DPT Technical Guide

How it works?

To explain how **DPT** works we have to go back to the basics of a diesel engine.

The main difference between diesel and petrol engines is the means by which the fuel/air mixture is introduced into the cylinder and then ignited. In the petrol engine, the fuel is mixed with the incoming air before it enters the cylinder, and the mixture is then ignited at the appropriate moment by a spark plug. At all conditions except full-throttle, the throttle butterfly restricts the airflow, and cylinder filling is incomplete. In the diesel engine, air alone is drawn into the cylinder and then compressed. Because of the diesel's high compression ratio (typically 20:1), the air gets very hot when compressed — up to 750°C (1 382°F). As the piston approaches the end of the compression stroke, fuel is injected into the combustion chamber under very high pressure, in the form of a finely-atomized spray. The temperature of the air is high enough to ignite the injected diesel fuel as it mixes with the air. The mixture then burns and provides the energy which drives the piston downwards on the combustion (power) stroke.

In a petrol engine we always need to inject extra energy to start the combustion cycle which is in the form of a spark. A petrol engine is not only fuel but also air regulated to make sure that the mixture is always 1 to 1 to keep it explosive. If we didn't regulate the amount of air in a petrol engine the overflow of air related to the fuel would not allow the mixture to be explosive any more. This also explains why a diesel engine in partial engine load needs less fuel, because the compression of the engine is not influenced by a throttle body.

In a diesel engine we don't have this problem because the air temperature and pressure are always higher (compression) which allow the diesel to self-combust. With a petrol engine you decrease the end compression in part engine load caused by the throttle body and this will decrease the compression and the efficiency of the engine.

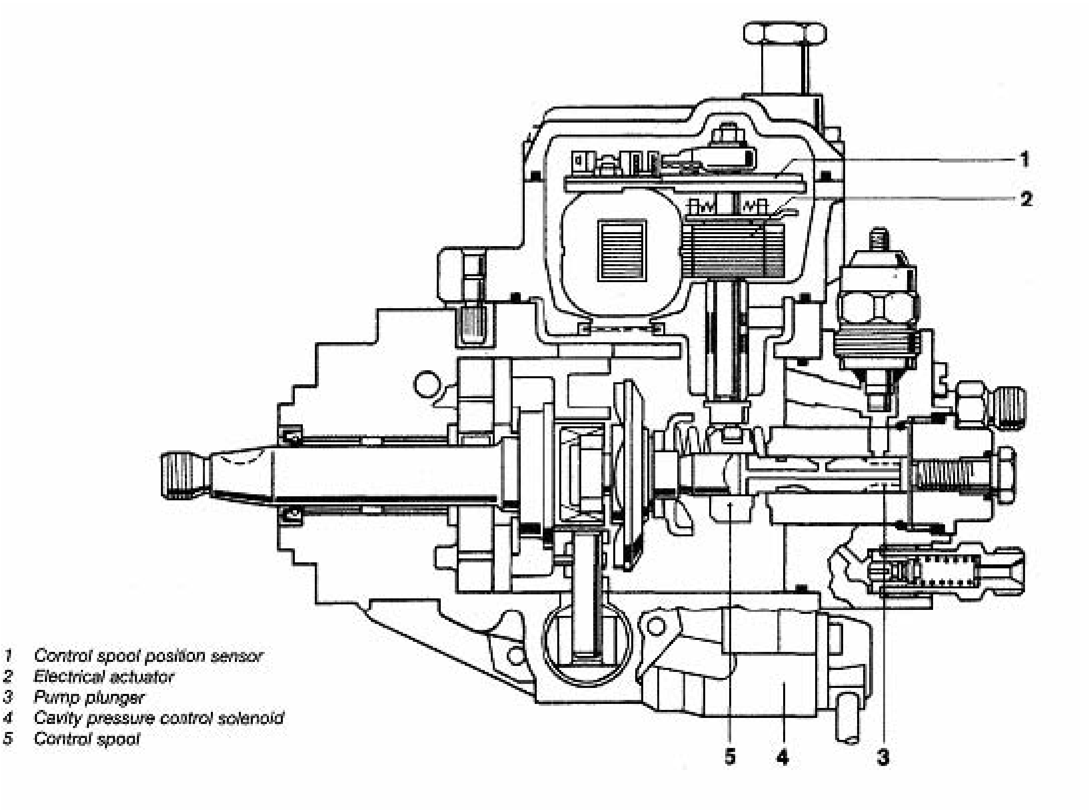
Only the amount of injected diesel will regulate the power-output of a diesel engine. When the engine runs in low engine-load there is always a remainder of air (oxygen) that is not used for the combustion. Also when the engine is running on full load there is still a big remainder of air that is not used for combustion. Depending on the engine manufacturer this remainder is anywhere from] 20% up to an astonishing 50%! When we inject extra diesel under these conditions we create extra engine power almost 1 to 1 related to the extra amount of diesel we have injected. So by regulating extra diesel we regulate extra power. The engine manufacturer keeps this remainder of air to guarantee that the engine always will run within the stated emissions and fuel consumption (MPG). Also when the car is used in countries that have ambient temperatures above 40 degrees Celsius and poor fuel quality it will still maintain its emissions level. In Europe we have very good fuel quality and almost no ambient temperatures above 40 degrees Celsius. By injecting extra diesel to "tune" the car it is possible to increase power without creating a negative outcome related to emissions (smoke).

If we would like to "Tune" the car we just have to make sure we inject more diesel into the engine to create more BHP.

How do we inject more diesel?

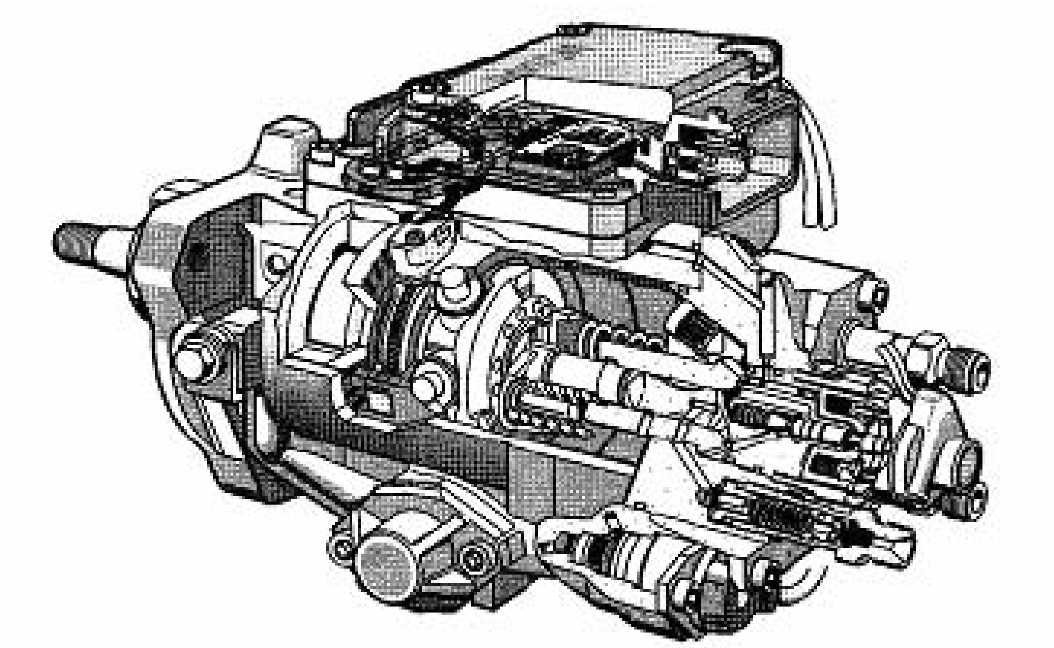
Explanation of DPT on Various Technologies

VP37



These systems are fitted with either an inline or rotary injection pump. Engine speed is controlled mechanically via throttle lever/pedal connected directly to pump or via pneumatic arrangement. The systems with inline pumps are the most reliable as the pump is very robust and can handle poor quality fuels (for a while that is). Common types/makes of inline pumps are SIMMS - CAV - LUCAS - (MINIMEC, MAJORMEC), GARDNER. BOSCH - DENSO - ZEXEL (A, P, H Types), SIGMA.If we look at the VP37 system it is only possible to inject longer, because the pressure characteristics and the flow characteristics are mechanical fixed into the engine. With a **DPT** unit connected to the fuel pump, we can alter the feedback signal that will give the engine ECU the correct information regarding the amount of injected diesel. So by readjusting this signal we can indirectly let the engine ECU inject more diesel into the engine. **DPT** measures the amount of turbo pressure and will proportionally adjust the flow of diesel. Some other manufacturer's products will only alter the diesel flow without measuring the boost pressure in the intake stroke of the engine and this will result in. "Too much" diesel being injected which will result in black smoke in the lower rev range.

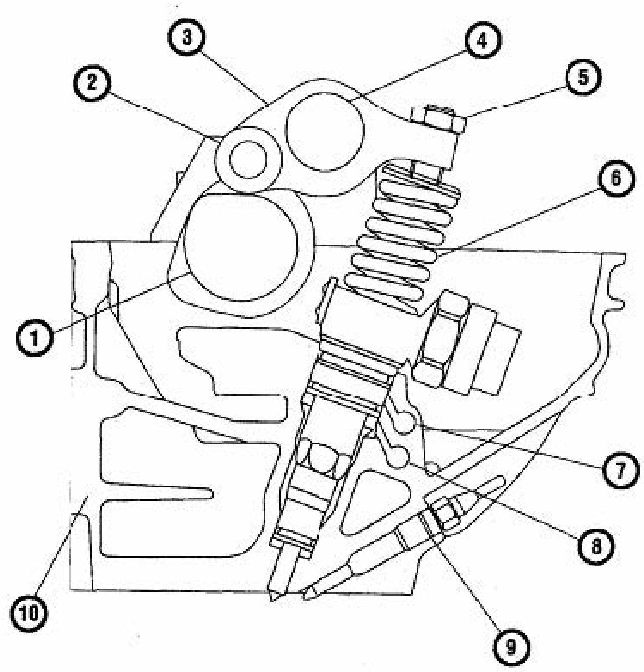
VP44



First sold in 1996, the VP pump was the first electronically controlled pump with a high pressure solenoid valve to measure the amount of fuel injected to each cylinder with extreme accuracy and at a very high injection pressure (over 1,800 bars). New VP pumps are fitted with a monoblock injection system containing the pump and the electronics. At the current level of development, the VP 44 axial piston distributor pump achieves an injection pressure of over 1,800 bars at the injector. Its hydraulic efficiency has been optimised to give a driving torque that is the same as that of a traditional distributor pump, despite a considerable increase in pressure. The fuel is metered via a solenoid valve. A minute but precisely metered amount of fuel is pre-injected to reduce combustion noise. New generation VP 44 pumps have a computer mounted directly on the pump casing that controls the injection and engine functions, removing the need for a separate computer for the engine and making for a very compact, complete system.

The VP44 system works the same like the VP37 system, however the feedback signal of the pump back to the engine ECU is not in hard signals but hidden into a digital can-bus (Controller Area Network) signal. Altering this signal is more difficult because the **DPT** unit has to read the amount of fuel injected out of the can-bus line, alter it, and put it back onto the can-bus. **DPT** not only gives a proportional offset of diesel, but also reads the amount of already injected diesel out of the can-bus, and so it is capable of adjusting fuel proportionally without causing smoke in the atmospheric situation of the engine without causing smoke in the atmospheric situation of the engine.

PD (Pump Düse)



Pump injector installation

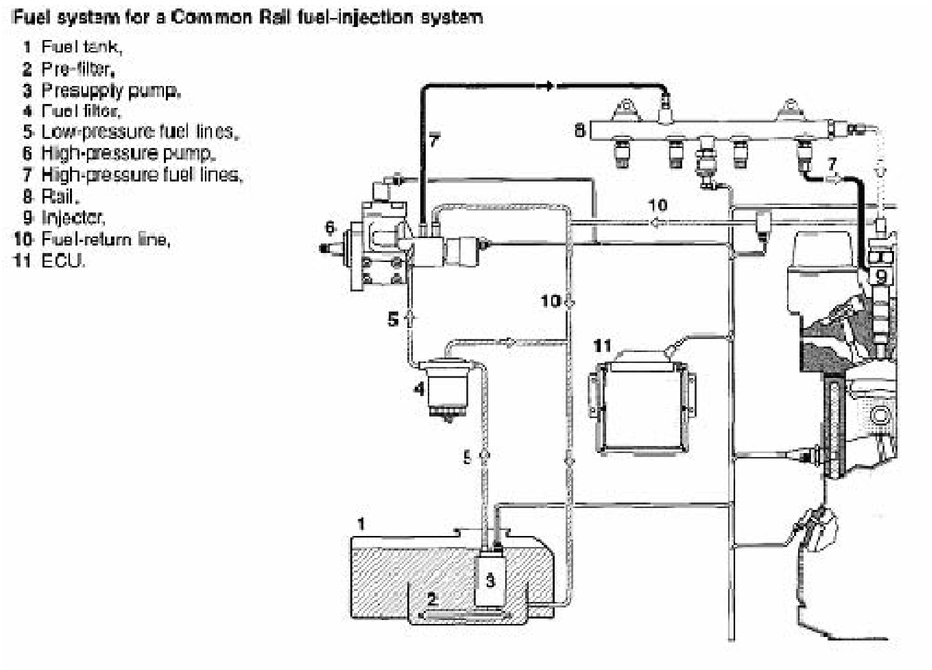
1 Camshaft injection lobe	4 Rocker shaft	8 Fuel supply line
2 Rocker roller	5 Ball-pin adjuster	9 Glow plug
3 Rocker	6 Pump injector	10 Cylinder head
	7 Fuel return line	

Although regarded as a whole new system the actual principle of this injection system began with the American engine builders, Cummins. The Cummins PT system was fitted to many trucks and became a legend (at that time) due to its reliability and economy.

PD (Pump Düse Einheit) or UIS (Unit Injection System) systems are fitted to an increasing number of vehicles including Volvo FH12 trucks, Land Rover TD5 and the newer 1.2/1.4/1.9/2.0 VW engines. This injection system also has no injection pump and injection pressures (up to 2000bar) are achieved via the cam shaft acting upon the pump units. Again, this system is highly sensitive to contamination and the price of replacement parts is very high. Common manufacturers of these systems are BOSCH and DELPHI. If we look to the (PD) system of the VAG group, Electrical tuning only can change the injection time, caused by the pressure characteristics and the flow characteristics are also mechanically fixed into the engine-injectors.

By altering signals like fuel-temperature and boost-pressure we can simulate different working conditions of the engine as feedback to the engine ECU. The engine ECU will recalibrate fuel expansion, boost and torque-mapping. The ECU will indirectly change the amount of injected diesel which will result in more BHP output.

Common Rail (CR)



What is Common Rail?
In 1997, Bosch began mass producing the Common Rail accumulator injection system. With injection pressures of up to as much as 1,350 bars, new high pressure pumps and even more efficient control modules, the latest generation of Common Rail systems makes engines even cleaner, quieter and more powerful than before.

In the Common Rail system, a high pressure pump compresses the fuel and delivers it to the high pressure accumulator called the "rail". The fuel is injected into the combustion chambers in exact amounts with precision timing by injectors controlled by solenoid valves. Common Rail is the only injection system in which the fuel pressure is independent of the injection sequence, in such a way that the injection pressure can be freely chosen over a range of between 250 and 1,350 bars as defined by the engine mapping. The pressure is measured in the rail by means of a sensor and is constantly applied to the injector. The opening and closing of the injectors is hydraulically controlled – by the actuation of the solenoid valves. Pre-injection and main injection are controlled by cyclical actuation of the solenoid valve. Minimum injection rates of 1 to 2 mm/stroke are obtained with switching times of less than 200 micro-seconds. But this does not mean that Common Rail technology can be developed no further. Indeed, Bosch is currently developing a piezo-electronically actuated Common Rail system which will achieve much higher operating speeds than those of the solenoid valves used today. This innovative technology will open up new possibilities, which constitutes an enormous advantage in order to be able to meet the ever more demanding pollution reduction standards of the future.

If we want to inject more diesel we can do this in two ways, one is to inject longer or the second is to inject under a higher pressure. The system on which the **DPT** unit obtains the best results is to inject the diesel using a higher pressure.

The system is easy to install, directly on the Common Rail pressure sensor (MAP sensor). The great benefit of the system is that it completely digital which means that the onboard processor can not only increase the amount of pressure by altering the rail signal but it is also capable of measuring the actual pressure in the rail and do calculations on the pressure which gives the freedom of regulation within the saved parameters. If the system measures levels that could harm the fuel system, it can respond within a millisecond, and provide the engine ECU a much higher level so that it regulated the pressure back also within a millisecond. By creating mathematical maps into the tuning device, the processor can learn and readjust itself which makes it a very reliable system. By altering the information regarding the amount of rail pressure we can easily make sure the engine produces up to 35% more BHP output.

Why only Turbo Diesels?

Turbo Diesels have a great remainder of air caused by the turbo, and normally aspirated engines have only approximately 8% margin left to hit the smoke border (black smoke) If we inject more than this 8% margin we create excess black smoke, and it's very hard to let the normally aspirated engine breath more air. The only solution to allow it to breathe better is a different camshaft, bigger valves and or mount a turbo, what results in much higher costs to tune the car.

Why it will not adversely affect the life of the engine?

Engine manufacturers always design an engine that has 3 basic properties,
Emission levels, lifespan and fuel consumption.

These three values are always connected, however increasing the BHP output and torque will not adversely affect the life of the engine, because:
Engine manufacturers will have left a margin of approx 50% into their engines.
The time period (duty cycle) of the asked extra power is very low, this means that only approx. 3-5% of the lifespan of the engine the engine delivers more than normal power output.
In general the amount of extra wear and tear is not measurable.

Why emissions are not adversely effected?

It we look to the emissions of a diesel powered vehicle, we can see 7 different exhaust gasses are produced CO2, CO, HC, NOx, SO2, O2, C (smoke) and H2O (water). With a **DPT** fitted on a Common Rail engine it is possible to inject shorter but under a higher pressure and this will result in a shorter combustion time. By decreasing the combustion time, the starting and average combustion temperature will rise. Nitrogen in the air that the engine has breathes in has the property that the higher the temperature the more of the nitrogen will bind with O2 (oxygen). This will create a higher level of NOx emissions, but the efficiency of the engine will rise so that the CO, CO2, HC, SO2 and C levels will decrease.

It is fixed that when lowering the CO2 in a diesel engine by improving the efficiency this will result in increasing the NOx levels. NOx levels can only be measured in a laboratory environment and do not affect the current MOT legislations. However if the amount of extra injected fuel is too high, the engine starts to smoke (C of carbon). In general the emissions are lower except for the NOx levels.

How our unit can be "personalised" to driver preference / requirement?

The **DPT** unit can very easily be personalised to the driver requirements because it's fully digital. Basically this means that the standard program that is installed on the chip has extra adjustment available to the user. Only a specialised dealer with our programming tool can make these extra adjustments so that the extra power is delivered lower down the rev-range i.e. for towing applications or is more progressive for economical purposes. Please consult your dealer for more information.

What do the terms BHP & Torque mean in real terms?

BHP

This term was coined by James Watt, who invented a new type of steam engine in the eighteenth century. Watt found that the horse could do a certain amount of work per second; when he sold his steam engines, this measurement allowed him to estimate the worth of an engine in terms of the number of horses it would replace. Therefore, a six-horsepower engine was capable of replacing six horses.
Brake horsepower (BHP) Brake horsepower was a term commonly used before the 1970s in the United States, and is still common in the United Kingdom. It refers to the brake dynamometer, the device for measuring the true power of the engine. Stating power in 'BHP' gives some indication that this is a true reading, rather than a calculated or predicted one. However, it does not tell where the power reading was taken at the flywheel, transmission or drive wheels. The average car loses between 15-20% of its power from the flywheel to the road wheel.
Normally when you talk about 100 BHP on a car it means that the engine can produce 100 BHP at the crankshaft.

If you would measure it at the wheels, you would only measure approx. 75 BHP, this means that a normal car has approx. 15-35% losses from the crank onto the road.

1 BHP = 0,736 Kilowatt, what that means is that if an engine delivers 100BHP, the engine delivers 73.7 KW = 73700 watts of energy out of the crankshaft. If you have a heater of 2000 Watts, you can put approx. 37 heaters next to this engine to get a picture how much energy we are talking about.

Torque

Torque is a force that tends to rotate or turn things. You generate a torque any time you apply a force using a wrench. Tightening the wheel nuts on your car is a good example. When you use a wrench, you apply a force to the handle. This force creates a torque on the wheel nut, which tends to turn the nut. English units of torque are pound-inches or pound-feet; the SI unit is the Newton-meter. Notice that the torque units contain a distance and a force. To calculate the torque, you just multiply the force by the distance from the centre. In the case of the wheel nuts, if the wrench is a foot long, and you put 200 pounds of force on it, you are generating 200 pound-feet of torque. If you use a 2-foot wrench, you only need to put 100 pounds of force on it to generate the same amount of torque. A car engine creates torque and uses it to spin the crankshaft. This torque is created exactly the same way: A force is applied at a distance.

The combustion of gas in the cylinder creates pressure against the piston. That pressure creates a force on the piston, which pushes it down. The force is transmitted from the piston to the connecting rod, and from the connecting rod into the crankshaft. The horizontal distance changes as the crankshaft spins, so the torque also changes, since torque equals force multiplied by distance. You might be wondering why only the horizontal distance is important in determining the torque in an engine?, when the piston is at the top of its stroke, the connecting rod points straight down at the center of the crankshaft. No torque is generated in this position, because only the force that acts on the lever in a direction perpendicular to the lever generates a torque.

If you have ever tried to loosen really tight wheel nuts on your car, you know a good way to make a lot of torque is to position the wrench so that it is horizontal, and then stand on the end of the wrench - this way you are applying all of your weight at a distance equal to the length of the wrench. If you were to position the wrench with the handle pointing straight up, and then stand on the top of the handle (assuming you could keep your balance), you would have no chance of loosening the lug nut. You might as well stand directly on the wheel nut itself.

How does the unit provide better fuel consumption?

The **DPT** optimisation changes the motors torque characteristic, and it becomes substantially more elastic; this means there are less gear changes required especially in traffic. Therefore the engine is not working as hard. A reduction in fuel consumption is possible of upto 15% if the driving style remians unchanged and the extra power is not utilised.

So how will this benefit;

A Caravaner / regular tow bar user?
A Performance orientated driver?
A 50,000 miles per annum diesel driving sales rep/user?

DPT will benefit a caravan or a regular tow bar user with more torque (pulling power).
The results will be noticed as driving up hills without changing down a gear or two, more acceleration, and more top end speed.

A Performance orientated driver will notice better acceleration and or a higher top speed of the car and will in most applications literally ‘feel’ the difference.

A sales rep/high mileage user who does not use the extra engine power and whose driving style remains unchanged will notice less fuel consumption caused by a more efficient combustion. In most cases a saving of up to 10% is possible which makes it ideal for fleet users or high mileage users as the **DPT** unit will pay for itself in a short period of time.