

THE ROUGH TUNING



S50/S52 ENGINE:

ABOUT THE M3

The E36 M3 had big boots to fill following the E30 model that had really put BMW on the map for fast and superb handling saloon cars. The M1 was a supercar and the M3 brought the supercar dream to the more average guy on the street. He could own a piece of race car and after the immense success of the M3 on the track, the road car manners of the new E36 would have to be exceptional. And BMW didn't disappoint. The E36 was introduced in late 1990 (for the 1991 model) in Europe with model roll-out planned for the US, Canada and even Australia. Initially, some motoring journalists slated the new BMW for sketchy build quality with loose and inferior-feeling interior trim panels especially. But these doubts were quickly dealt with and by the time the M3 hit the dealer showrooms late in 1992, the world was in love with the butch new model with its sexy curves. This love affair was to continue right up until 1999.

The new model saw huge technological advances over the older E30 model, the most significant of them was the new multi-link rear suspension called Z-axis. This was a development borrowed from the Z1 sports car and 850 super coupé. This would give a much better handling car and more even

weight distribution in the car.

But it was under the bonnet where the biggest news was. Out went the four-cylinder S14 engine that had been pushed as far as it could with the E30 M3 racers. It was time for a new engine and this time DOHC engines were used across the range. The new motor was substantially bigger in capacity at 2990cc and developed plenty more power too, with peak output at 286bhp.

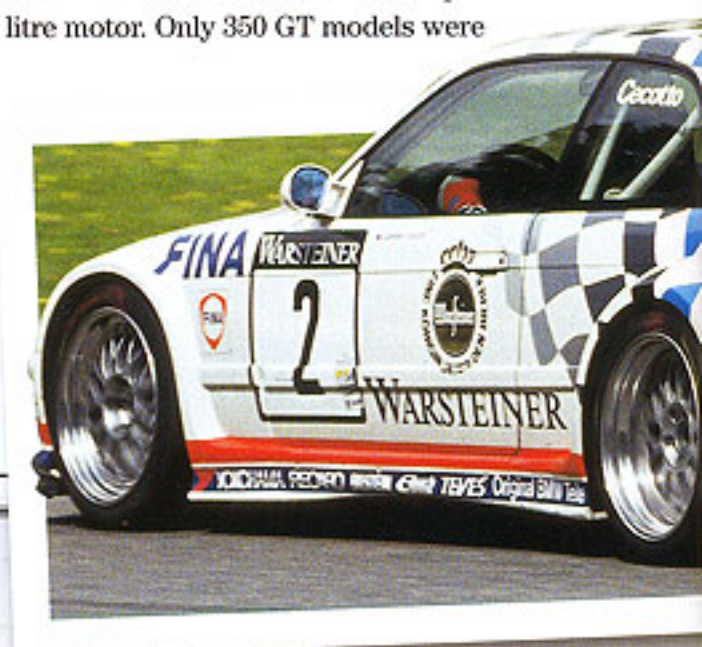
In the middle of 1995, the M3 Coupé and saloon were upgraded to a 317bhp, 3.2-litre engine called the S52. We saw BMW flexing its technological muscles with the introduction of VANOS variable valve timing too. This has come in for some criticism over the years, but in reality isn't much more unreliable than any other engine components. Variable valve timing means the timing of the valve openings can be constantly adjusted to give optimum engine performance based on a number of engine parameters. Whereas traditional cams have fixed timing throughout the rev range, VANOS adjusts the valve actions to give the driver instant power and torque wherever they are in the rev range, so ironing out flat spots. It's even better at giving the engine all the fuel and oxygen it can gulp down under hard acceleration, whereas a traditional engine would have to wait for the valve timing to catch up or come on-cam. The valves are controlled by electronic solenoids that open

Hopefully you caught the first installment of our Rough Tuning Guide last month when we looked at the S14 engine found in the E30 M3. This month we're taking an in-depth look at its younger brother, the S50 and S52, as found under the bonnet of the E36 M3. Following in the track heritage tyre treads of the E30 M3, the E36 was the first M3 to carry a six-cylinder motor and would become a tuners' favourite. 550bhp is possible and we're about to show you how.



and close in a split second. Some engines rattle at low revs when the failing VANOS solenoids aren't doing anything, causing many owners to take their cars back to the dealer.

In 1994 BMW introduced the limited edition M3 GT model. Like the previous E30 road models produced for racing, the E36 M3 GT was a racing homologation special. It had shorter final drive ratio, stiffer suspension, M strut brace, adjustable front and rear spoilers, aluminium doors, forged 17" rims and carbon dash and centre console trim. Designed with the UK market in mind, all GTs came in British Racing green paint and under the bonnet was a 291bhp 3.0-litre motor. Only 350 GT models were



GUIDE

To get the best and, more importantly, the most reliable power from your engine, we're going to work up the tuning scale, starting with the most basic add-ons. To help you plan your tuning, we've broken the guide down into logical steps, increasing in power and budget as we go through.

To find out what works best, each month we speak to leading tuners who specialise in the featured engine, so they can tell us what power to expect and what works best without causing embarrassing failures.



built. 50 of the 200 models allocated for Europe were M3 GT Individuals built in right-hand drive for the UK market, but only had the stock power output of the normal M3.

Doubtful you'll ever see them over here, but Australia got 15 M3-R models ordered by BMW Australia for the Super Production series. There was also an M3 Anniversary Edition built in 1999 for Australia too.

BMW UK celebrated the end of the M3 production in late 1998 with 50 Special Edition coupés. These were all finished in Imola red and trimmed in Imola red leather with contrasting Anthracite suede. You can identify these models by the splitter under the front bumper, along with GT-spec rear wing and forged 17" double spoke rims.



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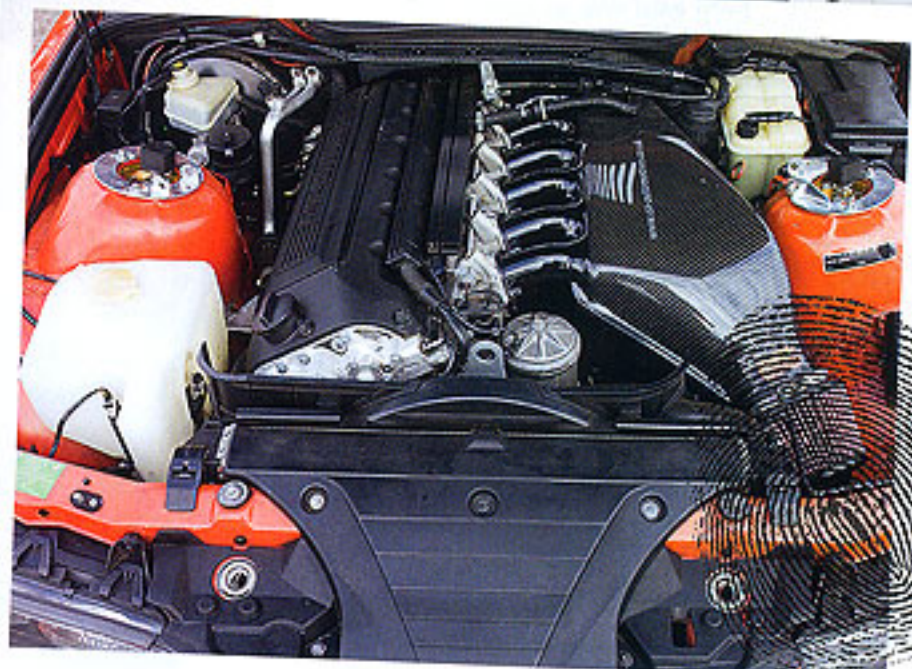
THE S50/S52 IN DETAIL

The early models delivered 286bhp (at 7000rpm) from the 2990cc in-line six-cylinder configuration. The twin-cam design was different to the regular production M50 24-valve motor of the time. BMW's M team engineered the engine to have an increased cylinder bore of 86mm and longer piston stroke of 85.8mm. The compression ratio of the engine was increased to 10.8:1. Further headwork saw the air tracts inside the head ported and polished to promote faster air flow through the head. Very much in keeping with the characteristic of the E30 M3, the new engine used an individual throttle body on each cylinder. As we explained last month, this is the ultimate engine setup and as keen tuners, it's a great system to base our power increases on. While they were at it, BMW engineers developed the most free-flowing intake and exhaust system they could to get the fuel/air in and exhaust gases out as fast as possible.

Again, like we would in the aftermarket, BMW has fitted more heavy-duty valve springs to cope with the high output demand of the M3 engine.

As we mentioned earlier, the new engine would also use variable valve timing called VANOS. Initially, this only worked on the intake valves but would eventually move to both inlet and exhaust for the Evo 3.2 engine. More great news for tuners was the use of Bosch Motronic M3.3 engine management using the common OBD1 system popular in German cars. To help the engine spin up fast there was a dual mass flywheel fitted to give great acceleration. S50 engines all use dual catalysts.

At the early part of the M3 S50 engine production BMW was also working on developing the all-conquering McLaren F1 supercar V12 engine. This work enabled the company to carry over some of the technology to its road cars and we saw these in the 3.2-litre version of the S50 called the S52. The big landmark in BMW engine production was finally exceeding the magical 100bhp-per-litre figure. This capacity increase came from a larger cylinder bore of 86.4mm and longer stroke of 91mm, taking the exact capacity to 3201cc. The compression ratio was upped to 11.3:1 (from 10.8:1) and the new pistons were a lightweight design attached to graphite-coated connecting rods (for increased strength). The engine had a new BMW/Siemens MSS50 engine management system too. As we mentioned, the engine now used the double VANOS continuously variable valve timing on both intake and exhaust cams. The inlet valves were increased in size to cope with the extra air/fuel being drawn and the intake and exhaust systems were redesigned to do the same. In order to ensure proper lubrication and strong oil pressure under high demands, BMW fitted a second oil pump. The final power output after all these changes was 321bhp at 7400rpm: a 35bhp hike. The torque level went up accordingly, from 236lb ft to 258lb ft.



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THE ROUGH TUNING GUIDE

BEFORE YOU START

Whenever we're considering tuning an engine we do all we can to make sure any potential extra power gains can be handled safely. If you already have an S50 or S52 engine, we're sure you take good care of it. If you're looking to buy one with a view to tuning it, then you should buy carefully. Despite these engines being old now and many well into six-figure miles, there's no reason why the engine shouldn't sound tight. Walk away from any car that has engine rattles. These motors were built to take more of a

hammering on the circuit than you'll ever give them on the road as long as they're properly serviced. A well looked-after M3 will come with a full service history, made even better if it's from a main dealer or specialist.

If you're unsure of the last time the car was serviced, better be to safe than sorry. Give it a fresh oil change, along with genuine oil filter and a set of spark plugs. For the sake of less than £100, it's peace of mind.

Many used E36 M3s will have covered their first lap of the odometer and be well into the second, with many M3s well

over ten-years-old and running out of space for candles on the birthday cake. But don't worry, this is a BMW engine and it was built well. The only real known issue is VANOS units failing. According to Roy at CA Automotive: "A lot of the failures can be avoided. Many die after the internal micro filter isn't changed. If you're in any doubt as to the last time it was done, change it. They only cost peanuts and can save you thousands." Roy said the tell-tale signs of a dying VANOS system are noisy engines (at the front of the engine bay) and lacklustre acceleration. Bear in mind this system was designed by Rolls Royce and ask how many high revving engines they build and you can see why a well thrashed M3 will give VANOS a hard time, especially on early cars. According to John Thorne at Thorney Motorsport, a simple VANOS fix can cost only a few hundred quid. A full replacement can be anything up to \$2500. He also said: "Don't be frightened by high miles. We've seen strong engines showing 280,000 miles. It's worth thinking about some basic engine remedial work though when approaching 200,000 miles to prolong the life of the engine, especially if you're planning modifications." Don't forget, prior to any big power conversions, you should carry out a leak and compression test to ensure your engine isn't excessively worn first.



STEP 1: POWER WITHOUT TUNING?

Instead of starting with the induction tuning of the engine, we just had to tell you about a couple of tricks to gain power. CA Auto told us that many cars benefit from power pulleys and fan deletion. Replacing any rotating wheels on things like water pumps and power steering, for example, can help gain you as much as 5bhp. Sound like fantasy? It's proven that if you reduce the rotating drag of these normally heavy wheels with lighter alloy versions, the engine can pick up faster and waste less power turning these wheels. A small step with great results. A pulley set will set you back around £175. Getting rid of the viscous fan driven by the engine can also help gain power in the same way. CA does an electric fan conversion using a Pacet unit that can be yours for only £140. This gets rid of a big rotating

mass and does away with the drag factor again. Another tip from Thorney Motorsport: check your throttle cable. These can get stiff and sticky. A simple

grease up or a replacement (at under thirty quid) can be a quick fix for cars that appear to be holding back.



STEP 2: BREATHING

With the BMW factory using individual throttle bodies as standard on the S50 and S52 motors, we need to look one step back from there at the air box and better still, its content. The stock filter will be made on a budget and the factory can't affordably improve the filter design, so we have to. We'd advise your first tuning step would be to drop in a quality performance panel air filter. The stock air box does a great job of keeping the filter in isolation from the ambient heat of the engine bay. For around £50 you've already helped your engine breathe easier and with less restriction. While there may be many open design induction kits which no doubt sound amazing, they're taking in hot air from the engine bay and so won't be delivering the best oxygen for your motor, which has to be cold for best power. K&N, for example, can solve this by supplying a 57-1000 kit, which is the cold air intake (CAI) housed in a special custom enclosure safe from warm air. K&N has dyno'd this kit for a proven 8bhp gain. For the same gain but in a much more sophisticated design, you

could try the holy grail of M3 intakes: GruppeM. Its carbon air box has a colossal intake scoop that sits unobtrusively between the headlights in the grille area and also uses genuine carbon fibre for the heat shielding. The only issue is that the price, at around £900, isn't cheap, but just check out the knowing nods from aficionados at the next show when you pop the bonnet. It's worth noting Simota does an equivalent system, which retails for much less at around £500. Both kits should release around 8bhp out on the road.

If you're running a 3.2-litre motor, you might want to look at the modified M50

intake manifold from CA Automotive. This gives an increased bore throttle body and improved air flow into the M52 head. This works on all S52 engines including the 320i, 323i and 328i models. CA claims an impressive 20bhp power gain for £510.

If you have a limitless budget and want the best, CA can supply a made-to-order CSL-style carbon air box with engine management remap for £1700. Sure, it's expensive, but when you find out the power gain is in the region of 20-30bhp (depending on the car) and gives a much more lively throttle, it starts to sound tempting, as well as gorgeous on the ear.



STEP 3: EXHAUST SYSTEM

You have a number of choices here depending on your budget. For this car it's all about the power gains, and manufacturers are keen to show you what they can deliver for your car despite the factory system being quite good to start with. Any company that can prove its design works means business. But this part of the tuning process won't be cheap if you want results. We'd say a proven system would end up setting you back four figures-plus, so shop carefully. Supersprint, for example, claims its system will give a dyno-proven 9bhp and 13ft lb of torque. Supersprint has superb fit and finish and it can supply a choice of standard performance rear exhausts, a lightweight version or a race section depending on your preference. It can also supply an affordable de-cat pipe for only a few hundred pounds, according to CA Auto.

Eisenmann is also a notorious name for hand-built-to-order stainless M3 exhausts, and it is easy to blow a grand on a titanium centre pipe section or just a rear section of the system. Its credibility comes from being the OE manufacturer for many supercar names including Alpina, McLaren, Porsche and more. Hell,

it can even give you the choice of sound levels according to what you need.

A popular combination of quality against price is Miltek, with the M3 system actually developed with Thorney Motorsport. For just over a grand you can have a full system from the cat-back finished in a quad 80mm tailpipe design. The beauty of the Miltek system is that it's refined and unobtrusive in normal driving, then comes on song when pushing hard.

You can also change to race cats for emission-friendly driving yet no loss of performance. These will set you back about £950, though. You will need catalysts for the MoT so you can choose to stick with your stock items or we'd say go for 100-cell race cats if you're on the search for more power. Don't just buy any old sports cat, either. You need to be buying a pukka top brand 100-cell cat from the likes of Thorney Motorsport (around £1100 for one with a lifetime guarantee) or CA Auto (£950). Don't be tempted to buy a cheapy from eBay just because it says it's a 100-cell race cat.

Of course, if you crave the ultimate then the GruppeM titanium system is a

work of art in intricate welding and fabrication. Nice if you've got £1600 to spare!



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STEP 4: ENGINE MANAGEMENT

The great advantage of the newer M3 models is the simple ECU tuning available through either the on-board OBD1 or OBD2 port. This gives direct access to the data for the engine management. The stock management has been made for the whole world and needs to take into account climate, humidity, fuel grading and speed limits. This one-map-suits-all approach is great until we start wanting more power. If we can tell the ECU that it's only going to run on the UK's cold air, then we're already making progress. We can tell it that we only want to operate on higher-octane fuel instead of the 95RON the car expects. And better still, we can remove the top speed restriction too. The map contains masses of information about how the stock M3

runs, but as soon as we start swapping parts for higher performance bits the ECU needs to change the engine settings to make the most of the new parts. Hours, days and even weeks have gone into developing uprated maps for the M3 and anything from 10-20bhp can be gained from a simple ECU remap. We'd advise speaking to an expert like Thorney Motorsport, for example, which, like many credible tuners, likes to dyno test the car before and after so you can see as well as feel the improvements. But the biggest advantage of a dyno remap is that the management can be reprogrammed to cater for your modifications. If you've already fitted an exhaust and CAI, then the engine management can be mapped to give extra fuel and ignition settings to match the extra air flow, thus generating the most potential power. This is where you're spending is good value for money. For around £500-£650



you could have a dyno remap. The team at Thorney are so confident you'll notice the difference after a dyno ECU remap that they let the customer drive the car before they pay, offering a full money-back guarantee if the results don't match its promises.

STEP 5: CAM AND HEAD UPGRADES

Cams are the last step for normally aspirated engines, as they tend to be lower on the bang for your buck scale of tuning. They're normally the last stage after you've done everything else we've discussed so far. Companies like Thorney like to stick with normally aspirated power as it's in keeping with the M3 driving experience.

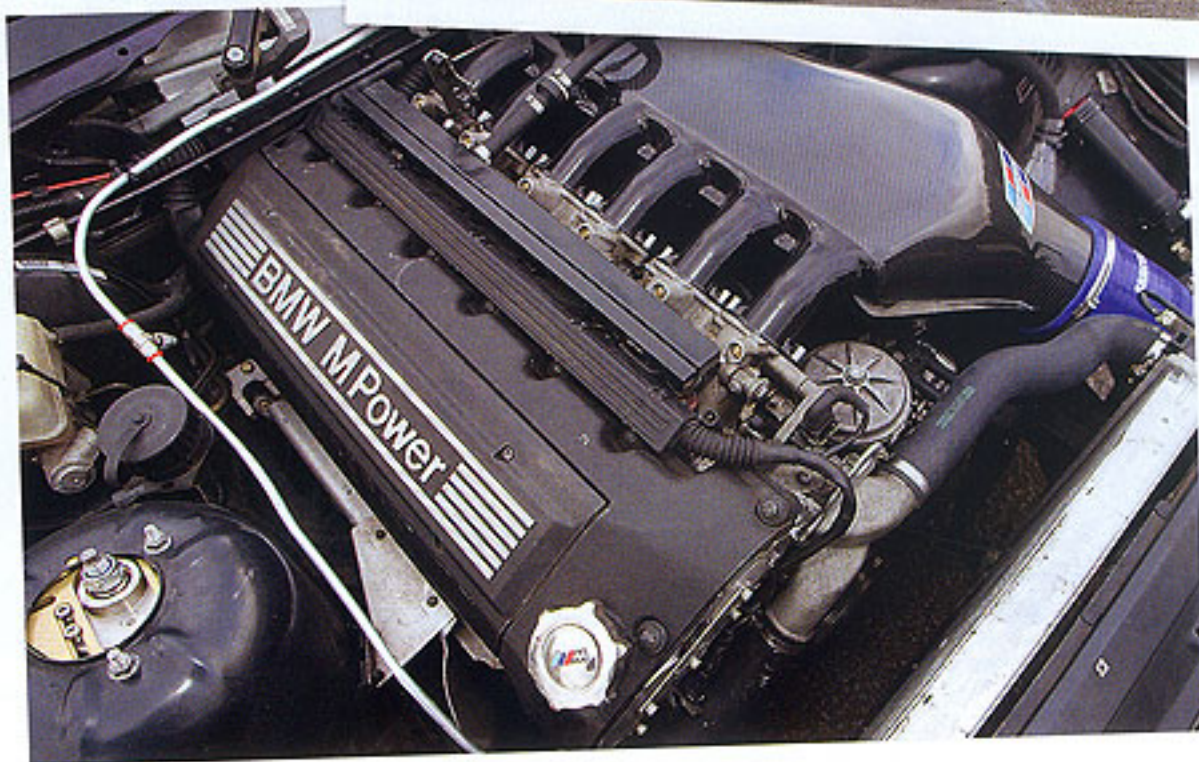
Whereas the previous E30 M3 was old-skool tech, now that we're dealing with variable valve timing things should get a little more complex. Or not. You see, the deal with the VANOS system is you can't really do anything with it when it comes to tuning, so most people junk the system and revert back to... you guessed it, old-skool tuning. The favoured cam brand of choice in the M3 is Schrick, which is notorious for German motors. Dropping in performance cams for a road engine will give you two noticeable changes in engine characteristics: less low-down torque but a whole load more power from around 3000rpm all the way to the redline. Most feel this is an acceptable trade-off as the revs are what make the M3 the gas that it is. The great news is that if you stick to the recommended cam duration of 284° for both inlet and exhaust cams, then

you can run standard valve lift that means you can retain your stock pistons. Schrick can supply cams above this mild spec right up to over 300° for race motors.

Of course, with fitting any cam kit comes the need to remap the engine to take the extra duration into account and ensure you're getting extra fuel into the engine to make the most of the valves being open for longer.

While the head design from the factory of both the M50 and M52 engines is very good, it's only made to run stock internal and external engine components. When we start to add uprated parts, we get closer to the limits of

the factory head design. If the head comes off for a cam swap, then mainly all that is needed is a de-coke and a gentle gas flowing to remove any built up carbon (coke) in the airways. A cam swap can, depending on the engine, releases around 12-15bhp, and don't forget to factor in around six to eight hours for the labour.



STEP 6: TURBO AND SUPERCHARGING

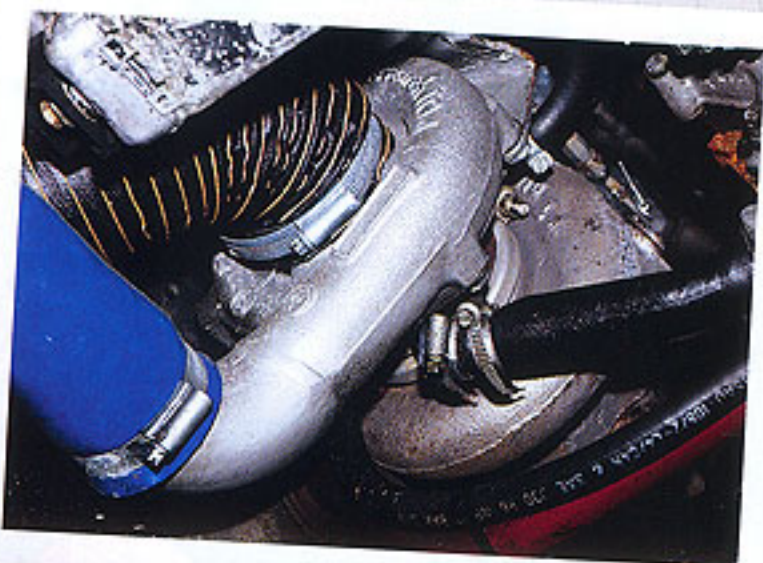
We've seen many US and foreign M3s using Active Autowerkes supercharger conversions to great effect. They use Rotrex C38 'chargers and can be fitted to a stock motor for around 300bhp at the wheels. Trouble is, most tuners now won't supply an off-the-shelf supercharger or turbocharger kit, preferring to get the car into their workshops and do the work as a bespoke conversion where everything is uprated to match the demands of the forced induction.

Every supercharger and turbo conversion needs to be engine and budget controlled. If you have a low mileage engine and a bit of cash to spare, you can bolt a turbo or supercharger to the stock engine and get results. If you have a higher mileage engine, we'd advise using this as time to uprate the engine internals and go low compression. Turbo conversions, by their nature, put more stress on the engine internals, so the limit of power achievable on stock compression is less than a supercharger's capability. Power figures are headline grabbing, with anything from 450bhp right up to 600bhp possible. It's far better and more reliable to decompress the engine with uprated head gasket, lower compression pistons, new stronger con rods (a weak spot with forced induction conversions) and uprated head and rod bolts. If your engine is high on miles it's worth replacing the crankshaft bearing shells too. If you're desperate to go turbo and haven't got the money for all the uprated low compression parts, CA Auto can use a double-steel lined head gasket to drop compression, but you won't be able to run so much boost. Turbo conversions start

from around \$6000 and go right up to \$9000.

Supercharging is more popular for the S50 and S52 engines as it's a more linear power delivery. No one buys an M3 to be peaky and all-or-nothing.

There's more power to be had before reinforcing with a supercharger conversion (compared to a turbo). CA Auto reckons it's not unheard of to get 450-500bhp with a strong standard engine, but that's not for flat-out everyday use. If you can afford to go low compression then there's potentially enough power available to see dyno numbers of around 550-570bhp. Conversion prices are all dependent on the level of power and the condition of the engine, but they will be around those for a turbo conversion mentioned above.



BUDGET: FROM £500 – £1000

Start with the affordable bits to get the ball rolling: lose the viscous fan and lighten the drag load with uprated pulleys. These will both help gain faster engine pick up and surprisingly a few bhp to boot. Get better breathing, more power and superb induction noise from an enclosed air box system from the likes of K&N, Simota or BMC. With this lot you'll have already picked up a handful of bhp for your budget.

FROM £1000 – £2000

This is where power increases start to get noticeable. Once we sort the induction side of things (above) we can look at the exhaust system. A top-notch system like we mentioned will not only give good power, but will substantially reduce the car weight as the factory system weighs a lot. To increase power, budget for around a grand to replace the catalysts with 100-cell race cats from a tuner selling big brands. Use the rest of your budget to choose a suitable rear exhaust system in whatever design you want. A decent exhaust will transform the sound of your M3 and add around 20-30bhp with the race cats fitted.

OVER £5000

The limit for n/a mods is pretty much reached now. To get more power you'll be looking at a supercharger or turbo conversion. Remember your M3 may become less suitable for road use with a power band high up the revs and small amounts of torque at low revs. Both conversions will give you anything up to 550bhp peak power. You can get more power on stock internals with supercharging due to the more linear power delivery: worth bearing in mind if the budget's tight.

USEFUL CONTACTS

CA Auto Tech:
0871 231 1010

www.ca-automotive.co.uk

Thorney Motorsport:
01908 238798

www.thorneymotorsport.co.uk

ETA Motorsport:
01474 850505

www.etamotorsport.co.uk

Bexley Motor Works:
0845 345 2306

www.bmsport.com

C3:
020 8778 0808:
www.c3bmw.co.uk

Custom Cars:
07958 432167

A Tech:
07787 114963

