

## CO2 to Synthetic Fuel



Drawing CO2 from the atmosphere and hydrogen from water can make liquid hydrocarbon fuel.

**The internal combustion engine and hydrocarbon based fuels are at the core of the automotive and broader transportation industry. A combination of renewable energy and the revival of an old idea might give us synthetic, carbon-neutral fuel to keep our vehicles on the road.**

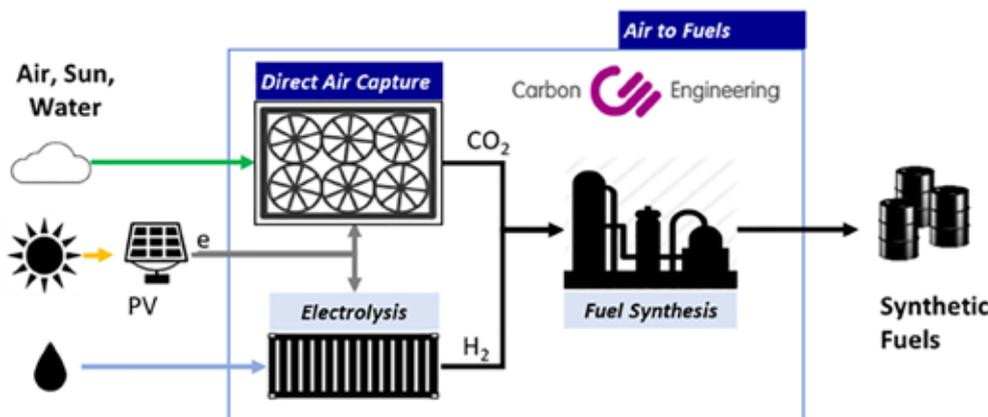
Hydrocarbons have become some of the most economically, politically and strategically essential resources in modern times, and now the scientific evidence is showing that we need to reduce their usage. A hydrocarbon is an organic compound consisting of hydrogen and carbon. It occurs naturally when organic matter (mostly plants) decomposes. Fossil fuels are ancient organic matter that has been subjected to pressure over a vast amount of time, to become crude oil or coal.

Synthetic materials are copies of natural products made from their basic

components. We have had synthetic oil for a while. However, most synthetic oil is still made from crude oil with synthetic additives. Full synthetic oil is a marketing term.

The Germans first produced synthetic fuel during World War II in a process which made high-quality aviation fuel from coal. Today high-quality petrol, diesel or aviation kerosene can be made from just hydrogen and carbon. Hydrogen can be split from water via electrolysis, and excess carbon can be extracted from atmosphere. As a result, there are now many companies developing systems to make synthetic hydrocarbon fuels.

Carbon Engineering is a Canadian-based clean energy company focusing on the commercialisation of Direct Air Capture (DAC) technology that captures carbon dioxide (CO2) directly from the atmosphere. They then use renewable electricity to split hydrogen from water, then their patented process which they call "Air to Fuel" can produce any blend of fuel you require. ▶



### Feature

#### Ford Ranger PJ/PK & Mazda BT50 UN: 4WD System Overview



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Carbon Engineering has been running their pilot plant since 2015, and independent reviews have shown that their systems for DAC and Air to Fuel works, and are viable to be scaled up for commercialisation. This has led to some big-name investors putting their money into the company. Bill Gates as well as fuel and mining companies Chevron, Occidental, and BHP have invested. Bosch is also pushing for more funding and research into synthetic fuels, and there are other companies around the world which have different processes to produce fuels or other industrial products from atmospheric CO2.

As long as renewable energy is used, these processes are carbon neutral, as it is drawing CO2 from the atmosphere, which is then burned in the engine and

released back into the atmosphere. From an environmental perspective, this is better than releasing extra carbon into the atmosphere by burning fossil fuels, which is carbon positive. The goal would be to draw down the CO2 and not burn it. Then this process would be carbon negative. However, zero-emission vehicles still need some work to achieve this goal.

Synthetic fuels have many advantages over fossil fuels which come from their very simple chemical make up. Fossil fuels have contaminants like sulphur, nitrogen and aromatics. Without these contaminants, synthetic fuels dramatically reduce HC, NOx and particulate emissions from petrol and diesel engines.

As the average age of a car is 15 years, a car sold today could still be on the road in the 2030s. These fuels could be made to be backward compatible with all past and current vehicles on the road. Synthetic fuels could be mixed in with the current fossil fuels with no apparent side effects.

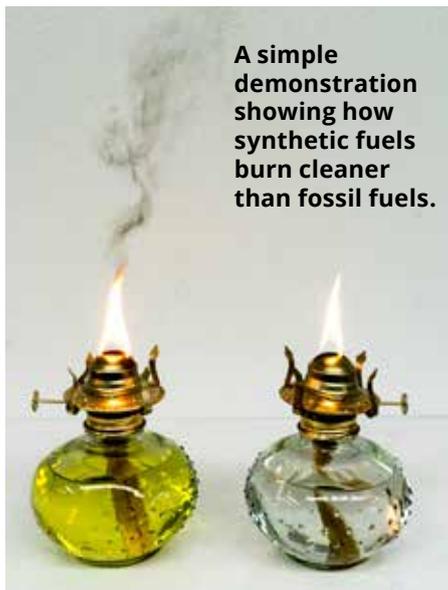
These cleaner fuels could solve many of the current problems the trade is having with modern vehicles. With fewer particulates produced, blocked DPF's would be a thing of the past. Less contaminants from blow-by gases may make oil last longer without turning to sludge. Fewer particles in the exhaust would reduce the carbon build up in intake manifolds from EGR systems.

To use these fuels would require no changes to the fuel delivery and retail systems that we already have in place. If they were more widely available, engines could be designed to use more advanced emissions control equipment to virtually eliminate all harmful emissions.

The primary issue that the emerging synthetic fuel industry faces is economical, as these fuels are currently more expensive than fossil fuels. However, as the processes become more refined and larger plants made, the price will become competitive. Or if there is some sort of trouble in the middle east, all of a sudden it might be cheaper for fuel companies and governments to set up a synthetic fuel plant anywhere there is fresh air, water and clean energy, that is not a possible combat zone.

The US navy is looking into this system for their nuclear-powered aircraft carriers, as they need to be regularly resupplied with jet fuel. They have energy to spare from the reactor, seawater and air. So a synthetic fuel plant on-board would keep the planes in the air without support fuel ships. If there is a strategic advantage to be had military investment will follow.

Synthetic fuels are not the solution to all our environmental problems, but they would assist us in reducing our carbon footprint while keeping the current vehicle fleet on the road. 



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# Mazda Spot Welding Tool Requirements



The Mazda Body Shop Manual recommended welding procedure for panel replacements is to use CO2 arc welding (plug welding) in place of original spot welds. Most panel shops now have advanced Inverter Spot Welding equipment that is capable of mimicking or replicating a factory spot weld.

This Spot Welding repair method is allowed providing the Spot Welder meets the following standards:

- Must be capable of welding multiple panels up to 6mm cross section.
- Must produce welds equivalent to OEM level standard.
- Must be able to identify and advise when a spot weld has been successfully or unsuccessfully performed.

**Note:** New panels fitted must have the same number or more Spot Welds applied as what the original panel fitted had.

At weld points that cannot be reached by a Spot Welder, a CO2 Arc Weld/Plug Weld must be applied.

Body repairers should contact Mazda Australia for further information regarding these requirements should there be any questions:

- Customer Line: 1800 034 411
- Customer email: [custserv@mazda.com.au](mailto:custserv@mazda.com.au)
- Online: Refer to [www.mazdamanuals.com.au](http://www.mazdamanuals.com.au) for repairer (paid) access to correct Body Repair Manuals. 



## TechTalk Needs Your Help

**As the year is coming to an end, we would like to thank all of the VACC members and Our Auto subscribers for their assistance in making Tech Talk an ongoing success. Your trade experience and knowledge has been invaluable.**

One of the challenges we have is getting relevant photos and images of vehicles faulty components. So, to all of the members that have assisted by allowing us to take pictures in your businesses or have taken photos and sent them in, we are sure your fellow

members thank you for your time and effort.

The articles that appear in Tech Talk mainly come from the information requests made to the Technical Advisory Service. If we seem to be getting a lot of calls on a subject, then we will produce an article, as it is clearly information the trade requires. However, we would like to be more proactive instead of reactive.

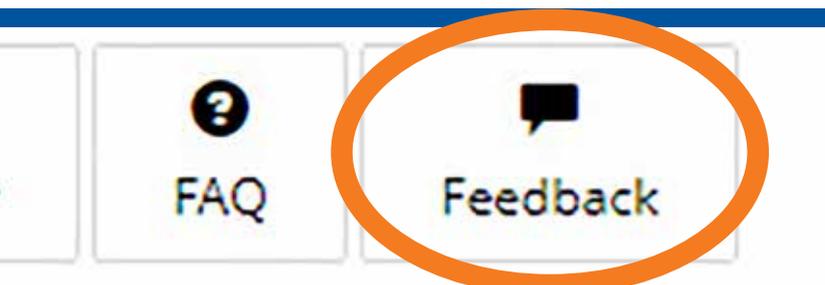
We are starting to write articles for next year's Tech Talk issues. So, if you have any ideas for articles or have

some information you think the trade needs, now is the time to contact the VACC's Technical Department;

- (03) 9829 1292
- [techtalk@vacc.com.au](mailto:techtalk@vacc.com.au)

Alternatively, if you are on Tech Online, you can use the Feedback button on the home page and type in your suggestion.

Tech Talk will be getting an updated look next year, but with your help, the content will be what you want. Thanks again for your support and see you in 2020. 



**The Feedback button is in the top right-hand corner of the home page of Tech Online.**

**If you have any suggestion for Tech Talk articles or other feedback on our technical products you can use this button to contact VACC's Technical Department.**

# Ford Ranger PJ PK & Mazda BT50 UN: 4WD System Overview

2006 - 2011 Ford Ranger PJ & PK  
2006 - 2011 Mazda BT50 UN

**The PJ and PK Ford Ranger and the UN Mazda BT50 made between 2006-2011 have proven to be a popular and reliable workhorse for tradespeople and the off-road crowd. These vehicles were designed by Mazda and rebadged by Ford, and share the same running gear and power-train. VACC's Technical Advisory Service receives calls on the four-wheel drive system as there are two variations, one for manual and another automatic transmissions. The four-wheel drive systems seem to be reliable. However, some common areas might need attention.**

## Transfer Cases

The transfer cases are different from the manual and automatic transmission versions. The manual transmission transfer case is simple, as it uses a gear stick to select four-wheel drive and high and low range.

The automatic version is more complicated as it uses a switch inside the vehicle which is monitored by a dedicated 4WD control unit mounted under the driver side dashboard. **See Diagram #10**

The 4WD control unit then sends a signal to the shift motor, which is mounted on the rear of the transfer case. The shift motor will then select four-wheel drive and high and low range. **See Diagram #11**

At the same time, the 4WD control unit energises a clutch solenoid coil inside the transfer case to pull the lock-up collar into position which engages 4H.



**Diagram #1**

*This 4WD system is the same for the Ranger and BT50. The manual and automatic transmissions have different transfer case.*

There is an output shaft speed sensor mounted at the rear of the transfer case which picks up the speed of the outer housing of the clutch solenoid coil. **See Diagram #11**

The 4WD control unit uses this speed signal to judge when to perform gear shifts.

## Shift Motor Assembly

The shift motor assembly is an electric motor with a right-angle reduction gearbox. This assembly engages with a triangular shaft on the transfer case to operate a cam to move linkages, which shifts the transfer case from 2H to 4H and then to 4L.

**See Diagram #11**

The 4WD control unit keeps track of which range the transfer case is in via the Motor Position Detection Switch, which is integrated into the back of the shift motor unit. This switch works similarly to a windscreen wiper motor's park position switch as it has a disc covered in a conductive material in a pattern to indicate the gear range selected.

**See Diagram #12**

Five brushes contact this disc and depending on which circuit is completed will tell the 4WD control unit the position of the motor, and therefore the gear range selected. More on this later.

## Remote Free-Wheel (RFW) System Operation

Both the manual and automatic variants share the same vacuum-operated Remote Free-Wheel (RFW) system on the front axle. However, the way that the RFW is controlled is different.

In the manual versions, when the RFW switch on the dashboard is turned on (**See Diagram #19**). The PCM will then energise the LOCK vacuum solenoid. This allows vacuum to be applied to the RFW actuator, which is a vacuum diaphragm. The RFW actuator then pulls on a linkage which moves a shift fork to engage a dog clutch inside the front axle to lock the axles.

**See Diagram #6 & #9**

**NOTE:** For the automatic versions the 4WD control unit energises the LOCK vacuum solenoid.

The RFW light on the dashboard will come on when the RFW switch on the front axle indicates that the shift is complete (manual only).

If it does not illuminate you might have to move the vehicle a short distance forward or back to allow the dog clutch to align and engage, then the light should come on. The RFW light will flash if the vehicle speed is over 100 kmh. ▶

**Diagram #2**

### Engine Bay Locations



**Diagram #3**

### P Code Table For Manual Transmissions

Codes	Description	Possible Cause
P1812	RFW Lock Solenoid Valve	Circuit Failure
P1813	RFW Lock Solenoid Valve	Open Circuit
P1814	RFW Lock Solenoid Valve	Short to Power
P1815	RFW Lock Solenoid Valve	Short to Ground
P1878	RFW Free Solenoid Valve	Circuit Failure
P1879	RFW Free Solenoid Valve	Open Circuit
P1880	RFW Free Solenoid Valve	Short to Power
P1885	RFW Free Solenoid Valve	Short to Ground

When the RFW switch is turned off, or 2H is selected the PCM or the 4WD control unit will energise the FREE vacuum solenoid which allows vacuum to be applied to the other side of the RFW actuator to disengage the dog clutch and allow the front axles to freewheel.

**See Diagram #6 & #9**

This reduces the rolling resistance, which increases fuel economy. The RFW light on the dashboard should be off once the shift is complete.

The vacuum pump on the engine generates the vacuum for this system. To prevent a reduction of system

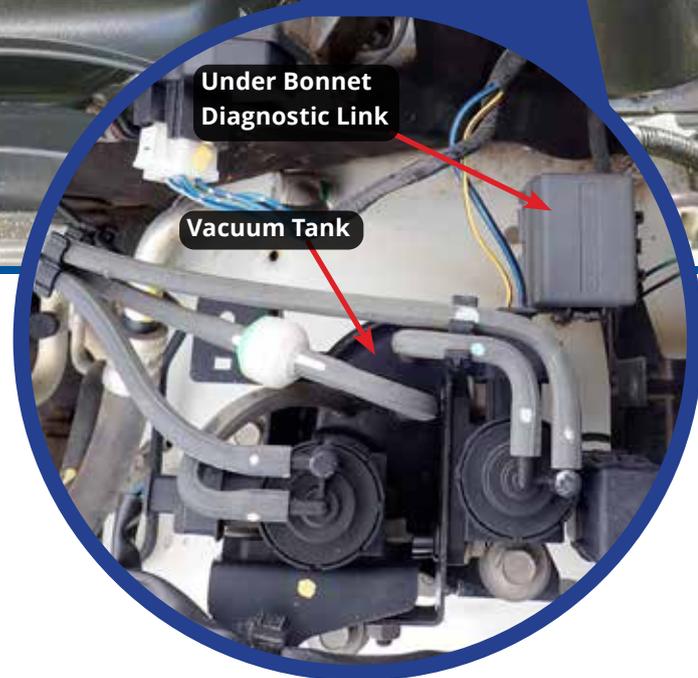
performance during high altitude a vacuum tank and a one-way valve is fitted upstream from the LOCK and FREE solenoids. **See Diagram #2**

### Diagnostics

The manual transmission version will have diagnostic trouble codes (DTCs) stored in the PCM for faults in the RFW system. Use a compatible scan tool to read and erase these codes as required.

**See Diagram #3**

For the automatic version which has the separate 4WD Control Unit, if it detects a fault, it will cause the 4WD and the 4L light to flash on the dash.



### Flash Code Access

To access these fault codes, you must use the following procedure

1. Ignition off.
2. Connect a test light to the FAT terminal of the diagnostic link, which is under the bonnet, and battery positive. **See Diagram #4**
3. Turn the ignition on.
4. The test light should flash out any stored codes three times, then it will flash the next code three times and so on. **See Diagram #5**
5. Record the codes then repair the systems as required. ▶

Diagram #4

### Diagnostic Link

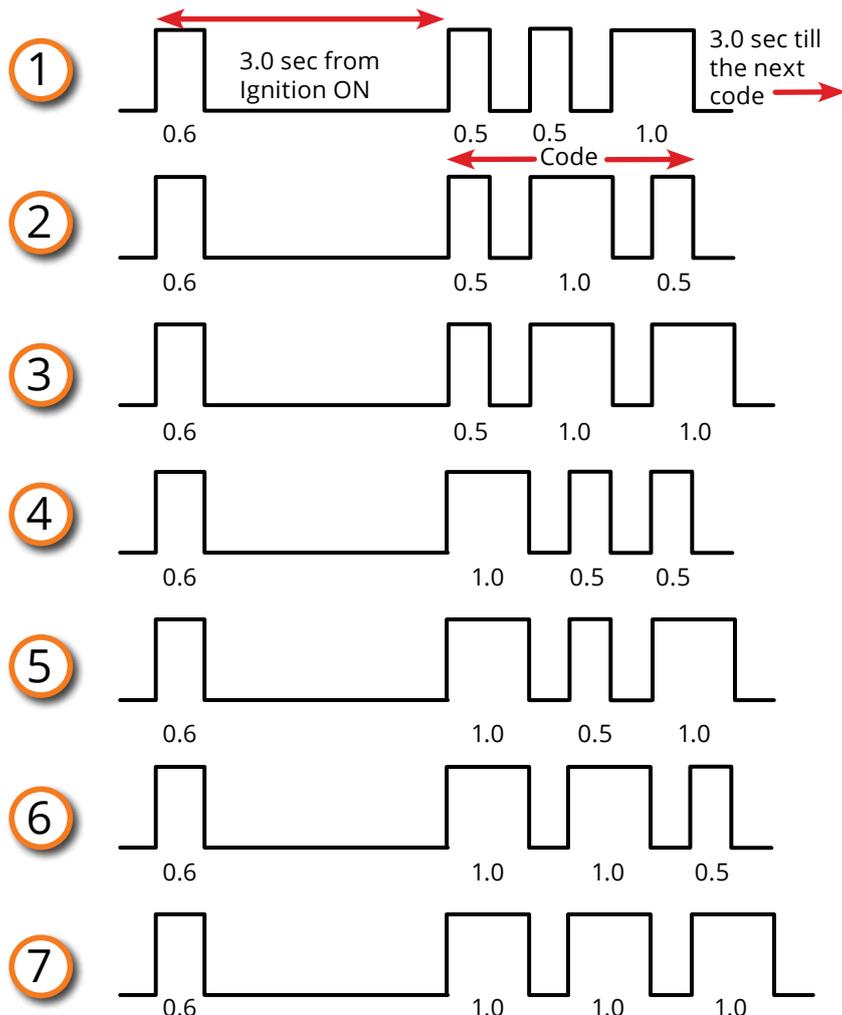


This diagnostic link is under the bonnet. Connect a test light between the FAT terminal and the battery positive. The test light will flash in the patterns shown in Diagram #5.

The description of the codes are shown in the table below.

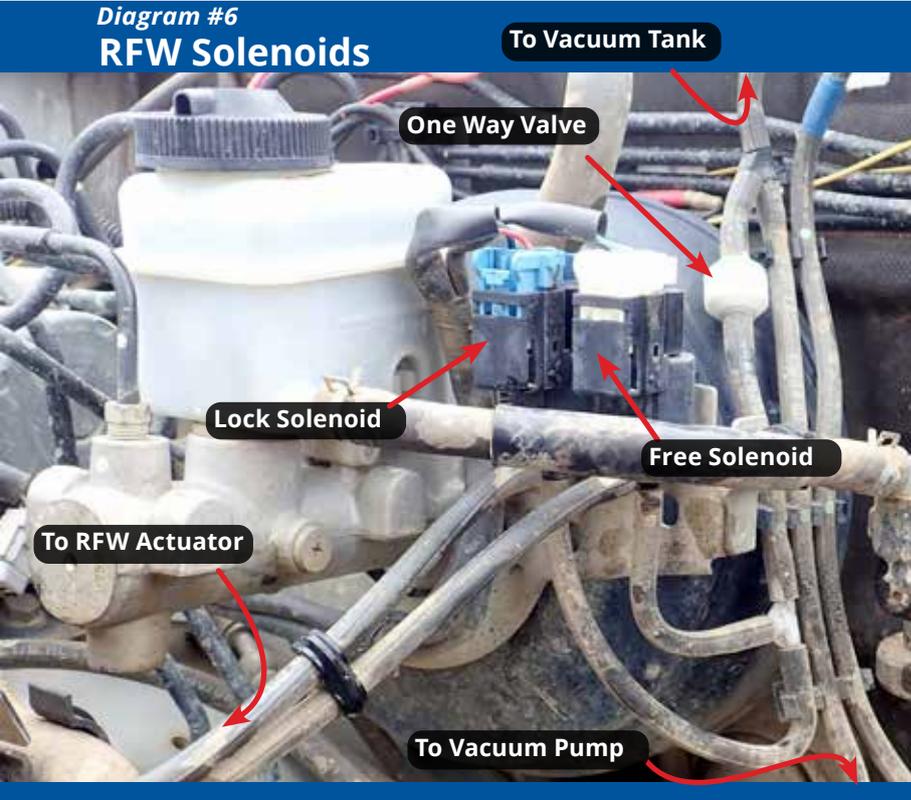
Diagram #5

### Flash Code Patterns for Automatic Transmissions

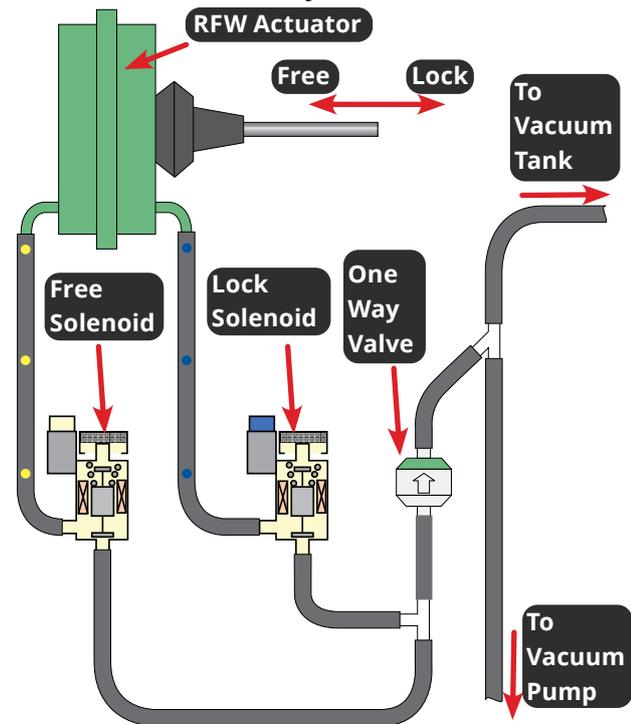


Flash Codes	Description	Possible Cause
1	4x4 Control Unit Fault	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground.</li> <li>• Control Unit Fault</li> <li>• Loose terminals in harness connector.</li> </ul>
2	Shift Motor	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground.</li> <li>• Motor Fault</li> <li>• Loose terminals in harness connector.</li> </ul>
3	Clutch Coil in Transfer Case	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground.</li> <li>• Clutch Coil Fault</li> <li>• Loose terminals in harness connector.</li> </ul>
4	Speed Sensor	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground.</li> <li>• Sensor Fault</li> <li>• Loose terminals in harness connector.</li> </ul>
5	Solenoid Valve	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground for the lock solenoid.</li> <li>• Open or short circuit to power or ground for the free solenoid.</li> <li>• Open or short circuit to power or ground for the 4WD relay.</li> <li>• Solenoid Valve Fault</li> <li>• 4WD Relay Fault</li> <li>• Loose terminals in harness connector.</li> </ul>
6	4WD Switch	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground for the 4WD Switch.</li> <li>• 4WD Switch Fault</li> <li>• Loose terminals in harness connector.</li> <li>• Possibly full of mud or water.</li> </ul>
7	Shift Motor Position Sensor	<ul style="list-style-type: none"> <li>• Open or short circuit to power or ground for the Shift Motor Position Sensor.</li> <li>• Shift Motor Position Sensor Fault</li> <li>• Loose terminals in harness connector.</li> </ul>

**Diagram #6**  
**RFW Solenoids**



**Diagram #7**  
**Vacuum Hose Layout**



### To Clear Flash Codes

1. Turn the ignition off.
2. Connect a jumper wire between the FAT terminal of the diagnostic link and ground. **See Diagram #4**
3. Turn the ignition on.
4. Wait for at least 5 seconds.
5. Turn ignition off.
6. Remove the jumper wire.
7. Check that no codes are present in the vehicle.

### Component Testing

Once you have retrieved the codes from the vehicle, test the relevant components as required.

However, there are many mechanical, electrical and vacuum related issues which could have caused the fault.

### Remote Free Wheel Actuator

1. Raise the vehicle safely.
2. Remove the vacuum lines from the

actuator. **See Diagram #9**

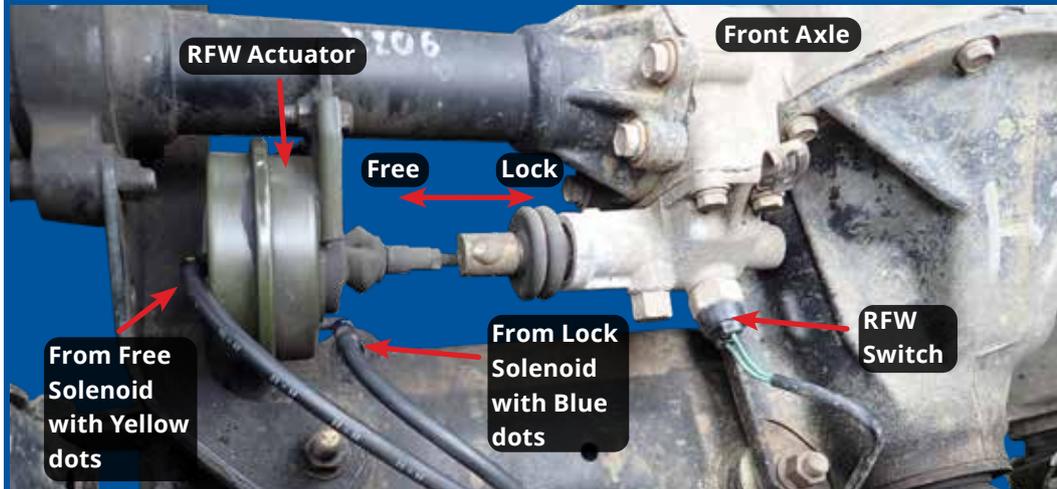
3. Connect a hand vacuum pump with a gauge to the free side of the actuator, then apply 26 kPa of vacuum.
4. The actuator should hold vacuum and move the connecting rod towards the left of the vehicle.
5. Repeat the above steps on the lock side. The actuator should hold vacuum and move the connecting rod towards the right of the vehicle. **See Diagram #7 & #9** ▶

**Diagram #8**  
**One Way Valve**

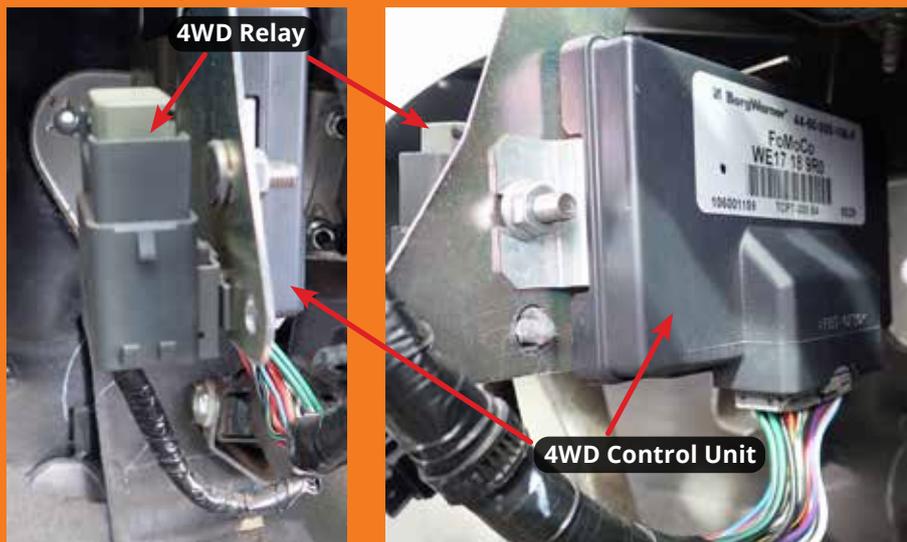


The one way valves will allow flow towards the green end. There is an arrow moulded into the white part of the valve, as highlighted above.

**Diagram #9**  
**Under Bonnet Fuse Box**



**Diagram #10**  
**4WD Relay and 4WD Control Unit**



The 4WD relay and control unit are mounted under the driver side dashboard. They are mounted on the same plate with one on each side. You may have to dismantle some covers to gain access.

6. If the actuator does not hold vacuum replace the actuator.
7. If it does hold vacuum, but the connecting rod does not move, there might be a fault in the clutch mechanism inside the front axle assembly.

**Free and Lock Solenoids**

1. Disconnect the wiring harness from the solenoids.  
**See Diagram #6**
2. Check for shorts and open circuits in the wiring from the control unit to the solenoids.
3. Check for continuity across the terminals of the solenoid.
4. If OK, apply 12 volts to one terminal and ground the other.
5. You should now be able to blow through from the side port, and ▶

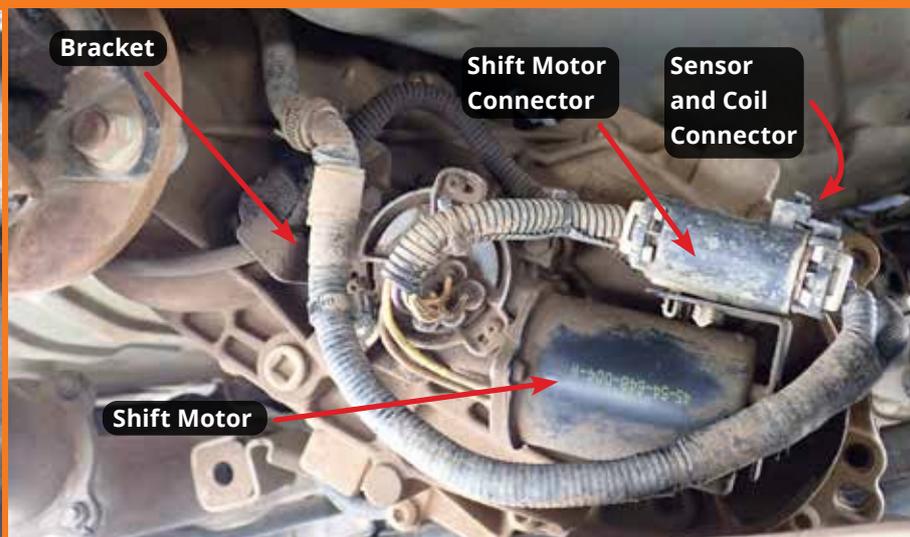
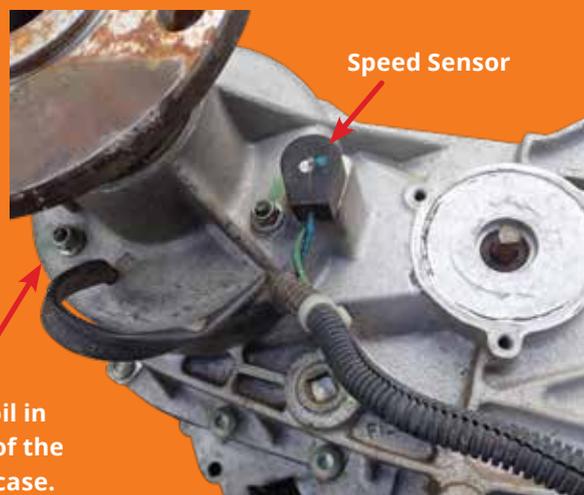
**Diagram #11**

**Locations on the Automatic Transfer Case**

The shift motor is mounted on the rear of the transfer case and rotates a triangular shaft to change the ranges.

With the shift motor removed the range positions are cast into the housing (poorly in the example shown).

This shaft should be relatively easy to turn. If not there could be a problem inside the transfer case.



air should come out the bottom port.

6. Replace if not to specification.

### Shift Motor Testing

1. Disconnect the wiring harness connector from the shift motor. **See Diagram #11**
2. Check for shorts and open circuits in the wiring from the control unit to the motor. **See Diagram #14**
3. Check the resistance between motor connector terminals 3b and 6b, you should have approximately **117 Ohms**. **See Diagram #14**
4. Apply battery voltage to terminal 6b, then connect terminal 3b to ground. The motor should move from 2H to 4H to 4L. Reverse the connections, and the motor should move in the opposite direction.

### Shift Motor Removal and Replacement

1. Disconnect the battery.
2. Remove the cover from under the transfer case.

3. Disconnect the speed sensor connector.
4. Remove the speed sensor bracket.
5. Remove the three bolts that mount the shift motor to the transfer case. **See Diagram #11**
6. Remove the single bolt from the motor to the transfer case.
7. The shift motor should now slide off the shaft on the transfer case.
8. To refit, ensure that the triangular shaft on the transfer case aligns with the triangular hole in the shift motor. **See Diagram #11**
9. Tighten shift motor mounting bolts to **8-11 Nm**.
10. Refit all components in the reverse order

### Clutch Coil

1. The coil is mounted inside the rear of the transfer case, however the connector is accessible. **See Diagram #11**
2. Check the resistance from terminals 3a to ground and you

should have **3 Ohms**.

### Speed Sensor

1. The sensor is located at the rear of the transfer case. **See Diagram #11 & #14**
2. Check the resistance between terminals 1a and 2a, and you should have approximately 300 Ohms. **See Diagram #14**

### De-tent Switch Testing

The 4WD indicator switch, Transfer Neutral Switch and the RFW Switch all operate in the same way and have the same specifications.

**See Diagram #9 & #15**

- When depressed, there should be continuity and when released should be open circuit.
- If they are to be replaced, tighten the new switch to **25-34 Nm**.

### Common Shift Motor Problems.

The manual version seems relatively trouble-free, the automatic version has some common issues with the shift motor assembly. These cause difficulties in shifting between 2H, 4H and 4L.

The most common causes are water or mud entering the shift motor connectors or into the shift motor position switch. **See Diagram #12**

This produces mixed signals to the 4WD control unit, which then does not shift and causes the 4WD light and the 4L light to flash on the dashboard. Allegedly, if the control unit thinks it is in 2H, the speed displayed on the speedo will be half of the road speed.

You should check the shift motor operation and resistances. If the shift motor or range position switch are out of specification, a new assembly is required. A new assembly from the manufacturer will be expensive. However, there now seems to be aftermarket options.

**See Diagram #17** ▶

**Diagram #12**

### Shift Motor Range Position Switch

Terminal	Motor Position		
	2H	4H	4L
1	-	-	Continuity
2	Continuity	Continuity	-
4	Continuity	-	Continuity
5	-	Continuity	-
7	Continuity	Continuity	Continuity

As the shift motor turns, the brushes contact different areas on the disc which will complete or open circuits. The control unit will then know which range the transfer case is in.



**Diagram #13**

4WD Control Unit Pindata

Terminal	Component	Condition	Voltage
1	Shift Motor	Motor Operating	Below 1.0V
		Motor Not Operating	Battery Voltage
2	Shift Motor	Motor Operating	Below 1.0V
		Motor Not Operating	Battery Voltage
3	Shift Motor	Motor Operating	Below 1.0V
		Motor Not Operating	Battery Voltage
4	Shift Motor	Motor Operating	Below 1.0V
		Motor Not Operating	Battery Voltage
5	Neutral Signal from Trans Range Switch.	Neutral	Below 1.0V
		Range other than Neutral	Approx 4.3 V
6	4WD Switch	2H or 4H Position	Battery Voltage
		4L Position	Below 1.0V
7	4WD Switch	2H Position	Below 1.0V
		4H or 4L Position	Battery Voltage
8	Shift Motor Position Switch Position 4	2H Position	Approx 5.0 V
		4H Position	Approx 5.0 V
		4L Position	Approx 4.2 V
9	Shift Motor Position Switch Position 2	2H Position	Approx 5.0 V
		4H Position	Approx 5.0 V
		4L Position	Approx 4.2 V
10	Shift Motor Position Switch Position 1	2H Position	Approx 5.0 V
		4H Position	Approx 5.0 V
		4L Position	Below 1.0V
11	-	-	-
12	Shift Motor Position Switch Position 3	2H Position	Approx 5.0 V
		4H Position	Approx 5.0 V
		4L Position	Approx 4.2 V
13	Vehicle Speed Sensor	Ignition OFF	Below 1.0V
		Ignition ON	Approx 5.0 V
14	Ground for Speed Sensor and Position Switch	Ignition OFF	Below 1.0V
		Ignition ON	Approx 5.0 V
15	-	-	-
16	-	-	-
17	Diagnostic Link	Ignition OFF	Below 1.0V
		Ignition ON	Approx 5.0 V
18	4WD Indicator Light	4WD Indicator Light OFF	Battery Voltage
		4WD Indicator Light ON	Below 1.0V
19	4L Indicator Light	4L Indicator Light OFF	Battery Voltage
		4L Indicator Light ON	Below 1.0V
20	Engine Fuse	Ignition OFF	Below 1.0V
		Ignition ON	Battery Voltage
21	Clutch Coil	Clutch Coil ON	Battery Voltage
		Clutch Coil OFF	Below 1.0V
22	Lock Solenoid Valve	Lock Solenoid Valve ON	Battery Voltage
		Lock Solenoid Valve OFF	Below 1.0V
23	Ground	All conditions	Below 1.0V
24	Ground	All conditions	Below 1.0V
25	PTC -AT Fuse	All conditions	Battery Voltage
26	PTC -AT Fuse	All conditions	Battery Voltage

If you are stuck in the middle of nowhere and you have diagnosed that the shift motor is not working, it is possible to open the shift motor assembly and possibly revive it to get you home. Remove the three bolts on the cover for the position switch. Then lever the cover it away from the assembly. Once apart you might find that there is corrosion on the switching disc, or it is full of water, mud or sand.

**See Diagram #12**

If you clean out the housing, and with some very fine sand paper or steel wool remove any corrosions on the disc and any contamination on the contact fingers. Reassemble and seal the housing with some appropriate sealant. Check and clean the harness connector as well. Fit the shift motor back on the transfer case, and it may come back to life. However, for a reliable repair, a new unit is recommend.

If this does not work, you might have to remove the shift motor and manually shift the transfer case. The shaft should turn easily with a spanner of an appropriate size. If not, the drive-line might be wound up, or there is a fault in the transfer case. This should be a last resort, because you could damage the triangular shaft on the transfer case.

Vacuum Leaks

Like many systems which use vacuum, this system can leak. Vacuum hoses can come off or split. If there are oil leaks, the hoses can be contaminated and degrade. If there has been some work done on the vehicle's engine, ensure that all vacuum hose are refitted to their original positions and the one way valves are the right way around. Check the hose positions are correct and that the system can produce and hold vacuum.

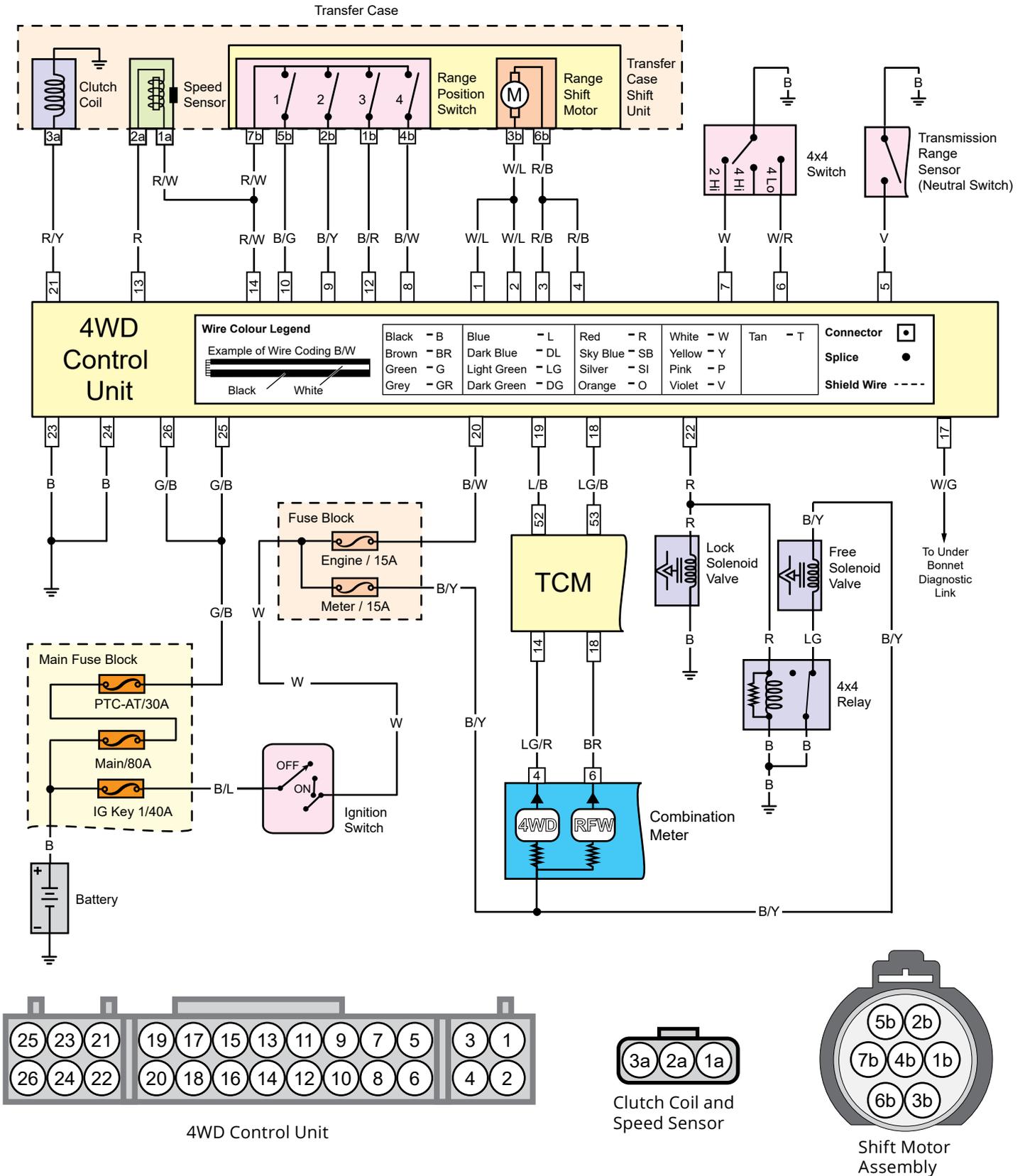
**See Diagram #7**

If the vehicle has been used in dusty conditions the solenoid valves filters can block which will stop them from bleeding off the vacuum and cause shifting issues.

**See Diagram #6** ▶

Diagram #14

### Automatic Transmission 4WD System



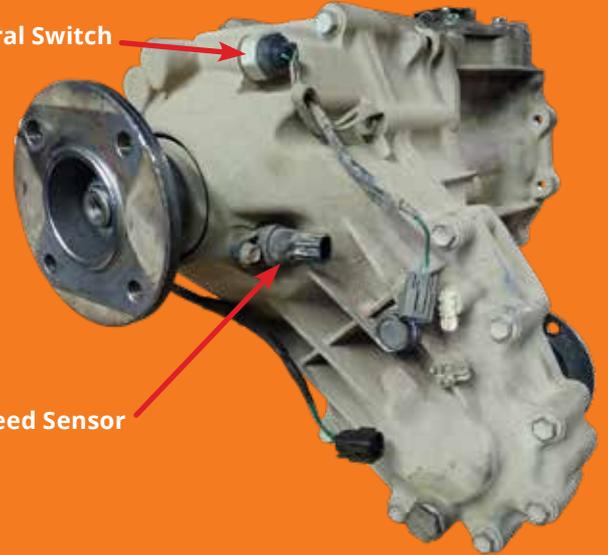
**Diagram #15**  
**Manual Transfer Case Switch Locations**

4WD Indicator Switch

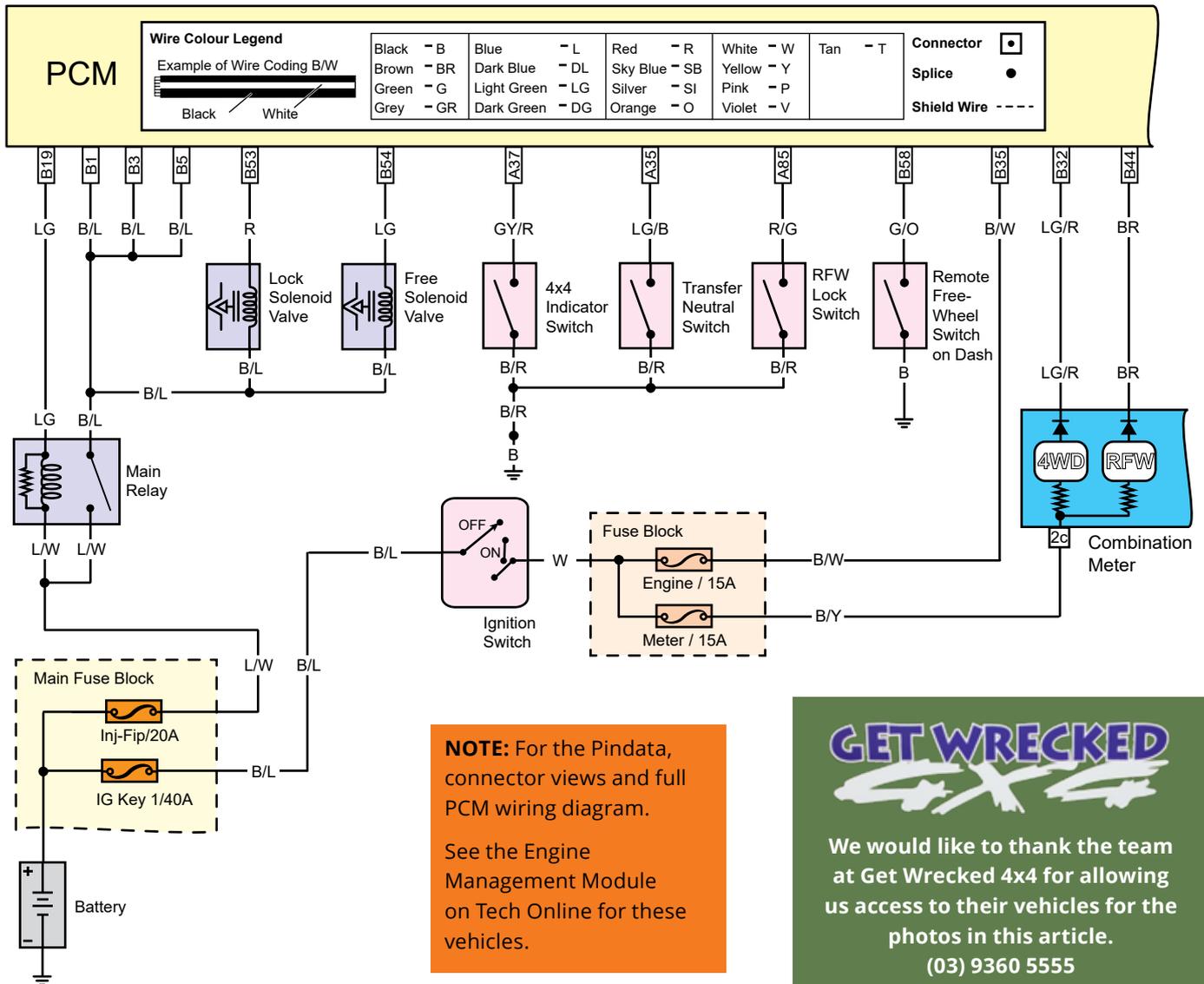


Transfer Neutral Switch

Speed Sensor



**Diagram #16**  
**Manual Transmission 4WD System**



**GET WRECKED**  
*4x4*

We would like to thank the team at Get Wrecked 4x4 for allowing us access to their vehicles for the photos in this article.  
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Diagram #17

### The Chinese Connection

Great Wall is using a Borg Warner transfer case for their 4WD vehicles. It is a different model of transfer case to the PJ / PK Ranger and the UN BT50. However, the shift motor seems to be the same, as it is being offered on various online retailers indicating that it is compatible with these models. This is a cheaper option when compared to a genuine shift motor from Ford or Mazda, which may cost approximately \$1000. The longevity of these cheaper online versions is hard to judge, but you can buy a hand full of them for the price of a genuine part.

There are some rumours that a similar shift motor assembly is used on the Kia Sorento and the Ssangyong Korando, Musso and Rexton vehicles. However, the connectors and shift patterns might be different.



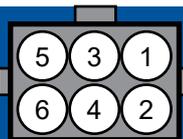
This aftermarket shift motor is allegedly compatible with Rangers, BT50 and various Great Wall vehicles and is available online.



This is the view of a transfer case in a Great Wall V240 and you can see the similar shift motor assembly.

Diagram #18

### 4WD Selector Switch



Mounted near the gear selector.

	4WD Position Switch		
Terminal	2H	4H	4L
1	Continuity	-	-
2	-	-	-
3	-	-	Continuity
4	-	Continuity	-
5	-	-	-
6	Continuity	Continuity	Continuity

### Lack Of Use

Lack of use can cause problems in these vehicles and many other makes and models of 4WD. Many owners have never engaged their vehicles 4WD system and when they need 4WD, it will not work.

It is not uncommon for the following to occur;

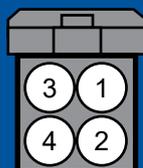
- Switches to become stuck which will then give incorrect signals.
- Actuator shafts can seize.
- Bearings can hammer away at there cups if they remain in the one position.

It is a good idea to tell your customers to engage their 4WD system at least once a month to ensure that everything works and to free up any components that might be starting to seize in position.

For information to remove and rebuild the transfer case or other driveline systems on the PK / PJ Ranger and the UN BT50. Log on to Tech Online or call VACC's Technical Advisory Service. [🔗](#)

Diagram #19

### RFW Switch



Mounted on the dash board to the right of the of the steering wheel.

	RFW Switch		
Terminal	Pressed	Pressed	Released
1	Continuity	-	Continuity
2	Continuity (Globe)	Continuity	Continuity (Globe)
3	Continuity	-	Continuity
4	-	Continuity	-

# RG Holden Colorado: Drum Brake Rear Wheel Bearings

2012 - 2015 Holden Colorado

VACC's Technical Advisory Service has been receiving calls from members for the replacement of RG Colorado rear wheel bearings. There are three different types of bearing designs, depending on if the vehicle is 4WD or if it has disc or drum brakes. It seems the 2WD drum brake versions are causing some issues. After being reassembled with a new wheel bearing kit, there is excessive end float in the bearing. This article will help you avoid this problem.

## The Common Problem

It appears that the genuine rear wheel bearing kit for these vehicles are expensive, which lead people to aftermarket solutions. These solutions are available, but there are some variations which cause trouble if the incorrect parts are ordered.

For the 2WD version, there seem to be two different sizes of bearing cups or seals in the aftermarket bearing kit, even though the part numbers are the same. Allegedly, at the end of the part number on the cup will be a -1 or a -2 (or -II)

The -1 version is about 2mm shorter than the -2 version. If the incorrect one is ordered you might have 2mm free play (specifications should be 0.4 mm maximum), or there might be no free play at all and the axle bearings may be overloaded and will not turn.

To avoid this, you should quote the part numbers of the bearing, cup and outer seal to ensure the bearing supplier can give you the correct parts. This is not an issue for the genuine kits.

The replacement procedure below can be used for both the single and double

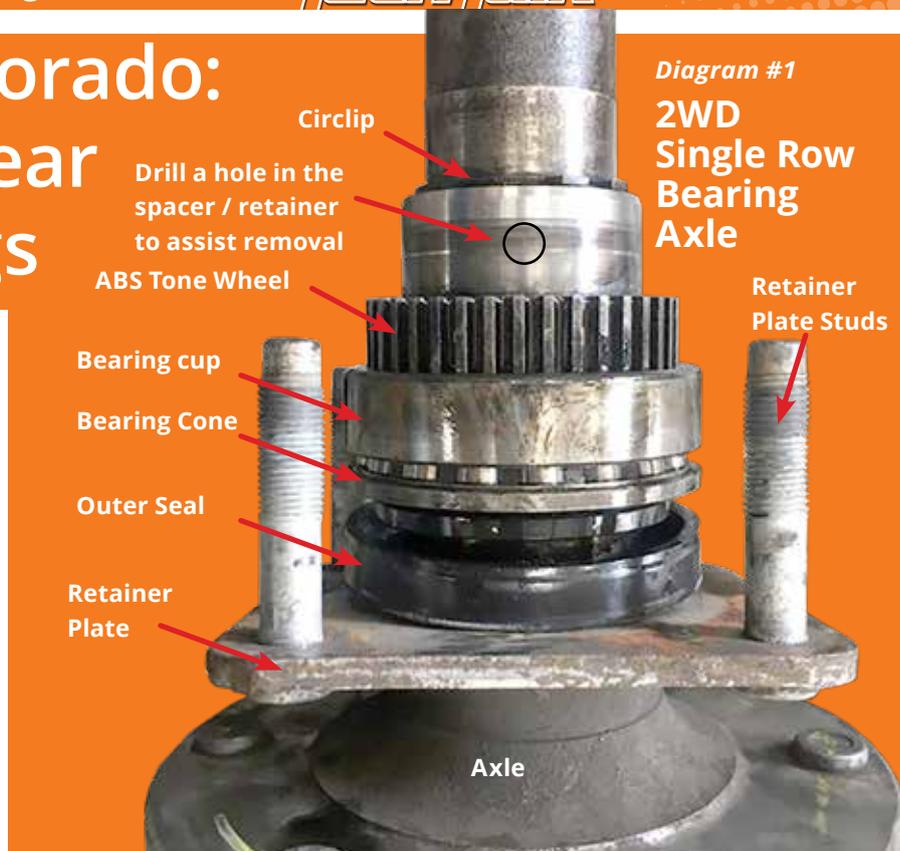


Diagram #1  
2WD  
Single Row  
Bearing  
Axle

row bearings with the differences highlighted.

## Special Tools

- J-42129 Wheel Hub Puller
- GE-02619-A Slide Hammer

## Axle Removal

1. Raise the vehicle and support safely.
2. Drain final drive assembly.
3. Remove the rear wheels.
4. Remove the rear wheel speed sensor (if fitted).
5. Remove the brake drum. It should slide off.
6. Remove the four nuts from the rear side of the brake backing plate.
7. Fit J-42129 Wheel Hub Puller to the axle by attaching it to the wheel studs, then attach GE-02619-A Slide Hammer. Use the slide hammer to remove the axle from the final drive housing.
8. Remove the seal from the final drive housing.

## Bearing Removal

1. Remove the circlip from the single row bearing axle. **See Diagram #1**
2. Mount the axle in a bench vice.
3. Remove the studs from the bearing retainer plate on both types.
4. Centre punch then drill a hole in the bearing spacer / retainer. **See Diagram #1 & #2**  
**WARNING:** Do not drill all the way through the spacer / retainer.
5. Use a hammer and chisel to split the spacer and drive it from the axle.
6. Fit a set of knife edges under the speed sensor tone wheel. Then use a press to remove the speed sensor tone wheel.
7. For the double row axle, using an appropriate tool remove the nut and washer from the axle. **See Diagram #2**
8. Using appropriate press tools under the bearing retaining plate. Press the retaining plate, outer ▶

seal and inner bearing race off the axle. **See Diagram #1**

- For the double row type. Press the axle out of the bearing housing. **See Diagram #2**
- Then press the bearing from the housing.

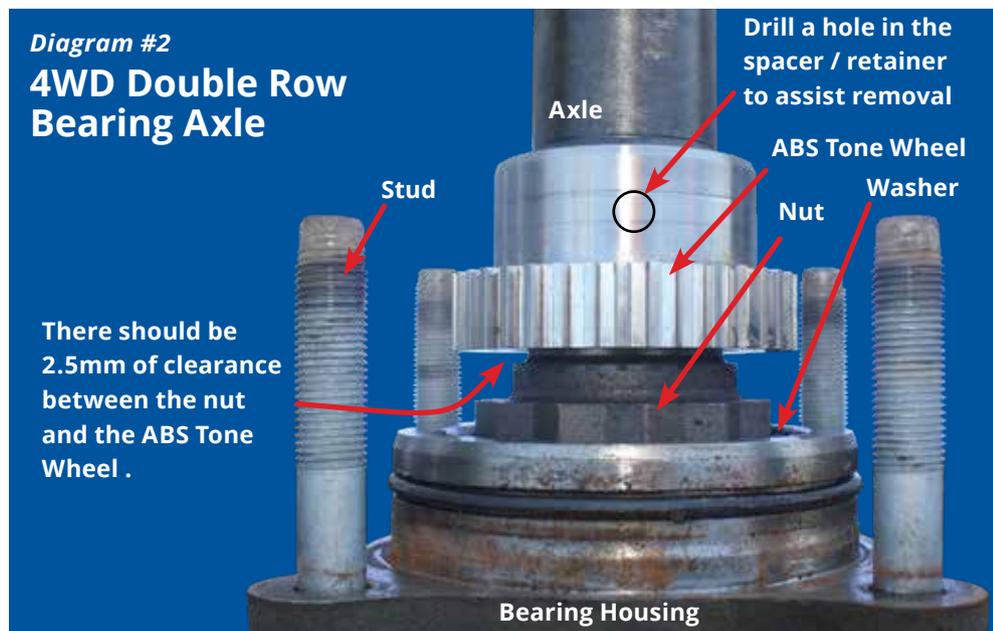
### Bearing Installation

- Fit a new inner seal into the final drive housing.
- Fit the studs back into the bearing retaining plate.
- For the single row bearing axle. Fit the retaining plate, new outer seal and new bearing race on the axle in this order and in the correct orientation. **See Diagram #1**
- For the double row bearing axle. Press a new bearing into the housing.
- Fit housing onto the axle in the correct orientation. **See Diagram #2**
- Using appropriate press tools. Press the above components onto the axle shaft.
- For the single row bearing axle. Position the bearing cup, wheel speed sensor tone wheel and the spacer on the axle in this order and in the correct orientation. **See Diagram #1**
- Using appropriate press tools. Press them onto the axle.

Diagram #2

### 4WD Double Row Bearing Axle

There should be 2.5mm of clearance between the nut and the ABS Tone Wheel .



- For the double row bearing axle. Refit the washer and tighten the nut to **84 Nm**. **See Diagram #2**
- Press on a new wheel speed tone wheel. **NOTE:** Ensure to leave a **2.5mm** gap from the edge of the nut. **See Diagram #2**
- Press on a new spacer
- For the single row bearing axle. Fit a new circlip to the axle. **See Diagram #1**

### Axle Installation

- Fit the axle into the final drive housing.
- Refit the four axle nuts and tighten to **84 Nm**.
- Check rear axle free play. Ensure

- that it does not exceed **0.4 mm**.
- Refit the brake drum.
- Refit the wheels and tighten wheel nuts to **118 Nm**.
- Refill final drive assembly with 2.3L of 75W-90 GL5.

For the replacement procedure for the DISC BRAKE VERSION call VACC's Technical Advisory Service.

For more information on the RG Colorado, log on to Tech Online or call VACC's Technical Advisory Service. [📄](#)

Thanks to Chris and the team at Northern Differentials for their assistance with this article.  
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# Diesel Fuel Failures



**The leading cause of Diesel injector failure is the result of poor fuel quality. In this article, we discuss the three major causes of injector failure associated with the properties of the fuel itself: excess wear, abrasion, and deposits.**

Before January 2006, diesel fuels contained relatively large amounts of sulphur. This sulphur is found in the crude oil that gets refined into diesel fuel. The sulphur in the fuel was used as a natural lubricant for the fuel system. Low sulphur diesel is now mandated in all diesel fuel segments. Diesel has a maximum allowable sulphur content of 10 parts per million (ppm) since January 2009. As refiners removed this sulphur, the lubrication benefits went away. As a result, diesel fuel refineries now put additives in the fuel to restore lubricity. The standard for measuring this lubricity is ASTM D-6079, which measures the size of a wear scar between two metal surfaces lubricated with the fuel. The less lubrication the fuel provides, the larger the wear scar. Many fuel distributors add additional lubricity to the fuel to limit premature wear.

## Abrasion

While fuel lubricity is an essential factor in determining the wear characteristics of the fuel injection system, it's not the only fuel-related cause of excess wear. The other potential cause of premature injector failure (due to wear) is caused by abrasion. All fuels contain small amounts of impurities, even the highest-quality diesel fuels.

*This is a command piston showing signs of abrasion.*



Some of these impurities include tiny particles that can pass through even the tightest on-board vehicle filters. If the fuel contains a large amount of these small, insoluble particles, over time they can abrade the injectors as they pass through during normal engine operation. In extreme cases, this abrasion can significantly alter the fuel spray pattern, causing reduced engine performance. In severe cases, it can even lead to injector failure. Good housekeeping practices by the fuel supplier, and good fuel filtration, can reduce the damage caused by this abrasion.

## Deposits

While excess wear is important to consider when discussing the cause of injector failure, one primary reason for injector failure today is due to excessive build-up of deposits. There are two major types of these deposits - external injector deposits and internal injector deposits. External injector deposits are generally caused by incompletely burned fuel that builds up around the injector holes. These deposits are referred to as coking deposits. While in most cases these deposits may not lead to injector failure, they can build up enough to disrupt the fuel spray, which leads to less efficient fuel combustion. This is often observed by the vehicle operator as a noticeable loss in power or lost fuel economy.

## Internal Diesel Injector Deposits

This deposit doesn't form on the external tips of the injectors, but

rather on the internal parts, such as the injector needles and pilot valves. These deposits often look similar to the coking deposits (dark brown in colour). While they can form in virtually any type of diesel engine, they typically only cause operational issues in the newer engines with precision injection systems. Injection pressures near 30,000 psi create a very fine fuel mist spray in the combustion chamber, resulting in more complete burning of the fuel. This yields lower emissions and can also improve fuel economy.

In order to maintain these high injection pressures, the injector assemblies have been highly engineered and have very tight clearance tolerances, sometimes as small as 1-3 microns (a human hair is typically 70-100 microns thick). So, you can imagine it wouldn't take much material depositing on these parts to cause poor injector needle actuation, leading to poor engine performance. In extreme cases, these deposits can lead to complete sticking or seizing of the injector needles, particularly after the vehicle has been shut down and the engine has been allowed to cool.

As these internal deposits build up, they can cause the same symptoms as the more traditional external coking deposits, namely lost power and reduced fuel economy. In extreme cases in which the injectors begin to stick completely, they can lead to excessive vehicle downtime and high maintenance costs. 

**For technical support or further information go to: [www.denso.com.au](http://www.denso.com.au)**

*Deposits on the nozzle tip can disrupt the spray pattern.*

