DOHC TUNING GUIDE

Across the Sierra model range, there are generally speaking three types of "tunable" engine: the OHC 'pinto', the DOHC 16v Cosworth and the 12v V6.

That is to say, having been involved in motorsport to some degree or another, each of the engines can be tuned relatively easily due to an abundance of knowledge and tuning accessories.

The 8v DOHC engine used from late 1989 onwards is somewhat different. Although it typically has good torque delivery and otherwise excellent potential, it has largely been ignored by tuning companies – the engine was never used widely in motorsport due to the success of the Cosworth 16v platform, and as a consequence is not seen as very tunable.

Ford's perception of the engine from the outset didn't help it's reputation amongst tuners - it is believed by some that Ford only ever intended it as a low maintenance, smooth running, economical, motorway mile muncher rather than a source of massive automotive power, brought in as a replacement for the ageing OHC 'pinto' engine to meet tougher emissions laws.

Indeed, if driven sensibly on a long motorway journey, fuel economy figures of between 40 and 45 miles-per-gallon can be realized quite easily from a well maintained car and it is perceived to be a more refined engine than the 'Pinto' it replaced. So refined that Ford still produce and fit the engine (albeit in 16v form) in 2.0 and 2.3 capacities to their Galaxy MPV today.

Because the 8v DOHC is largely ignored by tuners, the options for simple "bolt on" upgrades are fairly limited.

However, with a bit of thought and careful tweaking using available tuning components, very respectable and useful power gains can be had by following the guidelines contained in this How To...

Before undertaking any tuning work, make sure your engine is in good working order – trying to tune a half-ragged engine is a recipe for disaster and neither I nor Marty (whom wrote the article on which this is based) will be held responsible if you blow your engine up!

Fortunately the 8v DOHC is made of fairly strong stuff with the only known weak points being the timing chain and cylinder head gasket.

Cylinder head gaskets can be weakened by overheating, so attention should be given to the cooling system to ensure it can handle a tuned engines increased heat output – in particular the radiator, and the electric cooling fan thermostatic switch which is known to deteriorate and become less reliable with age.

In terms of the timing chain, this is prone to failure at high-mileage, particularly if too heavy a grade of oil has consistently been used as this leads to the chain being over-tensioned which in turn places strain on nylon components in the camshaft drive train – an idler sprocket and chain guides – which then prematurely fail causing chain de-railment, breakage and valve damage. Of course, the nylon components can disintegrate with age and mileage anyway, even if the correct grade of oil has been used...

As a safe alternative to "taking a risk" with your pride and joy, Marty recommends that the cylinder head gasket and timing chain (including idler sprocket, tensioner and guides) are pro-actively changed at intervals of between 100,000 and 120,000-miles, something I happen to agree with, having seen the results of failures of both items.

It's also a good idea to make sure the engine is in a relatively good state of tune and well maintained to start off with – been putting off changing the distributor cap and rotor arm? Get them changed, and ensure the plugs and HT leads are all in good condition while you're at it – a HT lead crossing over to earth at best will induce a misfire telling you it's poorly, but at worse will quietly sap power, reducing the fruits of your tuning labours.

Engine oil has a bearing on the engine's performance too – Ford quote acceptable viscosities of oil for the DOHC range from 5w30 to 10w40.

While using a race specification fully-synthetic 0w40 oil may make you feel better and your wallet lighter by a proportionate amount, it's not necessarily going to produce the best results and Marty recommends a 5w- or 10w30 grade oil in the DOHC rather than a heavier 10w40, though it should be noted that 10w40 is perfectly acceptable for normal road use.

Once the engine is in a "known state", the first stage is to get it breathing a bit better, working on the principle that the more air you can get into the engine (*and exhaust gases out*) quickly the more fuel you can burn and the more power your engine will produce.

Improving the engine's breathing involves work to three distinct areas to get the most return on your tuning time: the air filter and inlet manifold, the valve ports in the cylinder head, and the exhaust system.

1. Induction

The stock air filter and intake system is fairly restricted and a few options are available to sort this out: the cheapest being on EFi cars to drill some 1-inch holes in the airbox *below* where the air filter sits to help more air get at the air filter in the first place.

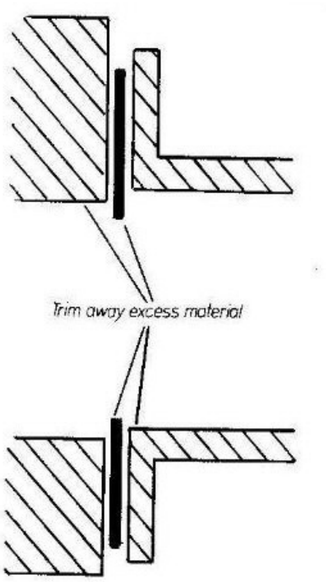
After that the next stage is fitting a free-flowing panel filter in place of the stock paper element, and finally complete replacement of the plastic air intake system with a cone-type filter (*of which the K&N 57i filtercharger system is a good example*).

In terms of the intake manifold itself, it is fairly good with relatively long straight primaries leading into the side of the cylinder head.

Due to their positioning, the fuel injectors pretty much squirt the atomized fuel straight into the combustion chamber through the open inlet valve – this means turbulence in the air flow through the manifold is not needed to ensure a good mix of air and fuel and so is not as critical as on cars fitted with carburettors.

With this in mind, the best thing that can be done to the inlet manifold is to 'match' it to the ports in the side of the cylinder head.

This involves trimming excess gasket material away and smoothing any ridges inside the manifold and inlet port itself to ensure there are no internal lips that will interfere with the flow of incoming air.



Example of 'port matching' to aid gas flow

2. Cylinder head

In terms of airflow, the cylinder head itself flows pretty well from stock, but that's not to say it can't be improved – casting imperfections, surface flaws, machining marks in the valve seats can all be removed to help airflow in and out of the combustion chamber.

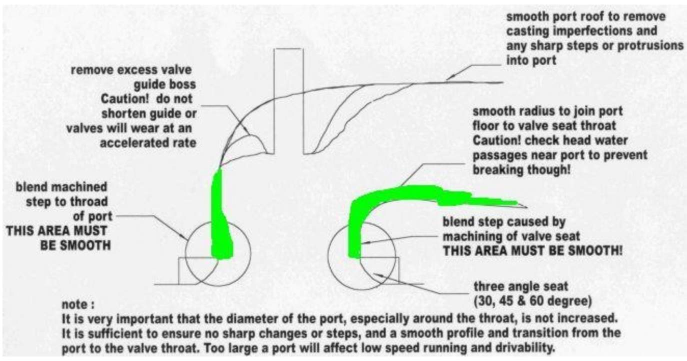
Because the cylinder head is made of fairly soft aluminium alloy, the usual grinding tools – such as polishing stones as supplied with hobby hand drills like the 'dremel' – will quickly clog up.

Marty recommends the use of a carbide bit cutter – he used his in a regular electric hand drill but stresses that material should be carefully removed, small amounts at a time.

Final finishing was done by hand with coarse-grade wet-n-dry glasspaper.

Drill-mounted carbide cutter – use carefully and do not attempt to remove too much material in one go!

The illustration below shows in green the areas that will benefit most from attention with the cutting tools.



The biggest single area needing attention for both inlet and exhaust valves is the step left in the casting of the cylinder head by machining to fit the valve seat inserts. This can be seen in the following picture, circled in green:

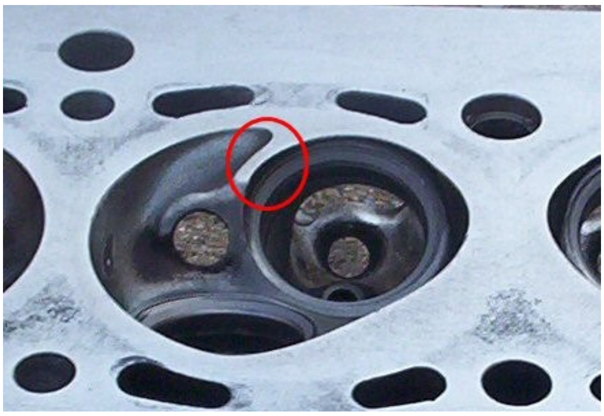
Step left in cylinder head by machining of valve seat (circled)

Through careful use of the carbide tool, this step can be removed, leaving a smooth transition between the port walls and the valve seat itself. This can be seen in the following photograph, again circled in green:

Valve seat step removed and valve seat blended into port walls

With the intake and exhaust ports in the head carefully ground smooth, attention can be turned to the combustion chamber itself. This is contained in the cylinder head rather than the piston crown as in some other engines and can be improved upon by modifying the swirl wall.

The swirl wall serves to 'direct' the incoming air / fuel mixture, giving it a spiral or *swirl* movement that helps the gases into the cylinder. Unfortunately it also partially restricts the inlet valve:



Because of this restriction, gains can be had by altering its shape to allow for more flow...

...by increasing the space for gas to pass through when the inlet valve is open.

The valves themselves also need attention. There is a ridge in the back of each valve head, almost like a step. This needs to be considerably smoothed. Mounting the valve stem in the chuck of a drill and using emery paper on the valve head is an easy method of dealing with this.

Before refitting the valves, ensure they are lapped in (*you may know this as "regrinding"*) and new stem oil seals are fitted.

3. Exhaust

The standard 2.0-litre exhaust is a fairly large bore but this in itself isn't great as the manifold and downpipes can be restrictive and should be replaced.

Ideally, the complete system should be replaced with a free-flowing system and a 4-2-1 manifold that will draw the exhaust gases away from the engine. 'off the shelf' 4-2-1 manifolds (*so called because they bring the 4 exhaust ports on the side of the engine into 2 secondary pipes then into 1 single connection to the exhaust system in a very efficient way*) are available for circa £170 + VAT from Ashley competition exhausts on 01922 720767 (www.ashleycompetitionexhausts.com) though a 10% discount is available at the time of writing for members of the Ford Sierra Owners Club.

The Ashley 4-2-1 exhaust manifold

Once the engines 'breathing' is sorted out, consideration can be given to the fuelling and timing side of things.

4. Camshafts

One performance upgrade the links the airflow through the engine with the timing is the camshafts.

The standard camshaft timing is fairly good, giving plenty of low-down power. A quick and easy upgrade for carburettor'd DOHC variants is to fit the inlet camshaft from an EFi model which has increased lift and, consequently, slightly longer duration.

Upgrade options beyond that are severely limited here compared to (for example) the OHC *Pinto* engine and at the time of writing there appear to be only two options from one aftermarket manufacturer: Piper engineering sells “fast road” and “ultimate road” specification camshafts for the DOHC.

The *fast road* specification has 270°-duration and claims to increase power by circa 10bhp, while the *ultimate road* has a duration of 280° and increases power by a claimed 15bhp. Both options cost in the region of £195 and are for re-profiled camshafts

Piper Engineering can be contacted on 01233 500200 or online via www.pipercams.co.uk

Fitting the wrong camshaft can ruin the usability of a car by moving the power band – that is, the range of engine speeds during which usable power is produced – far from what is practical for day-to-day town and city driving.

Some previous tuning magazines have also suggested that fitting performance camshafts to the DOHC engine is a waste of time for the gains produced though Marty's own feedback suggests otherwise: *I have fitted 270°-duration cams in my engine and low-down power hasn't been affected BUT mid-range power seems a lot stronger and at higher revs the engine just wants to keep on going*

5. Fuelling

For fuelling upgrades, the standard Ford fuel pressure regulator on the fuel rail can be adjusted as a way of cheaply obtaining better throttle response and 'ironing out' any flat spots.

This is achieved by prising out the tiny aluminium disc in the top of the fuel pressure regulator and turning the hexagonal screw inside between quarter- to half-a-turn clockwise with a suitable 4mm allen key. Over-adjusting it can lead to over-rich mixture which would wash oil from the cylinder bores causing accelerated engine wear at best and to dangerously elevated fuel pressure which can burst fuel lines, show weak points in fuel line unions, or prematurely burn out the fuel pump at worst.

However, as the standard DOHC injectors are rated at 191cc, this gives them a maximum output at 100% duty cycle of 34bhp each.

This means no matter what other modifications are done to the engine, it would only produce a maximum of circa 136bhp. Effectively it would be limited by the quantity of fuel that could be injected.

While increasing the fuel pressure will also increase the amount of fuel the injectors can deliver up to a point, the way around this ultimately is to fit larger fuel injectors with a higher flow rating.

Ideally the fuel injectors should be giving the engine its maximum power at around 80% of their duty cycle, and based on experience, Marty has recommended injectors that give 37.5bhp at 80% duty cycle (44bhp at 100%) each.

With four injectors per engine, this would give fuelling for a power output of between 150 (80%) and 175bhp (100%).

Increasing the size of the fuel injectors does need to be done carefully – the engine management system in cars equipped with a catalytic converter (and the associated HEGO / Lambda sensor) will automatically adjust their fuelling to suit the new injectors but cars without will need checking carefully on an exhaust gas analyser and rolling road to ensure the injectors are providing appropriate fuelling.

The fuel pressure regulator modification described above should NOT be performed on cars when using larger injectors as flow rates are calculated exactly at given fuel pressures and an arbitrary but well-meaning 'tweak' could upset the air / fuel mix leading to poor fuel economy, raised exhaust emissions, and accelerated engine wear.

6. Engine Management and Timing

All Sierra DOHC EFi engines are controlled by Ford's own EEC-IV engine management system which looks after both the fuelling and ignition timing based on the processing of inputs from various sensors around the engine.

Modification options to the DOHC's EEC-IV system are *very* limited – as mentioned at the beginning of this guide, the DOHC was never seen as a tunable engine.

However, this is not to say that nothing can be done! Aftermarket tuning companies such as Collins Performance Engineering developed 'piggyback' modules which plug into the cars engine management unit and modify the settings (or 'maps') for the ignition timing and fuelling to give increases in overall engine horsepower and torque that delivers 'all round driving enjoyment'

Such modules are sold under brand names like 'Powerchips' (Collins' own), 'Superchips' and 'Unichip'

Having spoken to professional tuners, the feedback that comes back is that some products are better than others for a given car with given modifications so seek advice what will work best for your particular car and modifications before purchasing.

As with the cams and exhaust manifold, an ECU 'chip' doesn't come cheap and can be expected to cost in the region of £250 for a standard 'piggyback' chip with a set of generic settings that may or may not work their best with your car, and circa £500 for a fully re-mappable 'piggyback' chip and a rolling road set-up to make sure the settings and car are matched perfectly.

Suffice to say that it isn't a cheap thing to do. While a standard 'off the shelf' chip may not release all the power your engine can make, it should certainly make the car more drivable and responsive, raising or disabling the inbuilt rev-limiter entirely and enabling you to make the most of any fast-road camshafts you may have fitted.

And we're done!

By following the six 'points' in this guide, your engine should produce a usable increase in both power and torque.

However to do everything suggested here, a budget of circa £1000 realistically needs to be set-aside and the returns seen would most likely not pass the 150bhp mark – meaning any increase seen is at most only 20% up on standard.

In tuning terms, this isn't a lot for the expenditure and this is why the DOHC engine has remained overlooked by tuners and owners alike – similar gains can be had from other engines for half the cost, and with scope for further increases to be made at a later date.

By following our advice, the DOHC engine will be pretty well taken to the limit of its ability without further and potentially very expensive work – such as for balanced and lightened bottom ends, or for the fitment of a turbo- or supercharger kit.

So what else can be done once we're reached that point?

It is technically possible to fit the 16v cylinder head found on the Mk5 Escort RS2000 – though this entails a complete change in engine management and all the re-wiring that goes with it, never mind differences in intake and exhaust systems that must be accommodated.

Another option is to fit the larger-capacity 16v 2.3 engine from a late-model Ford Scorpio. This is the same basic design as found in the Sierra, Mk5 Escort RS 2000 and Galaxy MPV. Fitted with RS2000 camshafts, the engine has the potential to go to circa 170bhp but again, this is a lot of work for relatively low return and earlier comments relating to rewiring of engine management systems and mechanical changes to 2.3 intake and exhaust systems and the engine's 'unique' balancer shafts apply.

Aftermarket engine management systems such as the widely-lauded Megasquirt system may be an option as a replacement for the limited Ford EEC-IV - but to get the best from them they require expensive rolling road time to set up precisely.

All three 'further options' are beyond the scope of this How To... at this point in time.

When making modifications to your car, remember to inform your insurance company at all stages – failure to do so may invalidate your insurance in the event of you needing to make a claim.

If you are in any way unsure about the information contained in this document, or your ability to undertake the work yourself, consult a suitable workshop manual, a qualified vehicle technician or performance specialist for clarification before proceeding.