

TUNER TECH

INK & PICS: DREW HARDIN

GOT Boost

Part One—The PES Solution to 1.8T Performance

Tech Facts

PES T-28 1.8T turbo system, including Garrett T-28 turbocharger, cast exhaust manifold, fuel injectors, custom ECU tuning, new mass-air sensor, intake plumbing

MSRP: \$3,799

Additional Info: The 2000 Passat receiving the PES kit was also modified with a custom air box, Spearco intercooler, auxiliary transmission cooler, plasma ignition coils, racing-style catalytic converter and a custom 3-inch stainless steel exhaust system

Shameless Plug: PES, 877/697-1688, www.pes-tuning.com

Additional Plugs: Coast Fabrication (custom exhaust system), 714/842-2603, Morgan Motorsports (dyno), 866/700-4MMS

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No doubt you've seen plenty of advertisements and magazine articles touting the performance improvements available by upgrading the turbocharger in a VW/Audi 1.8T engine. In fact, just a few pages away is a buyer's guide full of turbo kits and manufacturer's estimates of power gains.

If you're shopping for one of these kits, you face a real dilemma. How do you sort out the claims made by the various manufacturers? One way to do it is to take a close look at how the kit is supposed to improve power. Does it just stuff more air into the engine, or does it also address other tuning factors like fuel, ignition, and exhaust? Another good rule of thumb: Does the manufacturer back up its

power claims with real data? Talking big is easy. What's tough is backing up the talk with hard numbers pulled off of a dynamometer.

To give you an idea of how to go through the "homework" process, we thought we'd take a closer look at one of the 1.8T kits on the market for an A4/Passat: The T-28 Turbo System from Performance Engineered Systems (PES). This system caught our eye for one big reason—the turbocharger. While some manufacturers replace the stock KO3 turbo with a KO4 or a KO3/O4 hybrid, the PES system uses a Garrett T-28 turbo that's downright huge compared to the stock piece. Size matters in this case, as the T-28's ability to flow

large quantities of air is a key element in this system's power equation.

To get more power, you have to get more air into the motor, and that is essentially what a turbocharger does. However, putting more air "in" doesn't do you much good if you can't also get the exhaust air "out." To make optimal power, you have to get air through the engine, not just in. That's why PES went with the Garrett turbocharger. Both the turbine (the half of the turbo that is spun by exhaust gases) and the compressor (the other wheel that is driven by the turbine and pushes air into the intake

system), are far larger and flow a higher volume of air than the stock KO3 or even the KO4 turbo that other tuners use to upgrade the 1.8T. In addition, the PES kit includes a new cast exhaust manifold with larger runners to speed the feeding of the turbo unit, along with new intake plumbing, a larger mass-air meter, and a low restriction air cleaner to improve fresh airflow.

Airflow is a big part of what the T-28 system brings to the party, but that's not the end of it. Pushing a bunch more air into the engine won't make engine control issues to deal with as

well. You can't make more power without adding fuel to the air. So the PES kit includes RC Engineering fuel injectors that provide almost double the flow of the stock injectors.

Now, doubling the fuel flow can be a good thing under certain conditions, like wide-open throttle, for example. But what if you're just cruising down the highway? Do you still need twice the fuel? Uh, no. So PES, along with its partner Garrett Integrated Automotive Corporation (GIAC), spent a ton of R&D time configuring new computer controls to effectively map fuel delivery, ignition timing, and other factors to maximize the engine's potential throughout the rev range, given its new, higher air and fuel capacity. In order to get the new tuning software in the Passat's ECU, you have to send the computer to PES.

In its marketing literature, PES claims this turbo kit will pump 1.8T power production up from the stock output of 150 horsepower to about 270 horses with 270 lb-ft of peak torque. To back up these claims, PES published a series of dyno pulls on its website. In a test of a 2000 Passat, horsepower measured at the wheels went from 131 in stock configuration to 234 with the PES kit. Torque climbed from 144 lb-ft at the wheels to 239. PES figured a 15-percent power loss between the engine and the wheels, so it calculated flywheel horsepower for the modified motor at 269.7 and torque at 275 lb-ft. And those were conservative numbers, says PES, since the test mule still had its stock exhaust. Open up the breathing behind the motor, and the T-28 system could produce in excess of 300 horses.

To see if we could prove that, we contacted a local Passat owner, Femi Adegoke, who was in the process of building up his 2000 sedan and had a PES turbo upgrade kit on his to-do list. We watched over his shoulder as he bolted the kit into the car, and we'll be there when he takes his finished VW to a chassis dyno to see the results.

Femi's car is a good example of one that could break the 300-horse threshold. His Passat was far from stock before the turbo upgrade began. Femi had already added a custom air intake box (fed by a big duct under the bumper), a Neuspeed 2 1/4-inch after-cat exhaust system to help his engine breathe, a big Spearco intercooler mounted low on the VW's nose to chill the intake charge, and a set of

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Ignition Solutions plasma coil packs for a hotter ignition and better burn. With these mods in place, Femi took his Passat to the Dynojet chassis dynamometer at Morgan Motorsports in Reseda, California, and spun the drums to just a tick below 153 horsepower. Using PES' 15-percent factor, that meant Femi's 1.8T was already producing 176 horses at the flywheel, a 26hp gain.

Plus, while Femi had the Passat apart to mount the new turbo, he had some other mods in mind, too. He was going to swap out the stock catalytic converter for a Random Technology high-flow, metal-substrate cat. And the Neuspeed exhaust would be exchanged for a fully custom 3-inch stainless system. So no one really knew what the turbo would be capable of.

Sadly, we can't tell you yet. Magazine deadlines crashed head-on into precious shop time and kept us from getting the car finished before press time. But stay tuned for Part Two on Femi's Passat, including the low-down on the "after" dyno pulls.

1 The major components in the PES T-28 Turbosystem for 1.8T engines includes the Garrett T-28 turbocharger, new intake plumbing and low-restriction air cleaner, new cast exhaust manifold, high-flow fuel injectors, a blow-off valve, oil lines, and other plumbing and hardware. The heat shield didn't make it into the picture—it was just too damn big.

2 Check out the size difference between the Garrett T-28 turbo that's going into the Passat (*on the left*) and the stock K03 turbo that came out of it. Both the compressor (*on the intake side*) and the turbine (*on the exhaust side*) are substantially larger, to increase air flow both into and out of the engine. Getting air in and out is key to making big power.

3 Another comparison view of the T-28 (*left*) and K03 turbos illustrates just how much bigger the Garrett turbine is. Yes, it takes more exhaust to spin the larger wheel, but flow capacity on the compressor side is also increased. Plus, since the turbine housing is so much bigger, the greater volume of air spools the turbo up quickly, with little lag.



4 To feed that big compressor, PES has designed a cast exhaust manifold (*top*) with larger runners than the stock manifold. The high nickel content in the manifold makes it harder and more durable than the stock piece, so it'll better withstand the turbo's heat generation.

5 There's a lot to remove, disconnect, and set aside in the engine compartment before you can get to this step. The engine covers must come off, the stock air filter, air box, and all intake plumbing must be disconnected. The turbo must be disconnected from the exhaust manifold and the exhaust outlet, and all the oil and water lines must be taken off the turbo. It gets messy, so have some rags on hand to catch the leaking fluids. Then it's time to pull out the stock K03. When the turbo is out, remove the exhaust manifold.

6 Because the PES kit includes new fuel injectors, the stock injectors must be removed. Of course, this is a bit more complex than the photo shows, as all fuel lines and the fuel rail must be unhooked first. Have rags handy to catch any leaking fuel.

7 There's just a bit of difference between the stock fuel injectors (*on the right*) and the RC Engineering SL4-440 injectors used in the PES kit. The stock injectors flow about 240ccs per minute, the RC units will flow between 439 and 442.

8 The turbo installation begins with the mounting of the new exhaust manifold. Since the turbo must bolt to the underside of the manifold, it doesn't seem to make sense to put the manifold on first, but there's a bolt under the runners that would be impossible to reach with the turbo in place.

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9 There are several components that should be attached to the turbo before it goes in the car. These are the studs that hold the exhaust adapter to the turbine.

10 The exhaust adapter bolts to the turbine. The adapter was designed so that the exhaust flange is in the same position as the stock piece, so it will work with the car's stock exhaust, or an aftermarket system.

11 Next, fittings are attached to the turbo housing to allow coolant and oil in and out of the unit. This is the oil drain flange, which is attached to the braided-steel oil return line. The other end of this line runs to the oil pan.

12 With the exhaust manifold already on the engine it takes some maneuvering and wiggling of the turbo to get it to slide into place. It has to fit under the manifold, while the exhaust adapter pipe must be flush with the cat. Clearance is tight, but it does go in eventually.

13 Once the turbo is aligned properly, it bolts to the exhaust manifold *[where the wrench is]* and to the catalytic converter.

14 When the turbo is fastened in place, it's time to plumb the oil and coolant supply and drain lines.

15 Now it's time to begin fitting the intake pipes. A blue silicon collar goes on one end of the intake tube, and the other end is bolted to the compressor housing.

16 That silicon collar holds the engine's mass-air meter in place. The PES kit includes this mass-air-meter housing, which is much larger than the stock piece. The stock mass-air sensor is re-used and installed in the new housing. By using the new, larger housing, the sensor can accurately meter a greater volume of air throughout the engine's entire rev range and right up to redline. PES has found that the smaller stock housing can reach its effective limit with air flowing at engine speeds of only 4,200 to 4,600 rpm.

17 The low restriction air filter fits on the mass-air-meter housing, and then the filter/housing combo slides in place on the intake tube. Clamps hold the whole assembly in place.


18 This is the large heat shield that didn't fit into the kit photo at the beginning of the article. It effectively blocks heat coming from the turbo so it won't affect the temperature of the incoming air. The bottom of the shield attaches to the rubber plugs that held the bottom of the stock air box.

19 The top of the shield is held in place with this small strut, which also attaches to a mount point on the inner fender for the stock air box.

20 Here's how the Passat's engine bay looked after all the plumbing, fuel lines, and electricals were reconnected. All that's missing are the engine covers. Remember earlier how we said the heat shield "effectively blocks heat" coming from the turbo? After driving the car for an hour or so, Femi measured temperatures on either side of the shield and found nearly a 200-degree F difference between the turbo side (around 270-280 degrees) and the intake side (between 88 and 95 degrees). Meet back here next month to see how the PES-tuned 1.8T Passat fared on the dyno.



anticipates spending some time with his VW on the track, he had Coast Fabrication design a cat-bypass tube that can be slipped in place of the Random cat when it's time to do some hot laps. The bypass is definitely for "off-road" use only.

Now, before you call Coast Fab for a system for your own car, understand that theirs is a custom fabrication business. They cater primarily to full-competition race cars, but do some import and hot rod fabbing on the side. They do not have these Passat systems in stock awaiting shipment. The Coast engineers got under Femi's VW with a bunch of elbow-bent and straight pipes and mapped out a system for this particular car. The only way you can have one like it is if you're willing to bring your car to them and pay what it takes for craftsmen to build a one-off exhaust system. 

The Exhaust Equation

As PES so adamantly points out, you need to get air both in and out of an engine to make peak power. A turbocharger does a good job of force-feeding air into the motor, but you should also ensure that your car's exhaust system is up to the more demanding evacuation task.

Femi Adegoke had already equipped his Passat with an aftermarket exhaust system, but he felt the power potential

of the T-28 warranted further modifications. So he pulled off the almost new 2¹/₄-inch exhaust and replaced it with a custom 3-inch, T-304 stainless steel pipe designed and built by Coast Fabrication. In addition, he replaced the stock catalytic converter with a Random Technology racing cat that not only has a larger core diameter than the stock unit, but uses a metal substrate to promote greater flow.

But Femi wasn't done yet. Since he