

Land Rover Perkins Prima Engine Conversion

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8th of April 2004

Abstract

The primary reason for the selection of the Prima engine for duty in your Land Rover will be fuel economy. The Montego is well known for being frugal, 55mpg averages are common, but its also one of the cheapest engines to buy at the moment due to the ten plus year old cars failing their MOTs. The prima is also fairly well know for a long service life as well as its efficiency and it is a high reving diesel with very similar power delivery to the Land Rover petrol engine. It is not unusual to pay £50 - £150 for a car with a good engine, in fact many people are given the cars. So they have an edge over a lot of the other possibilities.

The engine doesn't fit on a Land Rover gearbox, so an adapter plate is needed to fit between the two, I supply these. The other problems are flywheel size and starter rotation, these are solved by the use of parts from a van supplied with the normaly aspirated version of the engine. The conversion doesn't require any chassis or bulkhead modifications, you will have to make or adapt an exhaust, alter the wiring and fabricate a throttle cable other than that it's all a bolt in job.

The conversion should make a swb do between 34-40mpg, I manage both figures, its drivable at motorway speeds and will generally keeps up with traffic that a 2.25 Land Rover diesel wouldn't.

Contents

1	Introduction	2
2	Engine.	3
2.1	Engine Source.	3
2.2	Engine Differances	4
2.3	Engine Problems Mileage and Stuff	5
2.4	Water Pipes	5
3	Conversion and Land Rovers	5
3.1	Series One Land Rovers	6
3.2	Series II and III Landrovers	6
3.3	90/110 Land Rovers	6

4	Parts Required for the Prima Conversion	6
4.1	parts to keep from the Montego	7
4.2	Other Parts Needed	7
5	Before Installation	8
5.1	Engine	8
5.2	Fit Adapter plate to engine.	10
6	Before Fitting Engine	10
6.1	Chassis Mounts	10
6.2	Clutch Hose	10
6.3	Wiring	10
7	Fitting the engine	10
A	Appendix	11
A.1	Timing Belt Change	11
A.2	Fan[alternator] Belt Alignment	11
A.3	Fasteners	12

1 Introduction

The Montegos claimed consumption figures of upto 60mpg certainly makes it a suitable candidate for improving the consumption of your Land Rover. I do 34-40mpg, depending on driving conditions and speed. With 34 mpg being motorway driving and 40 mpg pottering around the lanes where I live; this makes sense as the drag at 80mph on the motorway is a lot more than the drag when pottering around at 30-40 mph. I have a 36 mpg average over the last few months, this is a long enough period to use this figure as an statistical average.

Cost of Conversion. The major cost will be the custom parts, adapter and mounts. Unlike some other conversion where the engines will be the large part of the cost. I can speculate on the cost and I would expect it to be of the order of £500 that's assuming you pay £100 for the flywheel and starter motor¹. I haven't included things like a clutch as you would of needed a clutch anyway. You will also recover some of the cost by selling your old engine².

Return on your money can be seen in Figure1, this is based on current diesel and petrol costs and assuming 35mpg prima, 20 mpg petrol, which is being generous as some people only get 15-17mpg from the 2.25 petrol. The cost of conversion to LPG will in all likelihood make running lpg plus the cost of conversion very similar to the total for the Prima.

The conversion is all bolt in, no alteration to the chassis or bulkhead is required. You will need to fabricate an exhaust, a throttle cable and do a bit of wiring. I will outline options for all the problems I think you might encounter. Many people will have done things like this before and its all simple to them,

¹It's getting harder to find £20 starter and flywheels.

²I had loads of offers on my old engine while it was in the vehicle and could be seen running, so it might be a good idea to arrange sale and conversion to coincide.

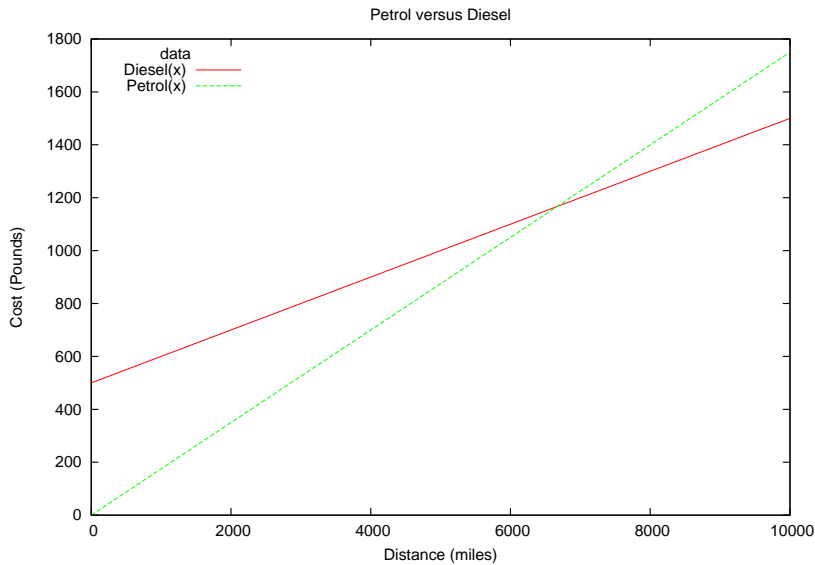


Figure 1: Graph comparing cost of running diesel and petrol, the break even point is the intersection.

some haven't and could do with a few words of advice; I never really know how much information is needed.

There are several websites detailing this conversion, and a few magazine articles have been written on the subject. I would have a look at them and read this before you start. If your in doubt e-mail me, I think once you start its all fairly obvious and there shouldnt be any problems. I have listed the two referances I found on google, looks like wittsend[] has updated his site, I wouldn't grind all the crankshaft register off as he has done, The material on the Dudleigh[] site is pretty similar to wittsends, Dudleigh do now make some comment on why they make their adapters from Ci. Mine are made from LM25T6 and only weigh 5kg, don't ask me why they want them heavy if it's weight distribution you would be better off with some weight at the end you want more weight on, if it's more weight in the middle eat a few more pies....

2 Engine.

2.1 Engine Source.

1. Turbo Charged
 - (a) Montego cars and estates
 - (b) Meastro Clubman cars
 - (c) Road sweeping machines

- (d) Stationary and marine engines
2. Normally Aspirated[n/a]
- (a) Montego vans
 - (b) maestro cars and vans
 - (c) Sherpa and LDV vans
 - (d) Stationary and marine engines

2.2 Engine Differences

Tdi and n/a engines have some fundamental differences, mechanical as well as fueling. The major ones being compression ratio and piston cooling. The pumps are different in that the turbo has a pressure operated enrichment device to control fueling. There are ancillary differences between engines, the most obvious is the van and stationary engines having different water and oil pumps, the oil filter interferes with the landrover chassis engine mount and the water pump is in the way of the alternator, when its shifted to the right hand side of the motor. Sumps are also different in cars with transverse engines and vans with inline engines, I have used a montego sump and not had any signs of oil swirl problems, though I would use the larger capacity sherpa sump if I had one..

So if you want a Tdi get one rather than getting a n/a engine and putting a turbo on it.

If you are using a n/a engine you will need to change some ancillaries just to fit it, unless it's from a Maestro.

Multi Stage and single stage injection. In ~1990 they changed the injectors to lower the emissions and noise I have seen specifications claiming lower and some claiming higher power output's with the two stage injectors. the two stage injectors cost a bit more. Mahle list different pistons for the multi[two] stage injection units, I am told the power went up they got a bit quieter and they use more fuel At the same time they changed the gearing so that may have had something to do with it. The multi stage injectors have the spill pipes located in the side of them, and the single stage have the spill pipes on top. untill someone can definatly say either is better i woudln't worry which one you get.

EGR, exhaust gas recirculation, This is an emission control system that allows exhaust gas to be recirculated to lower combustion temps and reducing NOx emissions. You can remove or disable the unit, or leave it as installed, if you remove the control gear it won't function, if you remove it you will need to block the hole in the manifolds. The EGR control is located on the bracket with the glow plug relay. Stopping it functioning will not affect your engine, it's closed at idle and if you disable it, it will stay shut all the time.

2.3 Engine Problems Mileage and Stuff

The engine is said to have a service life in excesses of 300,000 miles, while I was looking for an engine I was offered a few seemingly excellent cars with over 200,000 miles, I didn't like the idea of such high mileage so bought one with 98k on it. Some of the high ones came with full service history and seemed very good; so don't shy away from 100,000 mile cars. The most common fault with them is headgaskets. don't think this is a prima only fault since i have been taking much interest in diesels i have seen many japanese pickups getting replacement heads which cost far in excess of what this conversion is costing you, it seems to be the most common fault with all diesel engines. My engine had the headgasket gone and has done a year[15k] on a new head gasket without any problems. I didn't have the facility to skim the head when i didn't mine but I can do them now, so if you can't get it done locally. Have I mentioned cam belts yet? unless you have proof of when it was changed assume it needs changing.

2.4 Water Pipes

I get asked all the time where the water pipes go, in the absence of a diagram, I lost all my photos as well, I shall describe the layout.

The radiator has an inlet in the upper righthand³ corner and an outlet in the lower left hand corner. The bottom radiator hose has a branch which goes into the oil cooler and the oil cooler is then plumbed to to the heater. The bottom hose goes to the lower left hand inlet on the water pump.

The upper hose goes to the upper outlet on the lefthand side of the water pump. The heater is fed from the thermostat housing, the heater pipes are 3/4 [inch] on the Prima and 1/2 [inch] on the Land Rover. You can plumb the coolant system with 4 Landrover bottom hoses and a branch to the oil cooler from the Montego hose, you will need to join your heater hoses to the oil cooler and engine.

3 Conversion and Land Rovers

Land Rover engines are, well the petrol, strong and durable units designed a long time ago with the low revving high torque needs such as driving the pto. the petrol engine is pretty inefficient compared to modern engines. My experiences of landrover diesels, was that they were very slow and used a lot more diesel than expected considering the rate with which they moved. for more power the obvious choice is a Rover V8, under some conditions it uses no more fuel than the 2.25 litre petrol and it is a nice engine. The choice of diesel is quite wide, any truck with a 2-3 litre diesel is a candidate. The Prima stands out purely because of it's cost at the moment, it's nice light well designed powerplant that's pretty frugal though, possibly worth a second look even if you couldn't get a whole car for £50.

³Right hand being the righthand side when your sitting in the drivers seat.

3.1 Series One Land Rovers

I haven't had a series one so can't speak from first hand experience, I can only tell it like I am told. I gather a small bellhousing is used, there appear to be a few differences depending on engine it was fitted with. I am told some boxes accept the 4 cylinder bellhousing from a series II. which means you can use the 4 cylinder adapter if you bolt a bellhousing from a Sii 4 cylinder on to the s i gearbox. You just do the conversion as a later 4 cylinder. I am not sure about clutch plates and stuff. I would imagine you use the series I clutch plate and the later Pressure plate, thats if it's any different. Other wise it should all be the same.

3.2 Series II and III Landrovers

This conversion is for installation in a vehicle with a 4 cylinder bellhousing as on a series III gearbox, which obviously fits a series 2 and 2A.

3.3 90/110 Land Rovers

You can convert Defenders/90/110s by using bolt in bits, well sort of.

The Sherpa van comes with an LT77 gearbox. So you modify a Sherpa LT77 gearbox by rebuilding it with a Land Rover LT77 output shaft, you now have a gearbox which the prima engine will bolt to this will all fit to a Land Rover transfer box.

This route can be taken to convert series Land Rovers, but you will have to install this transfer box in your Landy and custom length props are required plus I gather there are a few awkward bits. People converting series vehicles like this that I have spoken to say they would use an adapter and the stock gearbox if they did the conversion again.

4 Parts Required for the Prima Conversion

1. Engine
2. Adapter plate
3. Engine mounts
4. Crankshaft pilot bearing, or adapter bush.
5. Radiator hoses
6. Wiring sudries
7. Fuel lines
8. Exhaust
9. Electric fan

10. A 975mm Fan belt, the part number will probably have 975 in it.

The above should be all the parts required.

4.1 parts to keep from the Montego

Assuming you had a Montego.

1. oil cooler, very efficient laminar flow oil-water cooler.
2. radiator hoses, you won't necessarily use them but bits are useful.
3. The engine wiring harness, with some of the main harness including the block plugs.
4. The rad fan, complete with shroud.
5. The exhaust system
6. The throttle cable
7. Fuel filter

If you didn't save these parts you will need to obtain suitable parts a walk around a scarp yard should net all parts. The Montego fan I had didn't have a shroud, a fiesta one is fine. You will find there is plenty of room between the engine and radiator to mount a fan on the back of the rad. the fan can be spun the opposite way and used as a pusher, but the blades aren't symmetrical and are designed to work a certain way.

4.2 Other Parts Needed

1. Starter motor from a 1986 1994 Sherpa or Ldv 2.0 Di van, these are 2.0 Di and 200D. If you look in some listings a 300series is also listed as having the engine fitted. These are vans fitted with the normally aspirated Perkins Prima engine.
2. A flywheel from the same source as the starter motor.
3. Fuel pipe to extend the fuel pipe to the filter and make a return.
4. Some wiring components to complete/alter your wiring.
5. A crankshaft oil seal is required, it goes in the adapter plate, it's a 4.125 x 3.5 x .375 oil seal and is available from all factors for any of the applications with this engine.
6. Some more radiator hoses.

5 Before Installation

5.1 Engine

Clean the engine thoroughly and examine for water and oil leaks, this is the time to fix them.

A new cam belt isn't a bad idea, unless it came with proof of when it was replaced assume it needs replacing see appendix 1 for belt change instruction.

How much you do in the way of servicing to the engine is up to you, it's probably not a bad idea to check everything. If the head gasket is gone do it now.

If you have the flat heater that's mounted centrally on the bulkhead the hoses might interfere with the vacuum hose to the brakes. Either shift the heater over [only just thought of this] or remove the hose fitting from the vacuum pump and bend it [cut it in half at an angle and weld it back together] then push it back into the vacuum pump. The tube is a press fit, if you warm the pump up the steel tube will pull out quite easily, replace in a similar manner.

The pressure signal pipe, from the turbo to the fuel pump will interfere with the turbo inlet hose. The pipe is connected to the inlet side of the turbo above the air inlet, you will see there is a plug diametrically opposite, below the inlet, move the pipe to this tapping and block the upper one with the plug that was blocking the lower hole.

Check all the adapter threads are clean. Check the adapter fit on the bellhousing, sometimes bellhousing nuts have distorted holes making the studs light, take a small round file to any holes like this. The fit of the adapter should be tight, I have measured stock adapters and they vary about .006 inches in bore, I machine them to the size of the small one making the adapter a snug fit.

I don't supply bolts to fit the adapter, see appendix 3.

Check all bolt holes are tapped deep enough to install the bolts in, just wind the bolt in and check that it will grip whatever its going to be holding, unless it obvious that the thread is deep enough it's best to make sure.

Remove the alternator and the cast iron alternator bracket from the lower left hand side of the block, an engine mount goes where this was located. Don't bin the alternator adjustment strap, the bit of metal with a hole and a slot in it. You can bolt the new alternator bracket to the engine now if you want, don't bolt the alternator on till the engine is in though; you can check the alignment see appendix 2.

The alternator Strap, the adjustable link, from the Montego fits, when you have drilled an extra 10 mm hole in it. You need to drill the hole as far from the slot as you can get but on the same surface as the slot. See Figure 2

This is a good time to paint the bulkhead fit new footwells or any other repairs that the engine could conceivably get in the way.

Figure 2: The alternator strap showing position of 'new' 10mm hole.

5.2 Fit Adapter plate to engine.

The Prima is sealed to the adapter plate with a gasket as standard, you can reuse or replace this gasket or just use rtv, I used RTV[suzuki bond] and the first time i ran the engine it leaked like hell, meant pulling the motor out to reseal it. It seals perfectly now without a gasket but if the gasket is OK I would of used it. Before bolting the adapter in put the oil seal in the adapter, it's easier to make sure you putting it in straight when the adapter is loose, it needs to go in square and should be below the level of the adapter. Fit the adapter with whatever sealant system you have decided on, snug all the bolts up and tighten them in a sequence and incrementaly, if you have a torque wrench the figures are 32lbs/ft for the 10mm bolts and 15 lbs/ft for the 8mm bolts and 20 lbs/ft for the the 12 mm bolt. If you snug them up and leave it to settle/ rtv to start curing then tighten fully after a few hours it shouldn't leak.

6 Before Fitting Engine

6.1 Chassis Mounts

You might find the new rubber mounts have a 10mm stud and it's tight in the chassis slot, run a file through the slot if it is, before putting the engine in.

6.2 Clutch Hose

I put a new clutch hose in, a one piece hose that doesn't use the stock bulkhead tab, makes more room and is easier to do up, ????????

6.3 Wiring

I did the wiring prior to fitting the engine, more room. I removed the starter solenoid from the bulkhead, you only need a relay now, The solenoid will be usefull for bolting the wires together if you don't have new starter cable. I replaced the starter cable with a cable that goes forwards and is attached to the cross member under the radiator and goes around the chassis and up the side of the block to the starter. I need to explain the wiring I think??????

7 Fitting the engine

I found that it was almost impossible to fit the engine on my own with both mounts bolted on to the block, I suggest you fit the engien without the mounts and then install them.

I leave two opposite studs ou of the adapter and put a couple of longer guide studs in place to help in initial alignment. when it's approx 3/4 of an inch from being all the way in the input shaft will be trying to slide into the bush wiggle it and maybe rotate the engine a bit as you try and slid it into position. don't force it in. I found it went in very easily without the mounts.

when the box/adapter are together fit the nuts and washers and do them up.

Remove the rubber mount's from the chassis and the righthand mount 'wedge', now lift the engine up, either with the crane or a jack and a plank under the sump[be carefull], you should be able to put the engine mounts in now. After the mounts are bolted to the block you can put the rubber mounts in, you can push the engine over to one side if necessary to squeeze the mounts in.

References

[1] <http://www.integerspin.co.uk>

[2] <http://www.nhua.co.uk/conversion/perkins.htm>

[3] <http://www.dudleigh.com>

A Appendix

A.1 Timing Belt Change

pins to lock the timing are required.

- For the crankshaft, the pin goes in the hole in the adapter plate and into a hole in the flywheel that is coincident at TDC. The hole is located on the right hand side of the adapter. Once the pin is in don't turn the crank as you might snap the pin.
- For the camshaft, on the top of the cam cover at the front and in the centre is a, 8 mm bolt remove this and there is a drilling that goes into the camshaft, fit a pin into this to locate and stop the camshaft rotating.
- For the injection pump, there is a slot at 11 o'clock on the injection pump pulley, in the hub of the pulley and in the injection pump there are two drillings that line up and accept a pin to lock the pump.

The pulleys are meant to be removed from the hubs and the belt tensioned before the pulleys are locked in place*****

A.2 Fan[alternator] Belt Alignment

The belt will last longer and run smoother if it's in alignment. the easiest way to check is to put the belt on and tighten the belt, if you look at the pulleys the belt shouldn't be leaving them at an angle, this is usually quite obvious.

a check can be made with a straight edge. place a straight edge across the water pump pulley and rotate the straight edge so it comes near to the alternator pulley, the distance from the pulley to the straight edge will depend on the two

pulleys[they are slightly different in profile]. you will probably be looking for a small gap between the straight edge and the alternator pulley, check from the water pump pulley to the top edge of the pulley and to the bottom edge.

to correct any misalignment put shims, washers, alignment within a few mm will be fine.

A.3 Fasteners

1. 8 off 10mm[1.5mm pitch] with a grip length of 25mm, these bolts fasten the adapter to the block.
2. 12 off 10mm with 25mm grip length[yes the same as above] to fasten the engine mounts to the block.
3. 3 off 8mm[1.25 pitch] these are the small bolts that fasten the adapter to the block .
4. 1 off 12mm [1.75mm pitch] I don't know the length but it's approx 60 mm grip length, this fastens the block to the adapter and goes through the block into the adapter and is located directly below the starter motor. check the bolt doesn't interfere with the ring gear.
5. 2 off 10mm socket cap heads with a 30 mm grip length. These are for attaching the starter motor to the adapter, I used socket heads as the easiest spanner to use is an allen key in a 3/8 drive socket with an extension. But if you don't have these allen keys it might be easier to hexagon head bolts or studs.
6. 12 off 3/8 UNC to UNF studs and nuts to bolt the adapter to the bell-housing. you can reuse the old studs and nuts but don't reuse damaged studs if they will cause damage to the threads in the adapter or if they will pull the studs from the adapter rather than the nuts coming off.

If you had a Montego you should have all the above bolts left after pulling the engine out, I would use the Montego wasted head washer headed bolts where possible. I have included the pitches and sizes so you know what you need if you have to buy any.

My bike background means I am rather fond of loctite, it never hurt to loctite everything.