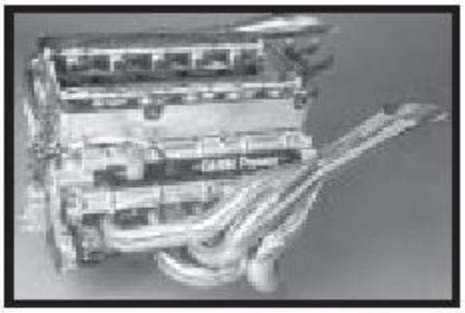
DINAN'S E46 M3 EXHAUST

By: Steve Dinan

After many months of development and far too many dyno-runs to count, our Free Flow Exhaust for the M3 is now shipping. I really couldn't be happier with the finished product as our team of engineers were able to accomplish every goal I had established for the performance muffler: improved flow for increased power, reduction of weight, a "throaty" exhaust note and a purposeful high performance look.

As our M3 exhaust employs a very unique design approach in order to accomplish our objectives, I thought that perhaps a more technical discussion on the subject might be of interest to performance enthusiasts. This paper will discuss a bit of general exhaust theory, the specific approach we have employed for the E46 M3 exhaust, as well as attempt to dispel some common misconceptions about exhaust tuning.

Exhaust Theory



BMW F1 Engine

There are two major areas of the complete exhaust system that are typically tuned for enhanced performance; the exhaust manifold .or header and the rear muffler(s). The exhaust manifold's length, tubing diameter and the manner in which each cylinder is linked to the other is critical when attempting to maximize an engine's power output. The manifold configuration can be manipulated in order to generate maximum power at low, middle or high rpm, changing the shape of the power curve accordingly. Naturally some compromise must be accepted when tuning an exhaust manifold for a street-car as the goal is typically to ensure balanced power output at low, middle and high rpm. This is in contrast to a race-engine where the exhaust manifold can be tuned specifically for maximum performance at high rpm.

After the exhaust manifold or header, optimum performance comes from making the balance of the exhaust system as short and large as possible. This approach will result in greater engine efficiency for maximum power, as well as minimizing the weight of the system. Probably the best example of an optimized, no-compromise exhaust system would be that of an F1 racecar. If you have ever had the opportunity to hear an F1 exhaust note, I think you will agree that it is best described as deafening. Clearly an exhaust system that even approached such a volume level in a performance street-car would draw far too much of the wrong sort of attention. Therefore, a modern street-car exhaust represents a number of performance compromises in order to achieve an acceptable exhaust volume, as well as meeting emissions standards.

In order to accommodate the various components and baffling necessary for a street-car, the exhaust system becomes longer and the flow of gasses more circuitous as noise and emissions standards are addressed. Each bend in the exhaust tubing, catalytic converter, resonator and so forth introduces restrictions to the exhaust flow, particularly at higher rpm where flow is most critical. Exhaust flow can actually reach hundreds of miles per hour when the engine is producing maximum power, which results in power robbing friction along the exhaust tubing walls, particularly when the gasses must change direction. This friction results in increased backpressure that can be quantified with a pressure gauge. In addition to the friction issue, a tube or opening that is too small will result in extra backpressure as well. This backpressure restricts the amount of gasses that can be passed through the engine, resulting in a reduction of peak power.

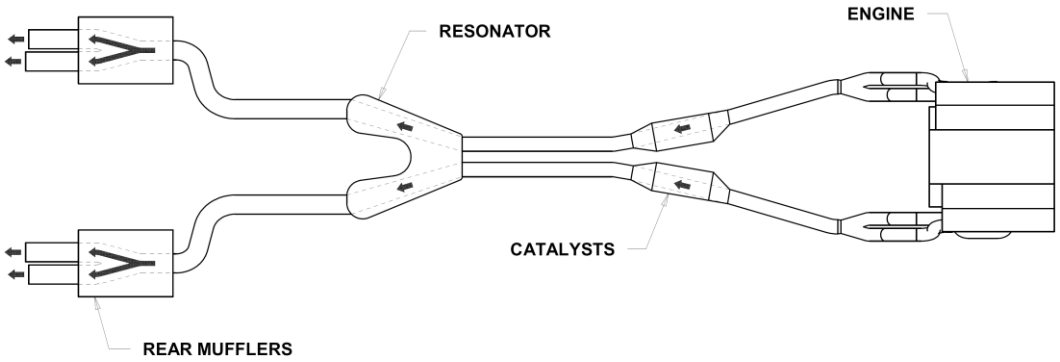
I'm fairly certain that many of you have been exposed to a "bench racing legend" that would have you believe that increased backpressure will improve low rpm power and that low backpressure will increase high rpm output. Nothing could be further from the truth. An exhaust system is sized for maximum flow at wide-open-throttle and peak rpm. All exhaust systems are "oversized" for lower engine speeds (rpm), as backpressure is so insignificant that it can't even be measured. Less back-pressure always results in more

power at higher rpm, with no negative effect on lower engine speed performance. The amount of power that can be extracted from an engine at a given rpm as a result of exhaust design is really limited by the exhaust manifold or header. After the header, less backpressure is always better.

The real challenge when tuning a street-car exhaust is to increase flow without making the system so loud as it becomes unacceptable or even illegal. It is also important to understand that vehicle manufacturers must meet more stringent maximum volume requirements than aftermarket manufacturers.

BMW's current M-cars feature a distinctive quad exhaust tip design, punctuating the cars' high performance image. This approach is very logical when applied to a "V" engine configuration because there are natural dual exhaust outputs with this engine design, as indicated in the following diagram. It should be noted, however, that packaging issues will certainly effect whether or not a dual muffler approach is feasible for a given BMW model, such as in the case of the 540 where a single muffler is employed as there is no space available for a second muffler.

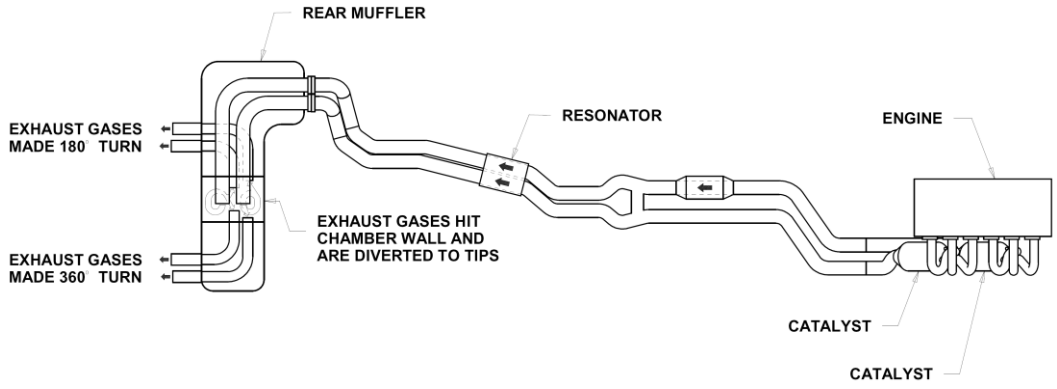
BMW M5 Exhaust (top view)



In this case, the engine and vehicle design lend themselves to a dual exhaust configuration as it does not require the introduction of additional bends or changes in the direction of exhaust flow, making it a perfectly logical approach for maximum flow and the resulting power gains.

When it comes to the E46 M3 muffler, however, the vehicle design apparently did not lend itself to the more traditional twin muffler approach, necessitating a "split" within the single muffler case in order to feed the four tips. This design requires that the exhaust flow changes direction, as indicated in the following diagram, increasing back pressure. As there is clearly no room available to install a second muffler on the M3, improved flow had to come from design changes within a single muffler case.

E46 M3 Stock Exhaust (top view)



Literally months of testing demonstrated conclusively that requiring exhaust gasses to make 180 and 360 degree turns within the stock muffler's internal chamber results in a large increase in back-pressure. Our pressure-tap measurements indicated 1.1 PSI at peak power (333 hp @ 7900 rpm). Analyzing other after-market manufacturer's mufflers revealed high backpressure readings as well, due to the fact that they employ a similar design to the stock system, albeit with larger internal chambers and tubing. This particular design also results in an exhaust note that is, apparently, unappealing to many M3 owners. The additional components necessary to direct the exhaust gasses to the four tips also increases the weight of the systems.

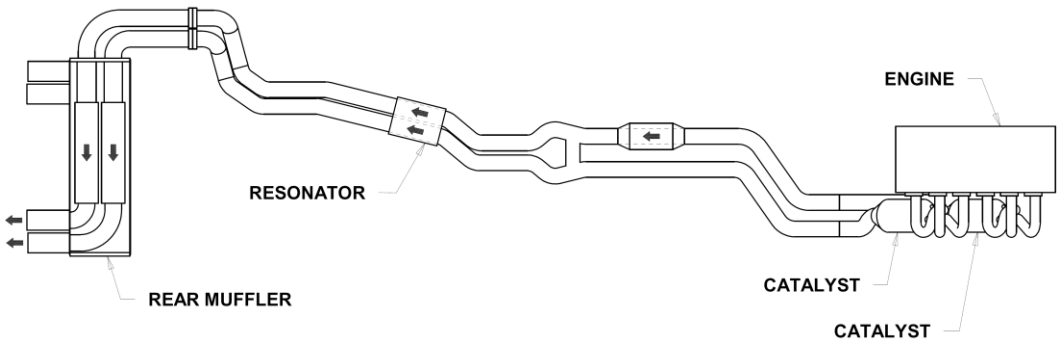
Despite mounting pressure from M3 owners to deliver the Dinan exhaust, we made a conscious decision to continue working toward a design that accomplished our stated objectives. While we certainly would have preferred to begin shipping the systems sooner, I simply won't accept compromises when it comes to performance. We worked and worked at designs that would maintain the dual exhaust outlets, but each iteration resulted in a heavy, tinny sounding exhaust note with far too much back-pressure to produce any substantial power gains.

The Dinan Solution

After analyzing many designs, we came to the conclusion that a more radical approach was required in order to produce a truly high performance exhaust. Further pressure tests and dyno runs confirmed our suspicions about the best approach for the E46 M3 muffler. Adopting a completely new design approach resulted in a significant improvement in flow, reducing backpressure by 82% at only .2 PSI. The exhaust note became throaty and aggressive, without being so loud that it would disturb or annoy any self-respecting enthusiast. Weight was reduced from 58 to 43 lbs., relieving the load by a full 26%.

As you can see from the diagram below, our M3 exhaust utilizes the two outlets on the right side of the muffler only. Recognizing that the four tips have become a significant visual design element for modern M-cars, as well as the fact that the rear valance has a cut out for the tips on the left side, the second set of tips were retained. While they are non-functional, the Mcar look is retained without compromising performance. The 3" tips have been ceramic coated for a striking high performance look, while eliminating any concern over uneven discoloration that would occur with polished stainless. Surveys conducted among M3 owners verified that the audible source of the exhaust output could not be pinpointed as coming from one side or the other. The Dinan Free Flow Exhaust was ready for production.

Dinan Free Flow Exhaust (top view)



The system produces measurable power gains, looks great and produces the exhaust note M3 owners have been waiting for. I believe that this latest exhaust design underscores the importance of real engineering, extensive testing and employing the highest quality materials. BMW-like fit and finish combined with the best warranty in the business makes for the definitive solution for your high performance M3 exhaust.