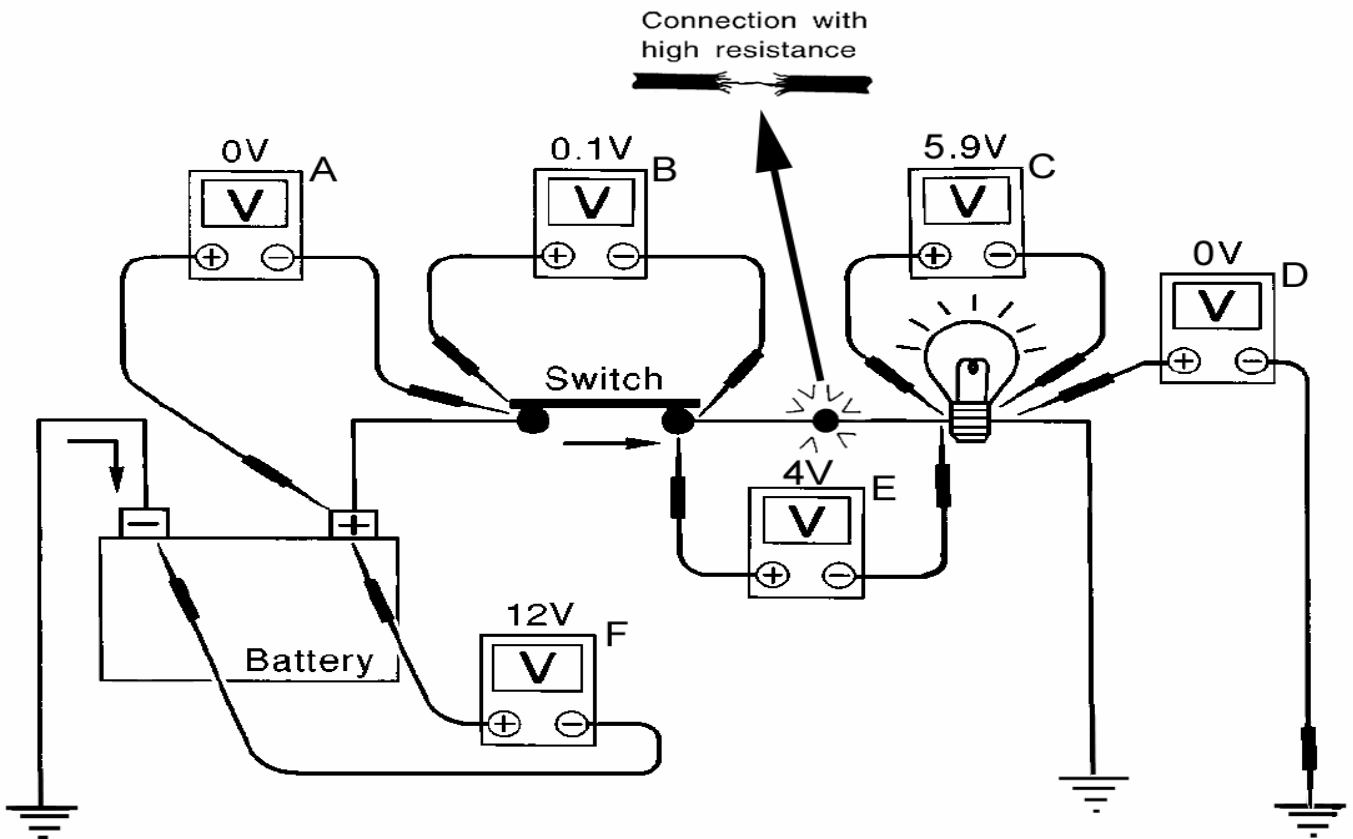
MEASUREMENT IN DIAGNOSIS

2. Voltage Drop (Cont'd..../)

Here is the same electrical circuit with a fault. The wiring is frayed & current has to now make it's way through the resistance which is caused by the frayed / damaged wire.

So now, the Voltage Drop across the:

- (A) Battery Positive lead to the Switch Input – 0V
- (B) Switch input & output terminals – 0.1 Volts
- **(E) Wire from switch output to bulb input – 4 volts**
- (C) Bulb – 5.9 Volts (example only, will always vary dependant on bulb type)
- (D) Ground circuit, from bulb output to Ground – 0 Volts.
- (F) Directly across the battery shows the full difference – 12V



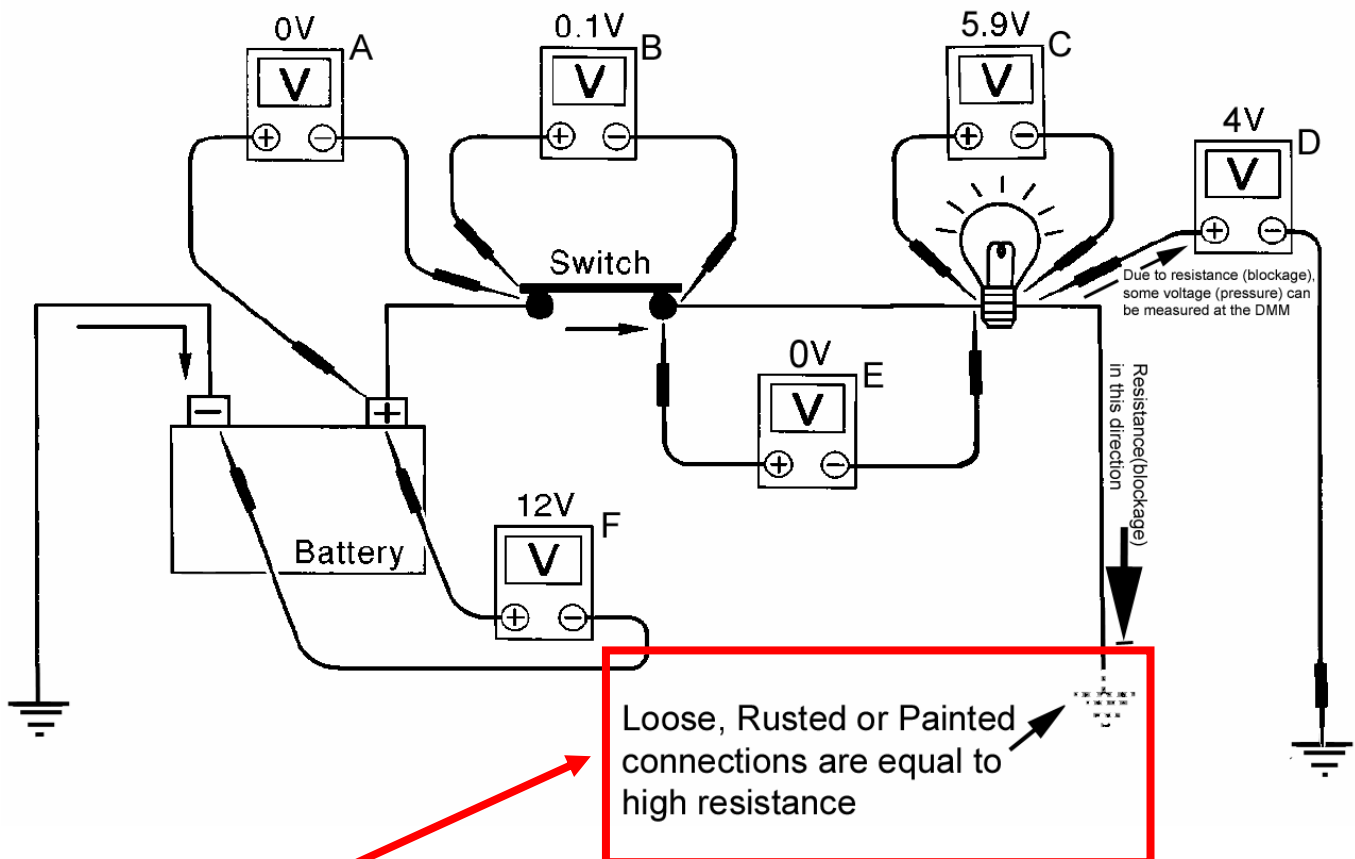
MEASUREMENT IN DIAGNOSIS

2. Voltage Drop (Cont'd..../)

Here is the same electrical circuit with yet another fault. In this case the wiring is OK, but now there is a bad ground contact.

So now, the Voltage Drop across the:

- (A) Battery Positive lead to the Switch Input – 0V
- (B) Switch input & output terminals – 0.1 Volts
- (E) Wire from switch output to bulb input – 0 volts
- (C) Bulb – 5.9 Volts (example only, will always vary dependant on bulb type)
- **(D) Ground circuit, from bulb output to Ground – 4 Volts.**
- (F) Directly across the battery shows the full difference – 12V



POOR GROUND CONTACTS ARE THE MOST COMMON CAUSE OF ELECTRICAL FAULTS. THIS IS THE COMMON CAUSE OF DTC's SUCH CAN U1000 & U1001 TO BE LOGGED.

MEASUREMENT IN DIAGNOSIS

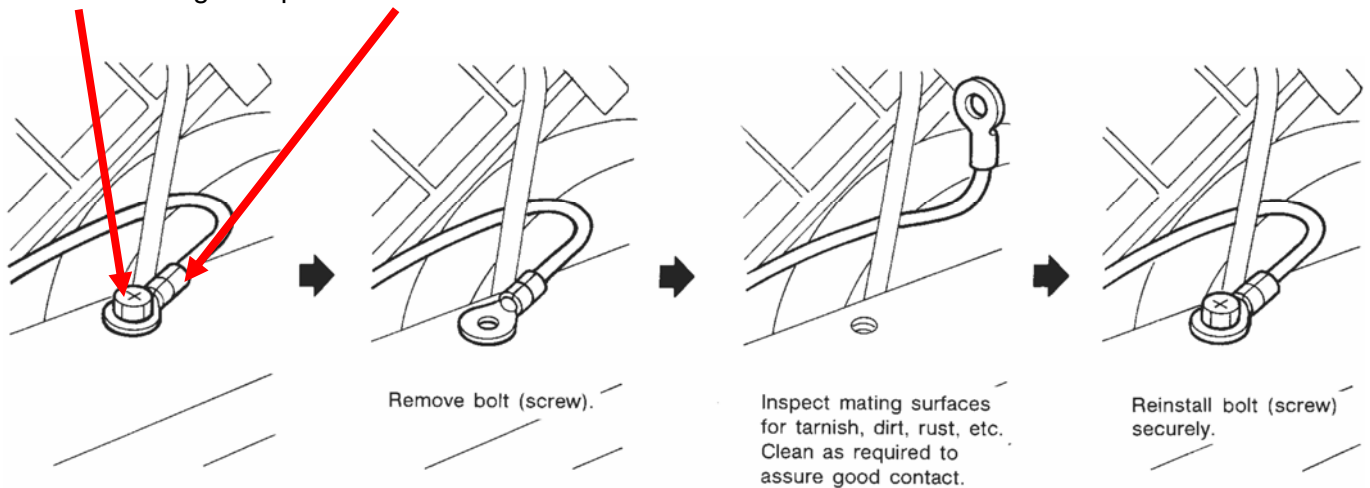
Ground Connection Voltage Drop

When tracking down an electrically related fault it is important to do a Voltage Drop test across ground connections.

This is very important in high current circuits like the starting and charging system, but should not be neglected in lower current electronic systems.

The ground should be tested with the circuit operating under as much electrical load as possible.

- Connect the Positive Voltmeter lead to the ground terminal
- Connect the Negative Voltmeter lead to the grounding bolt or another clean ground area
- Operate the circuit under load (including turning on accessories or cranking the engine)
- Measure Voltage Drop across the connection.



Repairing Grounds

When repairing or confirming ground connections, it is important to remove the bolt, inspect and clean the mating surfaces and then torque the bolt securely.

Ground cleaning procedure

Check for added-on accessories and any modifications to the ground circuits
Check for proper crimps and that all wires are securely fastened.

Voltage Drop Limits

Wire – negligible (< 0.001 Volts)

Ground connection – Approx. 0.1 Volts

Switch contacts – Approx. 0.3 Volts.

MEASUREMENT IN DIAGNOSIS

N16 Hatch Brake Lamp Failsafe Strategy

An interesting application of applying a change in Voltage Drop is found on the N16 Pulsar Ser II Hatch (Models with Electric Throttle Control only).

These vehicles are built for the European market and have a Failsafe strategy if both brake lamp bulbs are not working. If this occurs, the ECM will enter a Failsafe Mode and the engine will operate with a significant reduction in performance (further details are found on STB EC05-011). This situation will prompt the driver to have the vehicle checked.

Like most vehicles, the ECM monitors the application of the brakes for fuel control. Using the same input, it also monitors small changes in Voltage Drop in the brake lamp circuit to determine if all the brake lamps are working.

Essentially, the brake lamp circuit contains two groups of resistances in series, creating a Voltage Divider circuit with the Brake Signal input to the ECM.

Rear Brake Lights OK

The 1st diagram to the above right shows a normal brake light circuit.

The current from the battery travels through the close brake pedal switch contacts (switch contacts always have a slight resistance in them) & then it has a choice of travelling to the rear brake lights or to the ECM. The ECM at this point sees the voltage pressure in the circuit. So the ECM knows if the brakes are being applied or not.

However, seeing as all the Brake light globes are OK, the current will flow to ground as this circuit has far less resistance. So the ECM is NOT going to see the full 12V.

Rear Brake Light Globes OPEN Circuit (Blown globes)

In this case, the rear brake light circuit has a much higher resistance. The current can only travel to ground through the LED rear window brake light. So the voltage pressure build up in the circuit is sensed by the ECM (ECM reads a higher voltage). So the ECM now realises that there are no brake lights & it drives in failsafe mode until the fault is rectified.

NOTE: A bad ground connection or corroded bulb connections can cause the same condition!

