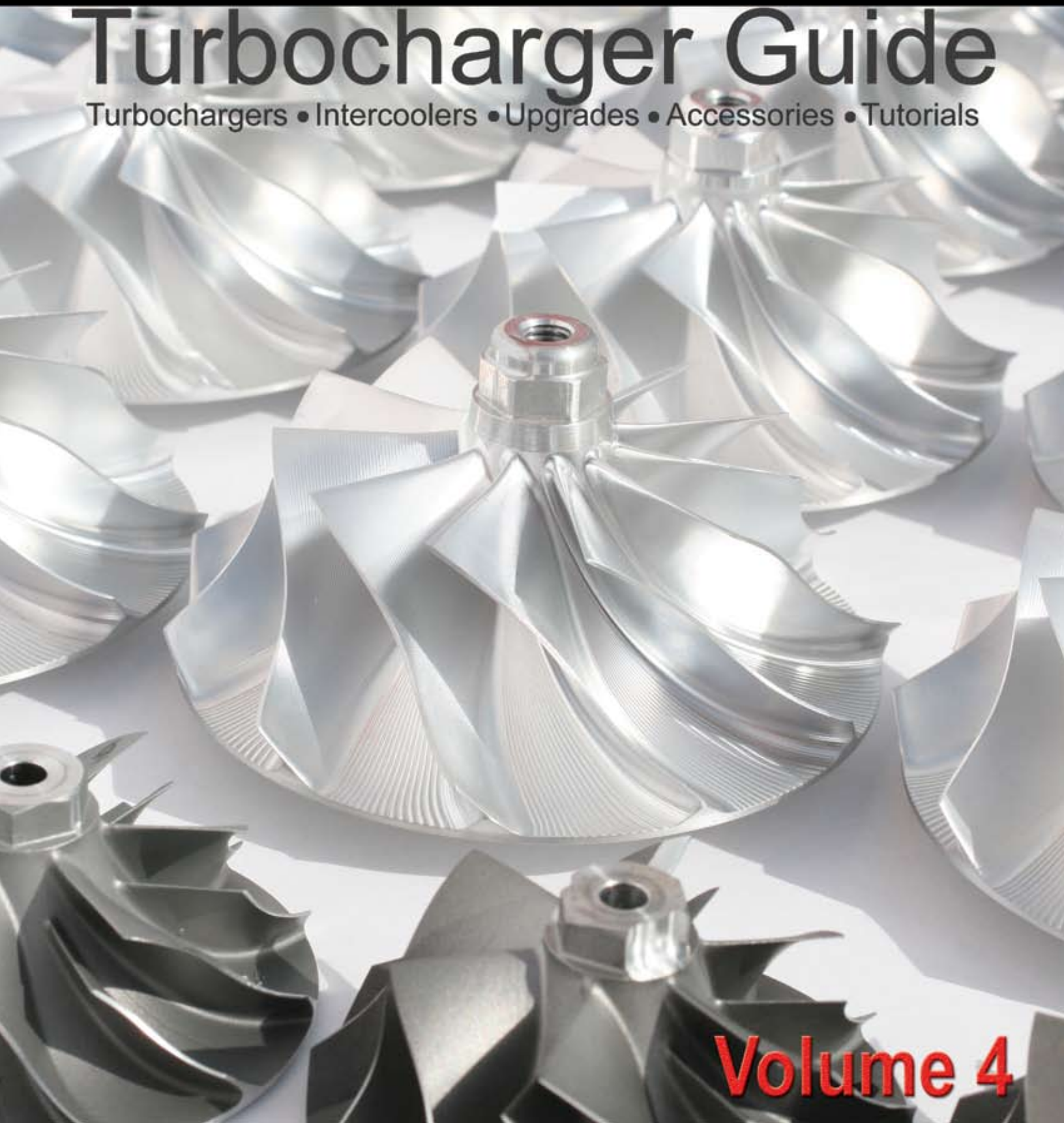


Garrett[®]

by Honeywell

Turbocharger Guide

Turbochargers • Intercoolers • Upgrades • Accessories • Tutorials



Volume 4



Rick Snavely-Ford Mustang-Twin GT5518R



Audi R15 Plus TDI - Twin VGT TR30R



Michael "Tex" Blackwell-Honda Civic-GTX4508R



Dave Brown-Mitsubishi Evo X-GT3076R Evo X Upgrade



Kyle Carter-Drag Rail-GT4202R & GT6041



Art Dick-Freightliner-(4) GT6041



Edmunds.com-Mitsubishi Evo X Upgrade



Andy Green - JCB DieselMAX - GT45 & GT55



Jason Greenwalt-Nissan 240SX-GT4718R



Scott Hovey-Dodge Ram-GT4202R



Dean Kearney-Nissan Silvia-GT3076R



Lisa Klassen-Mitsubishi Evo VIII-GT3582R



David Lott - Ford F350 - GT45R



Patrick McSwain-GMC 2500 Duramax-GT4718R



Elliot Moran-Mitsubishi Evo X-Evo X Upgrade



Pat Moro-Subaru WRX STI-GT3582R



Keith Neal-Ford Mustang-Twin GT5518R



Tom Paule-Nissan Sentra-GT3071R



Tony Perry-Mitsubishi Evo X-Evo X Upgrade



Peugeot 908 HDI FAP - Twin TR30R



George & Rocky Rehayem-Mazda MX6-GT5533



Gino Reyna - Subaru WRX STI - GT4088R



Jonathan Reynolds-Acura Integra-GTX4502R



James Robinson-Honda Element-Twin GT2560R



Steven Ruiz-Mitsubishi Evolution X-GT3582R



Conrad Scarry-Ford Mustang-Twin GT5518R



Carl Stevens Jr.-Chevrolet Camaro-Twin GT5533R



Annette Summer-Chevy BelAir-Twin GT5533R



David Swain-Dodge Ram-Cummins Upgrade Stg 2



Yukio Tiara-Subaru WRX-GT3076R



Kenny Tran-Scion TC-GT4508R



Stephan Verdier-Subaru WRX STI-GT3788R



"Wild" Bill Warner-Suzuki Hayabusa-GT4088R



Daniel Willie-Nissan 240SX-GT2871R



Tarzan Yamada-Subaru WRX STI-GT3788R

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Garrett® History

The heritage of the turbo business began in 1936 when young Cliff Garrett formed his company in a tiny, one-room office in Los Angeles. With encouragement and financial support from friends like Jack Northrop and Harry Wetzel, plus \$5,000 he borrowed on his own, Garrett founded the company that would later become the Garrett Corporation. Number of employees: 1. Number of customers: 1.



Today, that business couldn't be more different. Over time, the turbocharging business spun off to establish itself as a serious player in the engine boosting industry. Garrett® product is produced by over 6,000 employees and serves the leading global engine and vehicle manufacturers, including Audi, BMW, Chrysler, Daimler Benz, DDC, Fiat, Ford, General Motors, International Truck Co, Nissan, Peugeot, Renault, Saab and Volkswagen.

Through names such as AiResearch, AlliedSignal, and the Honeywell of today, Garrett® has sustained its reputation for revolutionizing turbocharger technologies generation after generation. From its long list of industry firsts to its leading-edge patented dual-ball bearing turbos for high performance vehicles, Garrett® develops and manufactures the same cutting-edge boosting expertise that goes into all Garrett® products. The fact that Garrett® turbochargers are the preferred choice of leading original equipment manufacturers and many top race teams in World Rally, American Le Mans, 24 Hours of Le Mans, and Pikes Peak is a telling example.



Today, Garrett® continues to redefine the art and science of boosting technology with advanced air management systems for the full spectrum of modern engines. With over 30,000 turbos produced EVERY DAY, you know the Garrett® name is one you can trust.

Garrett® Testing

A turbocharger is a highly technical product that requires superior design and intensive capital to produce. It must meet the most severe requirements that only a world-class manufacturer like Honeywell's Garrett® brand can achieve.

Garrett® is one of the few brands that subjects its turbos to several OE qualification tests that ensure that "Garrett" is only stamped on safe and reliable turbos! Some of these tests include:

* **On-Engine Durability** - A 1,000-hour general turbocharger durability test that is run on-engine in an engineering laboratory.

* **Compressor & Turbine Housing Containment** - A compressor/turbine wheel is set to "hub" burst at a specific speed. No portion of the wheel is allowed to penetrate a "containment shroud" surrounding the turbocharger; a test to ensure safety.

* **Shaft Motion** - The maximum tolerances of the bearing system are tested for rotor-dynamic stability beyond the maximum turbocharger operating speed. This means no bearing problems and a long turbo life.



* **Compressor & Turbine Performance** - The entire operating range of both the compressor and turbine are mapped on a "Performance Gas Stand." These test cells are calibrated to strict standards to assure accuracy and consistency.

* **Heat Soakback** - A turbocharger instrumented with thermocouples is taken beyond maximum operating temperature and shut down hard! Repeat this test four more times and make sure maximum temperatures stay within strict limits to avoid oil "coking" or build up inside the center housing. This is particularly critical for high temperature gasoline applications.

* **Thermal Cycle** - A 200-hour endurance test that cycles the turbocharger from low temperature to "glowing red" every 10 minutes. To ensure long turbo life, no cracking of the turbine housing or distortion of the heat shroud is accepted.

* **Rotor Inertia** - A measurement made to document the rotational inertia of the compressor and turbine wheels. Garrett® brand products are known for their high flow / low inertia characteristics.



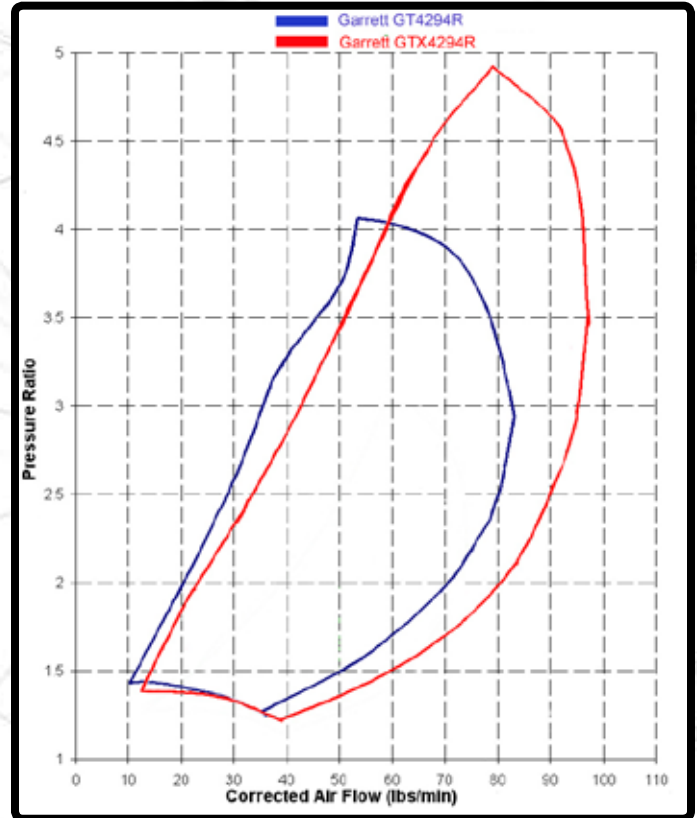
Visit www.TurboByGarrett.com for complete test list.

Garrett® GTX Turbochargers

The next step in the evolution of the turbocharger is here! Garrett® GTX Turbos feature all new compressor wheels with next generation aerodynamics and improved efficiency to deliver wicked performance!

Garrett® GTX Turbochargers provide higher flow and greater boost pressure ratios beyond the world-class Garrett® GT Series compressor wheels.

- * 10%+ Gain in flow over traditional GT compressor wheel designs
- * 10%+ Higher pressure ratio compared to traditional GT compressor wheel designs
- * Forged, fully machined wheels (billet) for expedited release
- * 11 Full-blade design for improved efficiency and ultra quiet operation
- * Outline interchangeable with Garrett® GT Series turbos
- * Garrett® OE-quality for unbeatable reliability



Garrett® Dual Ball Bearing

The journal bearing has long been the workhorse of the turbocharger. However, in the 1990's, Garrett® engineers developed a radically new and extremely efficient turbocharger. With wheel and bearing advances that provide crisp and strong throttle response up to 15% faster than traditional bearings, a Garrett® turbo will accelerate your vehicle more quickly than ever.

The patented dual ball bearing design also requires less oil to provide adequate lubrication. This in turn lowers oil volume and the chances for seal leakage. The lessened need for oil also makes the bearings more tolerant to marginal lube conditions and diminishes the possibility of turbocharger failure on engine shut down.

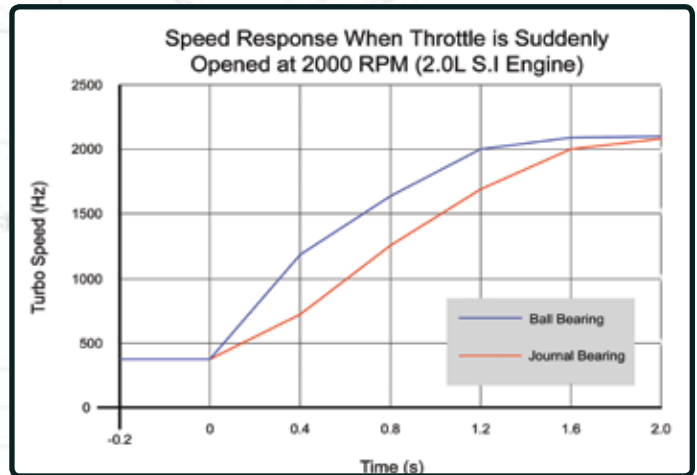
The Garrett® dual ball bearing cartridge gives better damping and control over shaft motion allowing enhanced reliability for both everyday and extreme driving conditions. The opposed angular contact bearing cartridge eliminates the need for the thrust bearing, commonly the weak link in the turbo bearing system. The bearing system in the GT turbocharger allows for improved shaft stability and less drag throughout the speed range.

While T-series turbos typically contain 54 components, GT turbos have an average of only 29. The 45% decrease in parts diminishes the opportunity for failure and results in smoother operation.

A Garrett® Turbo for Your Vehicle?

Garrett® is the only brand to offer a searchable database for turbo kits using its product.

Visit www.TurboByGarrett.com and enter your vehicle into our Turbo Application Search Engine (TASE) to find a turbo kit available for it using Garrett® turbochargers!



How a Turbo System Works

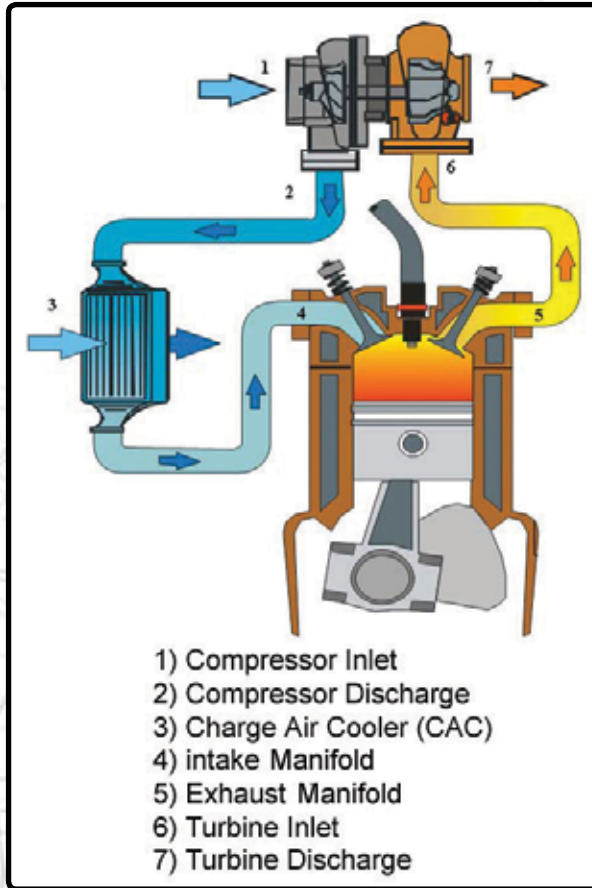
Engine power is proportional to the amount of air and fuel that can get into the cylinders. All else being equal, larger engines flow more air and as such will produce more power.

If we want our small engine to perform like a big engine, or simply make our bigger engine produce more power, our ultimate objective is to draw more air into the cylinder. By installing a Garrett® turbocharger, the power and performance of an engine can be dramatically increased.

The layout of the turbocharger in a given application is critical to a properly performing system.

So how does a turbocharger get more air into the engine? Let us first look at the schematic to the upper right.

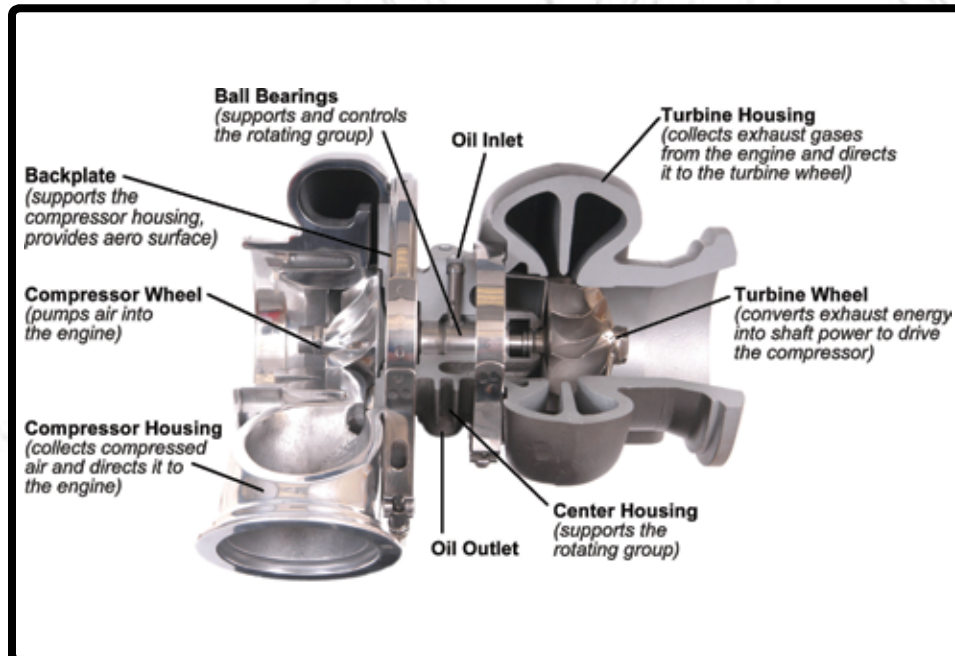
- Ambient air passes through the air filter (not shown) before entering the compressor [1].
- The air is then compressed which raises the air's density (mass / unit volume) [2].
- Many turbocharged engines have a charge air cooler (aka intercooler)



- [3] that cools the compressed air to further increase its density and to increase resistance to detonation.
- After passing through the intake

manifold [4], the air enters the engine's cylinders, which contain a fixed maximum volume. Since the air is at an elevated density, each cylinder can contain an increased mass of air. Higher air mass flow rate allows a higher fuel flow rate (with similar air/fuel ratio). Combusting more fuel results in more power being produced for a given size or displacement.

- After the fuel is burned in the cylinder, it is expelled during the cylinder's exhaust stroke into the exhaust manifold [5].
- The high temperature gas then continues on to the turbine [6]. The turbine creates backpressure on the engine which means engine exhaust pressure is higher than atmospheric pressure.
- A pressure and temperature drop occurs (expansion) across the turbine [7], which harnesses the energy of the exhaust gas to provide the power necessary to drive the compressor.



What are the Components of a Turbocharger?

- Compressor Housing
- Turbine Housing
- Center Housing and Rotating Assembly (CHRA)
 - Compressor Wheel
 - Turbine Wheel Assembly (wheel and shaft)
- Backplate
- Bearing System
- Oil Inlet
- Oil Outlet

How Do I Choose the Right Turbo?

Selecting the proper turbocharger for your specific application requires many inputs. With decades of collective turbocharging experience, the Garrett® Performance Distributors can assist in selecting the right turbocharger for your application.

The primary input in determining which turbocharger is appropriate is to have a target horsepower in mind. This should be as realistic as possible for the application. Remember that engine power is generally proportional to air and fuel flow. Thus, once you have a target power level identified, you begin to hone in on the turbocharger size, which is highly dependent on air flow requirements.

Other important factors include the type of application. An autocross car, for example, requires rapid boost response. A smaller turbocharger or smaller turbine housing would be most suitable for this application. While this will sacrifice ultimate power due to increased exhaust backpressure at higher engine speeds, boost response of the small turbo will be excellent.

Alternatively, on a car dedicated to track days, peak horsepower is a higher priority than low-end torque. Plus, engine speeds tend to be consistently higher. Here, a larger turbocharger or turbine housing will provide reduced backpressure but less immediate low-end response. This is a welcome trade-off given the intended operating conditions.

Selecting the turbocharger for your application goes beyond “how much boost” you want to run. Defining your target power level and the primary use for the application are the first steps in selecting the best Garrett® Turbo for your vehicle. This catalog includes the formulas and considerations needed to correctly match a turbo to either your gasoline or diesel engine!

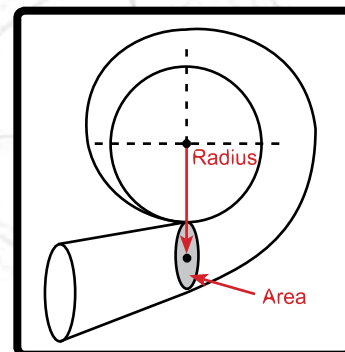
What is A/R?

A/R describes a geometric characteristic of all compressor and turbine housings. It is defined as the inlet cross-sectional area divided by the radius from the turbo centerline to the centroid of that area.

Compressor A/R - Compressor performance is largely insensitive to changes in A/R, but generally larger A/R housings are used to optimize the performance for low boost applications, and smaller housings are used for high boost applications. Usually there are not A/R options available for compressor housings.

Turbine A/R - Turbine performance is greatly affected by changing the A/R of the housing. Turbine A/R is used to adjust the flow capacity of the turbine.

Using a smaller A/R will increase the exhaust gas velocity into the turbine wheel, causing the wheel to spin faster at lower engine RPMs giving a quicker boost rise. This will also tend to increase exhaust backpressure and reduce the max power at high RPM. Conversely, using a larger A/R will lower exhaust gas velocity and delay boost rise, but the lower backpressure will give better high-RPM power. When deciding between A/R options, be realistic with the intended vehicle use and use the A/R to bias the performance toward the desired powerband.



What is Wheel Trim?

Trim is an area ratio used to describe both turbine and compressor wheels. Trim is calculated using the inducer and exducer diameters.

$$\text{Trim} = (\text{Inducer}^2 / \text{Exducer}^2) \times 100$$

Example:

Inducer diameter = 88mm

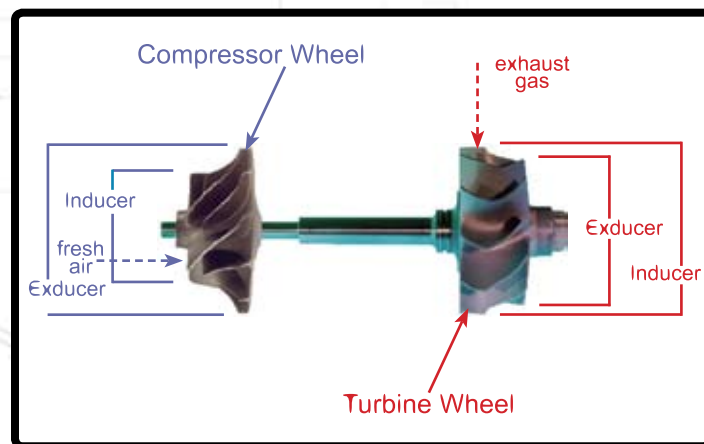
Exducer diameter = 117.5mm

$$\text{Trim} = (88^2 / 117.5^2) \times 100 = 56 \text{ Trim}$$

As trim is increased, the wheel can support more air/gas flow.

$$\text{Compressor Wheel Trim} = (\text{Inducer}^2 / \text{Exducer}^2) \times 100$$

$$\text{Turbine Wheel Trim} = (\text{Exducer}^2 / \text{Inducer}^2) \times 100$$



Other Components

Blow-Off (Bypass) Valves

The blow-off valve (BOV) is a pressure relief device on the intake tract to prevent the turbo's compressor from going into surge. The BOV should be installed between the compressor discharge and the throttle body, preferably downstream of the charge air cooler (if equipped).

When the throttle is closed rapidly, the



airflow is quickly reduced, causing flow instability and pressure fluctuations. These rapidly cycling pressure fluctuations are the audible evidence of surge. Surge can eventually lead to bearing failure due to the high loads associated with it.

Blow-off valves use a combination of manifold pressure signal and spring force to detect when the throttle is closed. When the throttle is closed rapidly, the BOV vents boost from the intake tract to atmosphere or recirculates it to relieve the pressure from the turbo, eliminating surge.

Wastegates

On the exhaust side, a wastegate provides a means to control the boost pressure generated by the turbocharger by controlling the turbocharger shaft speed. Some commercial diesel applications do not use a wastegate at all. This type of system is called a free floating turbocharger.

However, the vast majority of gasoline performance applications require a wastegate. There are two configurations of wastegates: internal and external. Both internal and external wastegates provide a means for exhaust gas to bypass the turbine wheel. Bypassing

this energy (e.g. exhaust flow) reduces the power driving the turbine wheel to match the power required for a given boost level. Similar to the BOV, the wastegate uses boost pressure and spring force to regulate the flow bypassing the turbine.



Internal wastegates are built into the turbine housing and consist of a "flapper" valve, crank arm, rod end, and pneumatic actuator. It is important to connect this actuator only to boost pressure since it is not designed to handle vacuum and as such should not be referenced to an intake manifold.



External wastegates are added to the exhaust plumbing on the exhaust manifold or header. The advantage of external wastegates is that the bypassed flow can be reintroduced into the exhaust stream further downstream of the turbine. This improves the turbine's performance. On racing applications, this wastegated exhaust flow can be vented directly to atmosphere.

Oil & Water Plumbing

The intake and exhaust plumbing often receives the focus, leaving the oil and water plumbing neglected.

Garrett® ball bearing turbochargers require less oil than journal bearing turbos. Therefore an oil inlet restrictor is recommended if you have oil pressure over approximately 40 psig. The oil outlet should be plumbed to the oil pan above the oil level (for wet sump systems). Since the oil drain is gravity fed, it is important that the oil outlet points downward, and that the drain tube does not become horizontal or go "uphill" at any point.



Following a hot shutdown of a turbocharger, heat soak begins. This means that the heat in the head, exhaust manifold, and turbine housing raises the temperature of the turbo's center housing. These extreme temperatures can result in oil coking.

Water-cooled center housings were introduced to minimize the effects of heat soak-back. These use unpressurized coolant from the engine to act as a heat sink after engine shutdown, preventing the oil from coking. The water lines utilize a thermal siphon effect to reduce the peak heat soak-back temperature after key-off. The layout of the pipes should eliminate peaks and troughs with the (cool) water inlet on the low side. To help this along, it is advantageous to tilt the turbocharger approximately 25° about the axis of shaft rotation.

Garrett® offers many turbos that are water-cooled for enhanced durability.

Want to learn more?

Visit <http://www.TurboByGarrett.com> and check out the Turbo Tech section for more great articles!

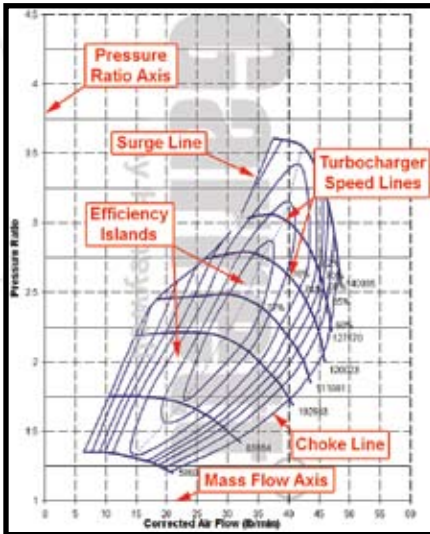
This article is more involved and will describe parts of the compressor map, how to estimate pressure ratio and mass flow rate for your engine as well as how to plot the points on the maps to help choose the right turbocharger. Have your calculator handy!

Parts of the Compressor Map

The compressor map is a graph that describes a particular compressor's performance characteristics, including efficiency, mass flow range, boost pressure capability, and turbo speed. Shown below is a figure that identifies aspects of a typical compressor map:

Pressure Ratio

Pressure Ratio (Π_c) is defined as the Absolute outlet pressure divided by the Absolute Inlet Pressure.



Where:

Π_c = Pressure Ratio

P1c = Compressor Inlet Pressure

P2c = Compressor Discharge Pressure

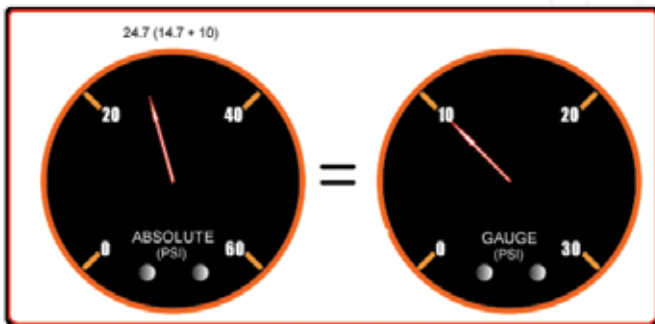
It is important to use units of Absolute Pressure for both P1c and P2c. Remember that Absolute Pressure at sea level is 14.7 psia (in units of psia, the "a" refers to "absolute"). This is referred to as standard atmospheric pressure at standard conditions.

Gauge Pressure (in units of psig, the g refers to "gauge") measures the pressure above atmospheric, so a Gauge Pressure reading at atmospheric conditions will read zero. Boost gauges measure the manifold pressure relative to atmospheric pressure, and thus are measuring Gauge Pressure. This is important when determining P2c. For example, a reading of 12 psig on a boost gauge means that the air pressure in the manifold is 12 psi above atmospheric pressure.

For a day at standard atmospheric conditions:
12 psig + 14.7 psia = 26.7 psi Absolute Pressure in the manifold,
the Pressure Ratio at this condition can now be calculated:

$$26.7 \text{ psia} / 14.7 \text{ psia} = 1.82$$

However, this assumes there is no adverse impact of the air filter assembly at the compressor inlet.



In determining Pressure Ratio, the Absolute Pressure at the compressor inlet (P2c) is often LESS than the Ambient Pressure, especially at high load. Why is this? Any restriction (caused by the air filter or restrictive ducting) will result in a "depression," or pressure loss, upstream of the compressor that needs to be

accounted for when determining pressure ratio. This depression can be 1 psig or more on some intake systems. In this case P1c on a standard day is:

$$14.7 \text{ psia} - 1 \text{ psig} = 13.7 \text{ psia at compressor inlet}$$

Taking into account the 1 psig intake depression, the pressure ratio is now.

$$(12 \text{ psig} + 14.7 \text{ psia}) / 13.7 \text{ psia} = 1.95.$$

That's great, but what if you're not at sea level? In this case, simply substitute the actual atmospheric pressure in place of the 14.7 psi in the equations above to give a more accurate calculation. At higher elevations, this can have a significant effect on pressure ratio.

For example, at Denver's 5000 feet elevation, the atmospheric pressure is typically around 12.4 psia. In this case, the pressure ratio calculation, taking into account the intake depression, is:

$$(12 \text{ psig} + 12.4 \text{ psia}) / (12.4 \text{ psia} - 1 \text{ psig}) = 2.14$$

Compared to the 1.82 pressure ratio calculated originally, this is a big difference.

As you can see in these examples, pressure ratio depends on a lot more than just boost.

Mass Flow Rate

Mass Flow Rate is the mass of air flowing through a compressor (and engine!) over a given period of time and is commonly expressed as lb/min (pounds per minute). Mass flow can be physically measured, but in many cases it is sufficient to estimate the mass flow for choosing the proper turbo.

Many people use Volumetric Flow Rate (expressed in cubic feet per minute, CFM or ft³/min) instead of mass flow rate. Volumetric flow rate can be converted to mass flow by multiplying by the air density. Air density at sea level is 0.076lb/ft³.

What is my mass flow rate? As a very general rule, turbocharged gasoline engines will generate 9.5-10.5 horsepower (as measured at the flywheel) for each lb/min of airflow. So, an engine with a target peak horsepower of 400 HP will require 36-44 lb/min of airflow to achieve that target. This is just a rough first approximation to help narrow the turbo selection options.

Surge Line

Surge is the left hand boundary of the compressor map. Operation to the left of this line represents a region of flow instability. This region is characterized by mild flutter to wildly fluctuating boost and "barking" from the compressor. Continued operation within this region can lead to premature turbo failure due to heavy thrust loading.

Surge is most commonly experienced when one of two situations exist. The first and most damaging is surge under load. It can be an indication that your compressor is too large. Surge is also commonly experienced when the throttle is quickly closed after boosting. This occurs because mass flow is drastically reduced as the throttle is closed, but the turbo is still spinning and generating boost. This immediately drives the operating point to the far left of the compressor map, right into surge. Surge will decay once the turbo speed finally slows enough to reduce the boost and move the operating point back into the stable region. This situation is commonly addressed by using a Blow-Off Valve (BOV) or bypass valve. A BOV functions to vent intake pressure to atmosphere so that the mass flow ramps down smoothly, keeping the compressor out of surge. In the case of a recirculating bypass valve, the airflow is recirculated back to the compressor inlet.

A Ported Shroud Compressor (see Fig. 2) is a feature that is incorporated into the compressor housing. It functions to move the surge line further to the left (see Fig. 3) by allowing some airflow to exit the wheel through the port to keep surge from occurring. This provides additional useable range and allows a larger compressor to be used for higher flow requirements without risking running the compressor into a dangerous surge condition. The presence of the ported shroud usually has a minor negative impact on compressor efficiency.

The Choke Line is the right hand boundary of the compressor map. For Garrett® maps, the choke line is typically defined by the point where the efficiency drops below 58%. In addition to the rapid drop of compressor efficiency past this point, the turbo speed will also be approaching or exceeding the allowable limit. If your actual or predicted operation is beyond this limit, a larger compressor is necessary.

Turbo Speed Lines are lines of constant turbo speed. Turbo speed for points between these lines can be estimated by interpolation. As turbo speed increases, the pressure ratio increases and/or mass flow increases. As indicated above in the choke line description, the turbo speed lines are very close together at the far right edge of the map. Once a compressor is operating past the choke limit, turbo speed increases very quickly and a turbo over-speed condition is very likely.

Efficiency Islands are concentric regions on the maps that represent the compressor efficiency at any point on the map. The smallest island near the center of the map is the highest or peak efficiency island. As the rings move out from there, the efficiency drops by the indicated amount until the surge and choke limits are reached.

Plotting Your Data on the Compressor Map

In this section, methods to calculate mass flow rate and boost pressure required to meet a horsepower target are presented. This data will then be used to choose the appropriate compressor and turbocharger. Having a Horsepower Target in mind is a vital part of the process. In addition to being necessary for calculating mass flow and boost pressure, a Horsepower Target is required for choosing the right fuel injectors, fuel pump and regulator, and other engine components.

Estimating Required Air Mass Flow and Boost Pressures to reach a Horsepower Target.

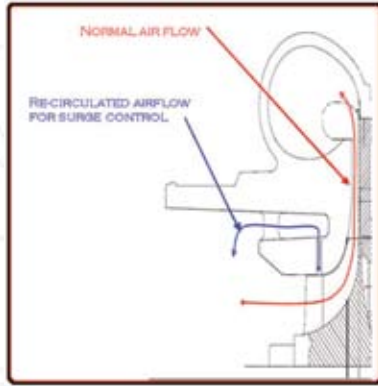


Fig 2

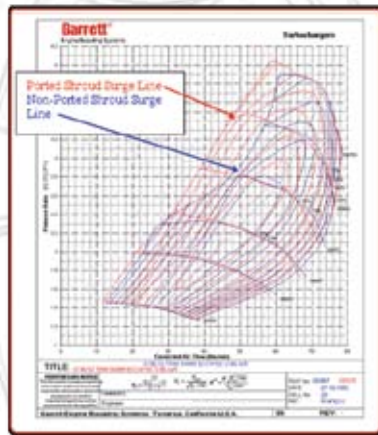


Fig 3

Things you need to know:

- Horsepower Target
- Engine Displacement
- Maximum RPM
- Ambient conditions (temperature and barometric pressure. Barometric pressure is usually given as inches of mercury and can be converted to psi by dividing by 2)

Things you need to estimate:

- Engine Volumetric Efficiency. Typical numbers for peak Volumetric Efficiency (VE) range in the 95%-99% for modern 4-valve heads, to 88%-95% for 2-valve designs. If you have a torque curve for your engine, you can use this to estimate VE at various engine speeds. On a well-tuned engine, the VE will peak at the torque peak, and this number can be used to scale the VE at other engine speeds. A 4-valve engine will typically have higher VE over more of its rev range than a 2-valve engine.
- Intake Manifold Temperature. Compressors with higher efficiency give lower manifold temperatures. Manifold temperatures of intercooled setups are typically 100 - 130 degrees F, while non-intercooled values can reach from 175-300 degrees F.
- Brake Specific Fuel Consumption (BSFC). BSFC describes the fuel flow rate required to generate each horsepower. General values of BSFC for turbocharged gasoline engines range from 0.50 to 0.60 and higher.

The units of BSFC are $\frac{lb}{Hp \cdot hr}$

Lower BSFC means that the engine requires less fuel to generate a given horsepower. Race fuels and aggressive tuning are required to reach the low end of the BSFC range described above.

For the equations below, we will divide BSFC by 60 to convert from hours to minutes.

To plot the compressor operating point, first calculate airflow:

Where: $W_a = HP \cdot \frac{A}{F} \cdot \frac{BSFC}{60}$

W_a = Airflow actual (lb/min)

HP = Horsepower Target (flywheel)

$\frac{A}{F}$ = Air/Fuel Ratio

$\frac{BSFC}{60}$ = Brake Specific Fuel Consumption = $(\frac{lb}{Hp \cdot hr}) \div 60$ (to convert from hours to minutes)

EXAMPLE:

I have an engine that I would like to make 400HP, I want to choose an air/fuel ratio of 12 and use a BSFC of 0.55. Plugging these numbers into the formula from above:

$$W_a = 400 \cdot 12 \cdot \frac{0.55}{60} = 44.0 \frac{lb}{min} \text{ of air.}$$

Thus, a compressor map that has the capability of at least 44 pounds per minute of airflow capacity is a good starting point.

Note that nowhere in this calculation did we enter any engine displacement or RPM numbers. This means that for any engine, in order to make 400 HP, it needs to flow about 44 lb/min (this assumes that BSFC remains constant across all engine types).

Naturally, a smaller displacement engine will require more boost or higher engine speed to meet this target than a larger engine will. So how much boost pressure would be required?

Calculate manifold pressure required to meet the Horsepower, or flow target:

$$MAP_{req} = \frac{Wa \cdot R \cdot (460 + T_m)}{VE \cdot \frac{N}{2} \cdot Vd}$$

Where:

- MAPreq = Manifold Absolute Pressure (psia) required to meet the horsepower target
- Wa = Airflow actual (lb/min)
- R = Gas Constant = 639.6
- Tm = Intake Manifold Temperature (degrees F)
- VE = Volumetric Efficiency
- N = Engine speed (RPM)
- Vd = engine displacement (Cubic Inches, convert from liters to CI by multiplying by 61.02, ex. 2.0 liters * 61.02 = 122 CI)

EXAMPLE:

To continue the example above, let's consider a 2.0 liter engine with the following description:

- Wa = 44 lb/min as previously calculated
- Tm = 130 degrees F
- VE = 92% at peak power
- N = 7200 RPM
- Vd = 2.0 liters * 61.02 = 122 CI

$$MAP_{req} = \frac{44 \cdot 639.6 \cdot (460 + 130)}{.92 \cdot \frac{7200}{2} \cdot 122} = 41.1 \text{ psia (remember, this is Absolute Pressure. Subtract Atmospheric Pressure to get Gauge Pressure (aka boost):}$$

$$41.1 \text{ psia} - 14.7 \text{ psia (at sea level)} = 26.4 \text{ psig boost}$$

As a comparison let's repeat the calculation for a larger displacement 5.0L (4942 cc/302 CI) engine.

Where:

- Wa = 44 lb/min as previously calculated
- Tm = 130 degrees F
- VE = 85% at peak power (it is a pushrod V-8)
- N = 6000 RPM
- Vd = 4.942 * 61.02 = 302 CI

$$MAP_{req} = \frac{44 \cdot 639.6 \cdot (460 + 130)}{.85 \cdot \frac{6000}{2} \cdot 302} = 21.6 \text{ psia (or 6.9 psig boost)}$$

This example illustrates that in order to reach the horsepower target of 400 hp, a larger engine requires lower manifold pressure but still needs 44lb/min of airflow. This can have a very significant effect on choosing the correct compressor.

With Mass Flow and Manifold Pressure, we are nearly ready to plot the data on the compressor map. The next step is to determine how much pressure loss exists between the compressor and the manifold. The best way to do this is to measure the pressure drop with a data acquisition system, but many times that is not practical.

Depending upon flow rate, charge air cooler characteristics, piping size, number/quality of the bends, throttle body restriction, etc., the plumbing pressure drop can be estimated. This can be 1 psi or less for a very well designed system. On certain restrictive OEM setups, especially those that have now higher-than-stock airflow levels, the pressure drop can be 4 psi or greater.

For our examples we will assume that there is a 2 psi loss. So to determine the Compressor Discharge Pressure (P2c), 2 psi will be added to the manifold pressure calculated above.

Where: $P_{2c} = MAP + \Delta P_{loss}$

- P2c = Compressor Discharge Pressure (psia)
- MAP = Manifold Absolute Pressure (psia)
- ΔPloss = Pressure Loss Between the Compressor and the Manifold (psi)

For the 2.0 L engine: $P_{2c} = 41.1 + 2 = 43.1 \text{ psia}$

For the 5.0 L engine: $P_{2c} = 21.6 + 2 = 23.6 \text{ psia}$

Remember our discussion on inlet depression in the Pressure Ratio discussion earlier, we said that a typical value might be 1 psi, so that is what will be used in this calculation. For this example, assume that we are at sea level, so Ambient Pressure is 14.7 psia.

We will need to subtract the 1 psi pressure loss from the ambient pressure to determine the Compressor Inlet Pressure (P1).

Where: $P_{1c} = P_{amb} - \Delta P_{loss}$

- P1c = Compressor Inlet Pressure (psia)
 - Pamb = Ambient Air Pressure (psia)
 - ΔPloss = Pressure Loss due to Air Filter/Piping (psi)
- P1c = 14.7 - 1 = 13.7 psia

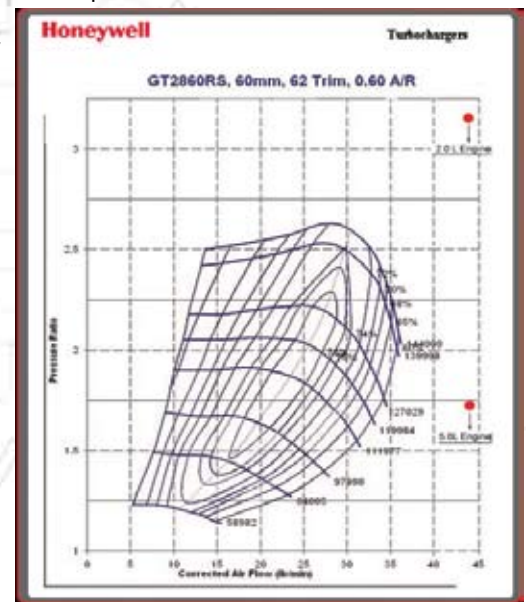
With this, we can calculate Pressure Ratio (Π_c) using the equation. $\Pi_c = \frac{P_{2c}}{P_{1c}}$

For the 2.0 L engine: $\Pi_c = \frac{43.1}{13.7} = 3.14$

For the 5.0 L engine: $\Pi_c = \frac{23.6}{13.7} = 1.72$

We now have enough information to plot these operating points on the compressor map. First we will try a GT2860RS. This turbo has a 60mm, 60 trim compressor wheel.

Clearly this compressor is too small, as both points are positioned far to the right and beyond the compressor's choke line.



Another potential candidate might be the Garrett® GT3076R. This turbo has a 76mm, 56 trim compressor wheel.

This is much better; at least both points are on the map! Let's look at each point in more detail.

For the 2.0L engine this point is in a very efficient area of the map, but since it is in the center of the map, there would be a concern that at lower engine speeds that it would be near or over the surge line. This might be ok for a high-rpm-biased powerband that might be used on a racing application, but a street application would be better served by a different compressor.

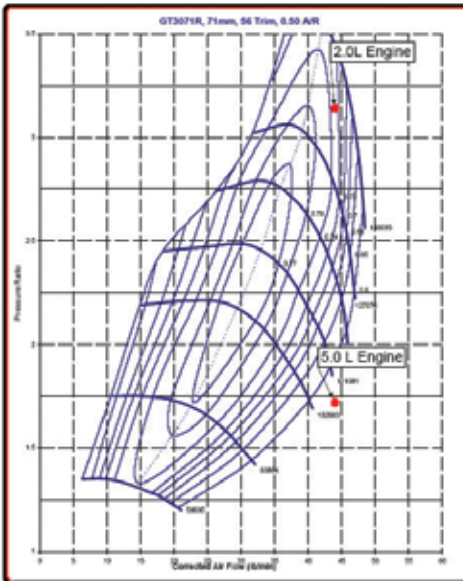
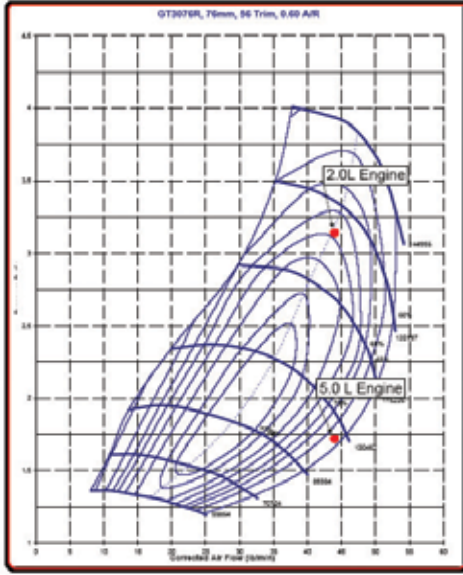
For the 5.0L engine, this looks like a very good street-biased powerband, with the lower engine speeds passing through the highest efficiency zone on the map, and plenty of margin to stay clear of surge. One area of concern would be turbo overspeed when revving the engine past peak power. A larger compressor would place the operating point nearer to the center of the map and would give some additional benefit to a high-rpm-biased powerband. We'll look at a larger compressor for the 5.0L after we figure out a good street match for the 2.0L engine.

So now lets look at a Garrett® GT3071R, which uses a 71mm, 56 trim compressor wheel.

For the 2.0L engine, this is a better mid-range-oriented compressor. The operating point is shifted a bit towards the choke side of the map and this provides additional surge margin. The lower engine speeds will now pass through the higher efficiency zones and give excellent performance and response.

For the 5.0L engine, the compressor is clearly too small and would not be considered.

Now that we have arrived at an acceptable compressor for the 2.0L engine, lets calculate a lower rpm point to plot on the map to better get a feel for what the engine operating line will look like. We can calculate this using the following formula:



$$W_a = \frac{MAP \cdot VE \cdot \frac{N}{2} \cdot V_d}{R \cdot (460 + T_m)}$$

We'll choose the engine speed at which we would expect to see peak torque, based on experience or an educated guess. In this case we'll choose 5000rpm.

Where:

- W_a = Airflow actual (lb/min)
- MAP = Manifold Absolute Pressure (psia) = 41.1 psia
- R = Gas Constant = 639.6
- T_m = Intake Manifold Temperature (degrees F) = 130
- VE = Volumetric Efficiency = 0.92
- N = Engine speed (RPM) = 5000rpm
- V_d = engine displacement (Cubic Inches, convert from liters to CI by multiplying by 61, ex. 2.0 liters * 61 = 122 CI)

$$W_a = \frac{41.1 \cdot 0.98 \cdot \frac{5000}{2} \cdot 122}{639.6 \cdot (460 + 130)} = 34.1 \text{ lb/min}$$

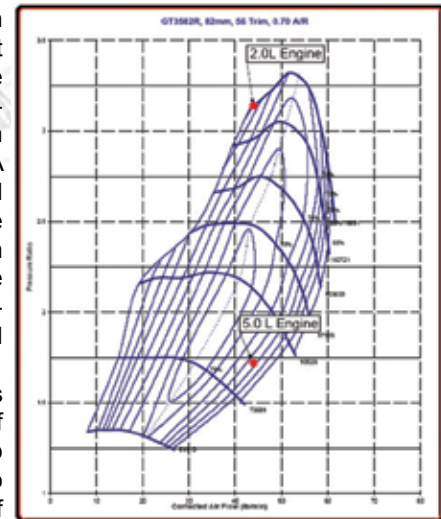
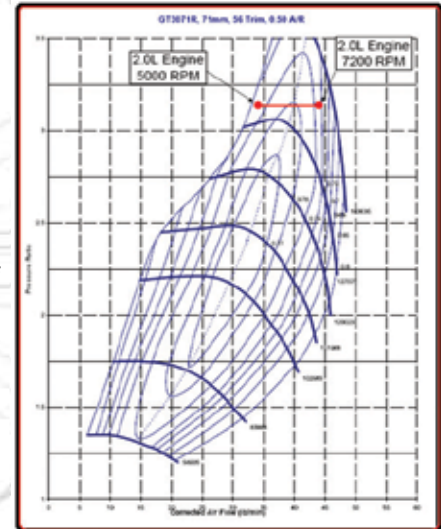
Plotting this on the GT3071R compressor map demonstrates the following operating points.

This provides a good representation of the operating line at that boost level, which is well suited to this map. At engine speeds lower than 5000 rpm the boost pressure will be lower, and the pressure ratio would be lower, to keep the compressor out of surge.

Back to the 5.0L engine. Let's look at a larger compressor's map. This time we will try a GT3582R with an 82mm, 56 trim compressor.

Here, compared to the GT3076R, we can see that this point is not quite so deep into choke and will give better high-rpm performance than the 76mm wheel. A further increase in wheel size would provide even better high-rpm performance, but at the cost of low- and mid-range response and drivability.

Hopefully this provided a basic idea of what a compressor map displays and how to choose a compressor. If real data is available to be substituted in place of estimation, more accurate results can be generated.



Today's diesel engines represent the state of the art in technology with high power density, excellent drivability, and good fuel economy. Fortunately for the diesel enthusiast, they are easier to upgrade for additional performance and the aftermarket is responding with more options for your high performance needs. As the major air system component, the turbocharger is a vital part of the performance equation and choosing the right turbo is critical to meeting your performance targets.

So why would I want to upgrade my Turbo Diesel engine?

Better towing performance -- Maybe you bought your truck to tow that gooseneck for work, to get your 5th wheel to the next resort or your boat to the lake. It sure would be nice to get up to freeway speeds quickly and maintain highway speeds in hilly terrain. With the right upgrades, that can be done safely and efficiently.

Competition Use -- More and more enthusiasts are interested in heavily modifying their vehicles for competition use. Some are weekend warriors that use their vehicles during the week for routine duty then go to the track on the weekends while others are building strictly race vehicles that give up streetability for the demands of the track.

More fun -- For many, making modifications for increased performance is a way of personalizing the vehicle and to have a bit more fun with the daily drive. There is a satisfaction that comes from modifications that put you back into your seat a little harder when the light turns green. And, there are always the grudge matches at the local drag strip.

What do I need to know to choose the right diesel upgrade turbocharger?

The amount of power that a diesel engine makes is directly proportional to the amount of fuel injected into the cylinder and that fuel needs sufficient air for complete combustion. For smoke-free performance, the engine needs about 18 times more air (by mass) than fuel. So clearly, as more fuel is added, additional air needs to be added also. In most applications, the stock turbo has some additional capacity for increased power, but as the compressor reaches the choke limit (maximum flow), the turbo speed increases rapidly, the efficiency drops dramatically, and the compressor discharge temperature ramps up very quickly. This creates a "snowball" effect in that the higher discharge temps mean higher intake manifold temps and higher exhaust gas temps. The lower efficiency means that more turbine power is required to reach the same boost causing higher back pressure in the exhaust manifold. This can usually be seen on an engine with a performance chip (at the highest power setting) and maybe an intake or exhaust upgrade. Under heavy acceleration, smoke is pouring from the tailpipe as the EGT's and turbo speeds are climbing into the danger zone requiring a prudent driver to back off the accelerator pedal early to keep from damaging the engine. Under these conditions, the stock turbo is running on borrowed time. With an upgrade turbocharger selected to compliment the extra fuel, smoke is drastically reduced, EGT's are under control and, since the turbo is operating in a more efficient range, horsepower and drivability are enhanced. When the modifications get more serious, a bigger turbo is a must-have to compliment even more fuel.

In order to decide on the appropriate turbocharger for your diesel engine, the very first thing that needs to be established is the

power target. Since turbochargers are sized by how much air they can deliver and airflow is proportional to engine power, a realistic horsepower goal is critical to make the right choice.

The concept of a realistic goal needs to be stressed in order to ensure maximum performance and satisfaction. Sure, everyone would like to have a mega-horsepower vehicle but past a reasonable limit, as the power goes up, the reliability, drivability and day-to-day utility is diminished. Things are more likely to go wrong, wear out and break down as the power output climbs.

Most project vehicles fall into one of the following general categories:

Great, So what turbo do I choose?

Intended Use	Approximate Power Increase Over Stock	Important Factors
Daily Driver Work Truck Tow Vehicle	+ 150 Horsepower	Reliability, Reduced EGTs, Drivability, Performance, Low Smoke
Weekend Warrior	+ 250 Horsepower	Still needs to pull regular duty during the week and have fun on weekends
Extreme Performance	+ 350 Horsepower	Street driven, but everyday drivability compromised for high performance
Competition	+ 400 Horsepower and up	100% performance, no compromises

Let's take each case and calculate a turbo choice based on the intended power increase. The first step is to read the catalog section "Turbo Selection - Gasoline" (pages 8-11). This article explains the reading of a compressor map and the equations needed to properly match a turbo. The examples given, however, are for gasoline engines, so the additional examples here will be using those same equations but with a diesel engine. Matches will be calculated with an Air Fuel Ratio (AFR) of 22:1 for low or no smoke performance. Likewise a typical Brake Specific Fuel Consumption (BSFC) is in the range of 0.38. Let's get started!

The first example will be for the **Daily Driver/Work Truck/Tow Vehicle** category. This includes vehicles up to 150HP over stock. But wait, this power level can be accomplished with just a chip or tuning module. So why bother with a new upgrade turbo? An upgrade turbo will enhance the gains made by installing the chip and other upgrades. The extra air and lower backpressure provided by the upgrade turbo will lower EGTs, allow more power with less smoke and address durability issues with the stock turbo at higher boost pressures and power levels. Because this will be a mild upgrade, boost response and drivability will be improved across the board.

EXAMPLE:

I have a 6.6L diesel engine that makes a claimed 325 flywheel horsepower (about 275 wheel Horsepower as measured on a chassis dyno). I would like to make 425 wheel HP; an increase of 150 wheel horsepower. Plugging these numbers into the formula and using the AFR and BSFC data from above:

Recall from Turbo Selection - Gasoline:

Where:

W_a = Airflow actual (lb/min)

HP = Horsepower Target

A/F = Air/Fuel Ratio

$\frac{BSFC}{60}$ = Brake Specific Fuel Consumption ($\frac{lb}{HP-hr}$) $\div 60$
(to convert from hours to minutes)

$$W_a = 425 \cdot 22 \cdot \frac{0.38}{60} = 59.2 \text{ lb/min of air.}$$

So we will need to choose a compressor map that has a capability of at least 59.2 pounds per minute of airflow capacity. Next, how much boost pressure will be needed?

Calculate the manifold pressure required to meet the horsepower target.

$$MAP_{req} = \frac{W_a \cdot R \cdot (460 + T_m)}{VE \cdot N / 2 \cdot V_d}$$

Where:

MAP_{req} = Manifold Absolute Pressure (psia) required to meet the horsepower target

W_a = Airflow actual (lb/min)

R = Gas Constant = 639.6

T_m = Intake Manifold Temperature (degrees F)

VE = Volumetric Efficiency

N = Engine speed (RPM)

V_d = engine displacement (Cubic Inches, convert from liters to CI by multiplying by 61, ex. 2.0 liters * 61 = 122 CI)

For our project engine:

W_a = 59.2 lb/min as previously calculated

T_m = 130 degrees F

VE = 98%

N = 3300 RPM

V_d = 6.6 liters * 61 = 400 CI

$$MAP_{req} = \frac{59.2 \cdot 639.6 \cdot (460 + 130)}{.98 \cdot 3300 / 2 \cdot 400}$$

= 34.5 psia (remember, this is Absolute Pressure; subtract Atmospheric Pressure to get Gauge Pressure, 34.5 psia - 14.7 psia (at sea level) = 19.8 psig).

So now we have a Mass Flow and Manifold Pressure. We are almost ready to plot the data on the compressor map. Next step is to determine how much pressure loss exists between the compressor and the manifold. The best way to do this is to measure the pressure drop with a data acquisition system, but many times that is not practical. Depending upon flow rate and charge air cooler size, piping size and number/quality of the bends, throttle body restriction, etc., you can estimate from 1 psi (or less) up to 4 psi (or higher). For our examples we will estimate that there is a 2 psi loss. Therefore we will need to add 2 psi to the manifold pressure in order to determine the Compressor Discharge Pressure (P_{2c}).

$$P_{2c} = MAP + \Delta P_{loss}$$

Where:

P_{2c} = Compressor Discharge Pressure (psia)

MAP = Manifold Absolute Pressure (psia)

ΔP_{loss} = Pressure loss between the Compressor and the Manifold (psi)

$$P_{2c} = 34.5 + 2 = 36.5 \text{ psia}$$

To get the correct inlet condition, it is now necessary to estimate the air filter or other restrictions. In the Pressure Ratio discussion earlier we said that a typical value might be 1 psi, so that is what will be used in this calculation. Also, we are going to assume that we are at sea level, so we are going to use an ambient pressure of 14.7 psia. We will need to subtract the 1 psi pressure loss from the Ambient Pressure to determine the Compressor Inlet Pressure (P_{1c}).

$$P_{1c} = P_{amb} - \Delta P_{loss}$$

Where:

P_{1c} = Compressor Inlet Pressure (psia)

P_{amb} = Ambient Air pressure (psia)

ΔP_{loss} = Pressure loss due to Air Filter/Piping (psi)

$$P_{1c} = 14.7 - 1 = 13.7 \text{ psia}$$

With this, we can calculate Pressure Ratio (Π_c) using the equation. $\Pi_c = \frac{P_{2c}}{P_{1c}}$

For the 2.0L engine:

$$\Pi_c = \frac{36.5}{13.7} = 2.7$$

We now have enough information to plot these operating points on the compressor map. First we will try a GT3788R. This turbo has an 88mm tip diameter 52 trim compressor wheel with a 64.45mm inducer.

As you can see, this point falls nicely on the map with some additional room for increased boost and mass flow if the horsepower target climbs. For this reason, the GT37R turbo family is applied on many of the Garrett PowerMax™ turbo kits that are sized for this horsepower range.

For the next example, let's look at the **Week-end Warrior**. This category is for daily driven vehicles that have up to 250 horsepower over stock or 525 wheel horsepower.

Plugging that power target into our formula yields an airflow requirement of:

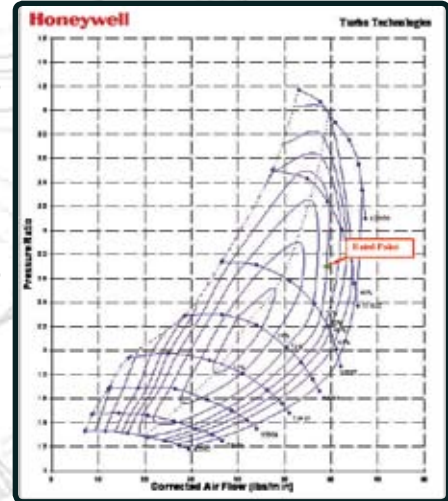
$$W_a = 525 \cdot 22 \cdot \frac{0.38}{60} = 73.2 \text{ lb/min of air flow.}$$

And a pressure ratio of:

$$MAP_{req} = \frac{73.2 \cdot 639.6 \cdot (460 + 130)}{.98 \cdot 3300 / 2 \cdot 400} = 43.5 \text{ psia}$$

$$P_{2c} = 43.5 + 2 = 45.5 \text{ psia}$$

$$\Pi_c = \frac{45.5}{13.7} = 3.3$$



Looking at the previous map, the compressor does not flow enough to support this requirement, so we must look at the next larger size compressor. (Technically, the engine could probably easily make this power with the previous compressor, but it would be at risk of more smoke, higher EGT's and backpressure; kind of like pushing a stock compressor too far...) The next larger turbo is a Garrett® GT4094R. Another option that could also be considered is the GT4294R which has a slightly larger inducer compressor and the next larger frame size turbine wheel. The larger wheel's inertia will slow down the response a bit, but provide better performance at the top end of the rpm range.

For the next example, let's look at the **Extreme Performance**. This category is for real hot rod vehicles that have up to 350 horsepower over stock and owners that are willing to give up some of the daily utility in order to achieve higher power gains.

Plugging that power target into our formula yields an airflow requirement of:

$$W_a = 62.5 \cdot 22^{0.38} / 60 = 87.1 \text{ lb/min of air}$$

And a pressure ratio of :

$$MAP_{req} = \frac{87.1 \cdot 639.6 \cdot (460 + 130)}{.98 \cdot 3300 / 2 \cdot 400} = 50.8 \text{ psia}$$

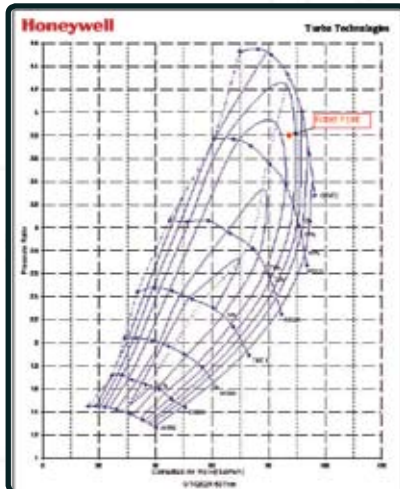
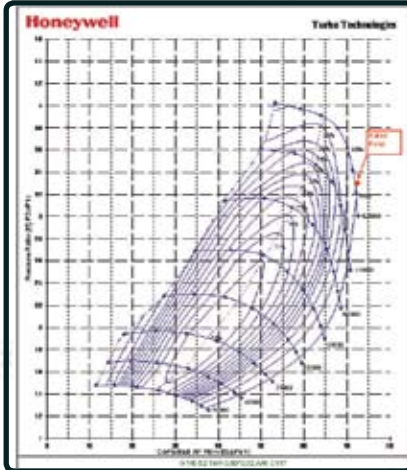
$$P_{2c} = 50.8 + 2 = 52.8 \text{ psia}$$

$$\Pi_c = \frac{52.8}{13.7} = 3.8$$

For this flow and pressure ratio, the GT4202R is appropriate and is shown below. Since this is approaching a pressure ratio of 4-to-1, we are about at the limit of a single turbo on an engine of this size.

Additional power gains can be had with more boost or a larger single turbo, but it is getting close to the edge of the envelope in terms of efficiency and turbo speed.

The final case is the **Competition** category. Since this is a special case and there are so many ways to go about an ultimate power diesel application, it is not possible to cover it adequately in this article. There are, however, some general guidelines. At this power level, as stated above, it is a good idea to consider a series turbo application. This is a situation where one turbo feeds another turbo, sharing the work of compressing the air across both compressors.



A larger turbo is designated as the "low-pressure" turbo and the smaller secondary stage as the "high pressure" turbo. The low-pressure compressor feeds the high-pressure compressor which then feeds the intake. On the turbine-side the exhaust first passes through the high-pressure turbine and then on to the low-pressure turbine before being routed out through the tailpipe. We can still calculate the required mass flow, but the pressure ratio is more involved and questions should be discussed with your local Garrett® PowerMax™ distributor. To calculate the required mass flow, we use the normal equation. This time the power target will be 500 wheel horsepower over stock, for a total of 775 wheel horsepower.

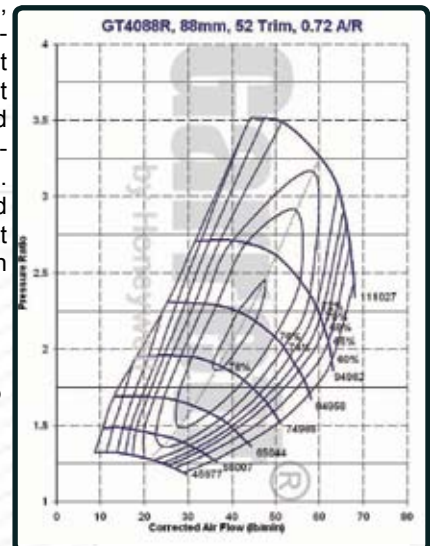
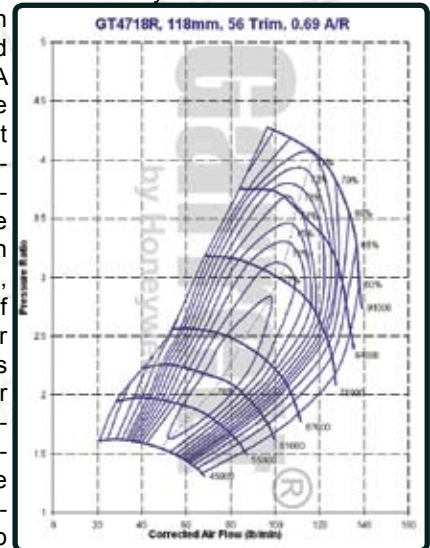
$$W_a = 775 \cdot 22^{0.38} / 60 = 108 \text{ lb/min of air flow.}$$

This air flow rate will apply only to the low-pressure compressor as the high-pressure compressor will be smaller because it is further pressurizing already compressed air. In most cases, the high-pressure turbo tends to be about two frame sizes smaller than the low pressure stage. So in this case, after selecting the appropriate low-pressure turbo (hint: look at the GT4718R compressor map), a GT4088R or GT4094R would be the likely candidates.

One more comment on choosing a properly sized turbine housing A/R. A smaller A/R will help the turbo come up on boost sooner and provide a better responding turbo application, but at the expense of higher back pressure in the higher rpm zones and, in some cases, a risk of pushing the compressor into surge if the boost rises too rapidly. On the other hand, a larger A/R will respond slower, but with better top end performance and reduced risk of running the compressor into surge. Generally speaking, the proper turbine housing is the largest one that will give acceptable boost response on the low end while allowing for more optimal top end performance.

This information should be used as a starting point for making decisions on proper turbo sizing.

For more specific information on your engine, consult a Garrett® PowerMax™ Distributor. Find your Garrett® PowerMax™ Distributor at www.TurboByGarrett.com.



This section is intended to cover many of the auxiliary systems in a more complete and in-depth manner. With this additional section, you will better understand how to optimize your turbo system.

Turbo System Optimization will cover:

1. Application Information
2. Turbo Match
3. System Components
 - Air Filter
 - Oil Supply & Drain
 - Water Lines
 - Charge Tubing & Charge-Air-Cooler
 - BOV
 - Wastegate
4. Common Causes of Oil Leakage
5. System Testing/Monitoring
6. 11-Point Checklist

1. Application Information

The most important thing to understand before designing a system is the application. Is it going to be used for road racing, drag racing or drifting or maybe it will be primarily a street driven car. The intended use greatly affects the turbo selection as well as the system components. A turbo system that works well for a 9 second drag car is most likely not going to work well for a drift car or road race car.

You need to have a target flywheel horsepower in mind. It will be used to help design the entire system.

2. Turbo Match

- Visit the Turbo Tech Section of www.TurboByGarrett.com.
- Or use the Turbo Selection sections of this catalog.
- Using formulas in Turbo Selection, calculate mass flow and pressure ratio (PR) at redline for your specific application.
- Plot mass flow and PR on several compressor maps to determine the best fit.
- For the example in this presentation, the "application" will be a 400 flywheel hp street car using pump gas, therefore the estimated mass flow ~ 40 lbs/min

3. System Components

Air Filter

It is important to appropriately size the air filter for the maximum flow rate of the application. For our specific example, we are looking for target face velocity of ≤ 130 ft/min at redline to minimize restriction so as to provide the turbo with all the air necessary for it to function optimally.

If the turbo does not have access to the proper amount of air, excessive restriction can occur and cause:

- Oil leakage from the compressor side piston ring, which results in oil loss, a fouled CAC and potentially smoke out of the tailpipe.
- Increased pressure ratio, which can lead to turbo overspeed.
- Overspeed will reduce turbo durability and could result in an early turbo failure.

Determining the correct air filter size

Example:

Face Velocity = 130 ft/min

Mass Flow = 40 lbs/min

Air density = 0.076 lbs/ft³

Mass Flow (lbs/min) = Volumetric Flow Rate (CFM) x Air Density (lbs/ft³)

Volumetric Flow Rate (CFM) = Mass Flow (lbs/min)

Air Density (lbs/ft³)

Volumetric Flow Rate = 526 CFM

**For twin turbo setups, simply divide the flow rate by two.

Face Velocity (ft/min) = Volumetric Flow rate (CFM) / Area (ft²)

Area (ft²) = Volumetric Flow rate (CFM) / Face Velocity (ft/min)

Area (ft²) = 526 / 130 = 4.05

Area (in²) = 4.05 x 144

Area = 582 in²

Now that we know the required surface area that our air filter must have, we need to determine the correct air filter size using information provided by the filter manufacturer. We will need to know the following information about the filters we are considering:

- Pleat height
- Pleat depth
- Number of pleats

Example:

Pleat Height = 9.00 in.

Pleat Depth = 0.55 in.

of Pleats = 60

Area (in²) = pleat height x pleat depth x # of pleats x 2

Area (in²) = 9.00 x 0.55 x 60 x 2

Area = 594 in²

Actual Filter Area (594 in²) > Calculated Area (582 in²)

Since the actual filter area (594 in²) is greater than the required area, this air filter will work for our application.

Oil Supply & Drainage

Journal Bearing Turbo

Journal-bearings function similarly to rod or crank bearings in an engine: oil pressure is required to keep components separated. An oil restrictor is generally not needed except for oil pressure-induced leakage.

The recommended oil feed for journal bearing turbochargers is -4AN or hose/tubing with an ID of approximately 0.25".

Be sure to use an oil filter that meets or exceeds the OEM specifications.

Ball Bearing Turbo

An oil restrictor is recommended for optimal performance with ball bearing turbochargers. Oil pressure of 40 – 45 psi at maximum engine speed is recommended to prevent damage to the turbocharger's internals. In order to achieve this pressure, a restrictor with a 0.040" orifice will normally suffice, but you should always verify the oil pressure entering the turbo after the restrictor to insure that the components are functioning properly.

Recommended oil feed is -3AN or -4AN line or hose/tubing with a similar ID.

As always, use an oil filter that meets or exceeds the OEM specifications.

OIL LEAKAGE SHOULD NOT OCCUR ON A PROPERLY FUNCTIONING SYSTEM IF RESTRICTOR IS NOT USED UNLESS THE SYSTEM PRESSURE IS EXCESSIVELY HIGH.

Oil Drain

In general, the larger the oil drain, the better. However, a -10AN is typically sufficient for proper oil drainage, but try not to have an inner diameter smaller than the drain hole in the housing as this will likely cause the oil to back up in the center housing. Speaking of oil backing up in the center housing, a gravity feed needs to be just that! The oil outlet should follow the direction of gravity +/-35° when installed in the vehicle on level ground. If a gravity feed is not possible, a scavenge pump should be used to insure that oil flows freely away from the center housing.

Avoid:

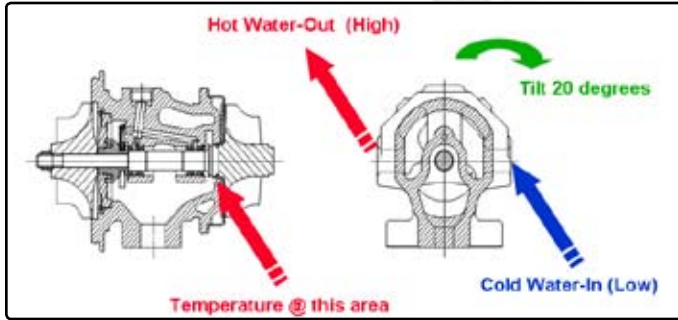
- Undulations in the line or extended lengths parallel to the ground
- Draining into oil pan below oil level
- Dead heading into a component behind the oil pan
- Area behind the oil pan (windage tray window) where oil sling occurs from crankshaft

When installing your turbocharger, insure that the turbocharger axis of rotation is parallel to the level ground within +/- 15°. This means that the oil inlet/outlet should be within 15° of being perpendicular to level ground.

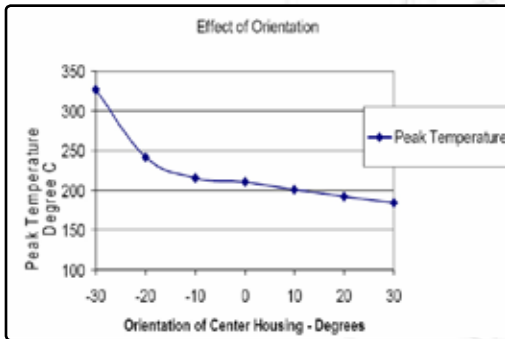
Water Lines

Water cooling is a key design feature for improved durability and we recommend that if your turbo has an allowance for water-cooling, hook up the water lines. Water cooling eliminates the destructive occurrence of oil coking by utilizing the Thermal Siphon Effect to reduce the Peak Heat Soak Back Temperature on the turbine side after shut-down.

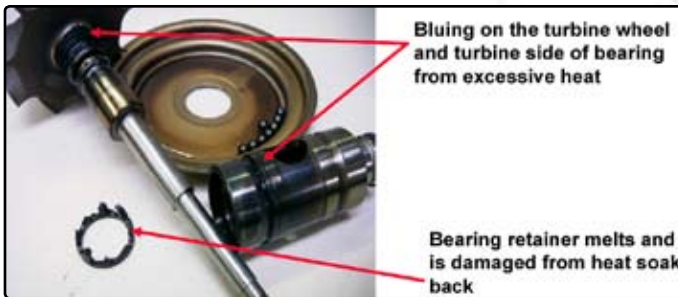
In order to get the greatest benefit from your water-cooling system, avoid undulations in the water lines to maximize the Thermal Siphon Effect.



Negative degrees: water outlet of center housing is lower than water inlet
 Positive degrees: water outlet of center housing is higher than water inlet



For best results, set the orientation of the center housing to 20°. Significant damage to the turbo can occur from improper water line setups.



Charge Tubing

The duct diameter should be sized with the capability to flow approximately 200 - 300 ft/sec. Selecting a flow diameter less than the calculated value results in the flow pressure dropping due to the restricted flow area. If the diameter is instead increased above the calculated value, the cooling flow expands to fill the larger diameter, which slows the transient response.

For bends in the tubing, a good design standard is to size the bend radius such that it is 1.5 times greater than the tubing diameter.

The flow area must be free of restrictive elements such as sharp transitions in size or configuration.

For our example:

- Tubing Diameter: velocity of 200 - 300 ft/sec is desirable. Too small a diameter will increase pressure drop. Too large can slow transient response.
- Velocity (ft/min) = Volumetric Flow rate (CFM) / Area (ft²)

Again, for twin turbo setups, divide the flow rate by (2).

Charge tubing design affects the overall performance, so there are a few points to keep in mind to get the best performance from your system.

- Duct bend radius:
 - Radius/diameter > 1.5
- Flow area:
 - Avoid area changes, sharp transitions, shape changes

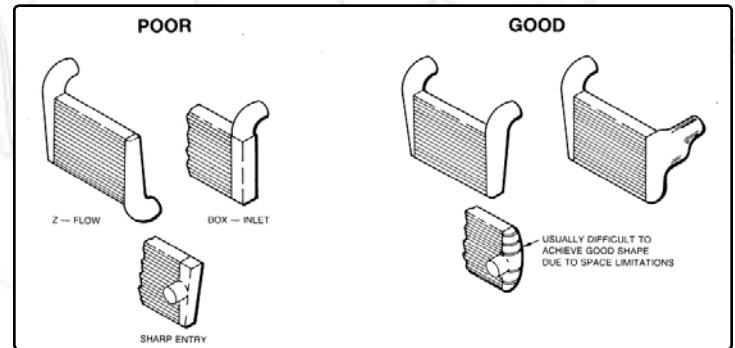
- Available packaging space in the vehicle usually dictates certain designs

Selecting a Charge Air Cooler (aka intercooler) has been made simple with www.TurboByGarrett.com's intercooler core page. Each core is rated for horsepower, making it as easy as matching your desired power target to the core. In general, use the largest core that will fit within the packaging constraints of the application.

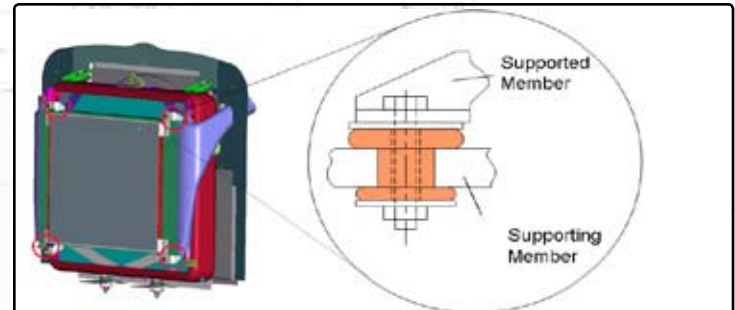
Part Number	Hot Flow Length (in)	Hot Flow Height (in)	Cold Flow Width (in)	Core Weight (lbs.)	Horsepower	Type
789317-6091	6.0	12.0	4.5	3.0	180	BP
789317-6094	6.0	12.0	3.0	5.2	210	BP
789319-6092	9.0	12.4	3.5	9.8	275	BP
789319-6095	18.0	6.2	3.0	7.3	310	BP
789317-6091	22.8	6.2	2.5	7.4	320	BP
789317-6093	16.0	12.3	3.0	9.5	370	BP
789321-6093	16.0	17.7	4.2	11.1	375	BP
789319-6095	18.0	7.6	3.5	10.8	425	BP
789318-6018	24.0	4.3	3.0	9.9	475	BP
789318-6091	32.0	12.0	3.0	11.5	475	BP
789319-6099	24.0	6.2	3.0	11.6	500	BP
789319-6017	18.0	12.0	3.0	11.2	510	BP
789447-6094	22.8	10.9	2.5	11.9	630	BP
789329-6026	18.0	10.9	3.8	10.7	675	BP

For our example:

Another important factor in selecting the correct intercooler is the end tank design. Proper manifold shape is critical in both minimizing charge air pressure drop and providing uniform flow distribution. Good manifold shapes minimize losses and provide fairly even flow distribution. The over-the-top design can starve the top tubes however. The side entry is ideal for both pressure drop and flow distribution, but it is usually not possible due to vehicle space limitations.



Proper mounting of the intercooler increases the durability of the system. Air to air charge air coolers are typically "soft-mounted", meaning they use rubber isolation grommets. This type of mounting is also used for the entire cooling module. The design guards against vibration failure by providing dampening of vibration loads. It also reduces thermal loads by providing for thermal expansion.



Benefits of Isolation:

- Guards against vibration by damping loads
- Reduces thermal loading by providing for thermal expansion

Blow Off Valves (BOV)

Using the proper blow off valve (BOV) affects the system performance. There are two main types to consider.

MAP (Manifold Absolute Pressure) sensor uses either a vent-to-atmosphere valve or a recirculation valve.

- Connect signal line to manifold source
- Surge can occur if spring rate is too stiff



MAF (Mass Air Flow) sensor uses a recirculation (bypass) valve for best drivability.

- Connect signal line to manifold source
- Position valve close to the turbo outlet for best performance (if valve can handle high temp).
- Surge can occur if valve and/or outlet plumbing are restrictive.



Wastegates

Internal wastegates are part of the turbo and integrated into the turbine housing. Two connection possibilities exist for signal line. The first is to connect line from compressor outlet (not manifold - vacuum) to the actuator. The second is to connect a line from compressor outlet to boost controller (PWM valve) and then to the actuator.

Manifold pressure is limited by the spring rate of the actuator.

Most OEM style actuators are not designed for vacuum, and thus, the diaphragm can be damaged resulting in excessive manifold pressure and engine damage.



External wastegates are separate from the turbo and integrated into the exhaust manifold rather than the turbine housing.

Connection to the manifold greatly affects flow capability, and correct orientation of the wastegate to the manifold is essential. For example, placing the wastegate at 90° to the manifold will reduce flow capacity by up to 50%! This greatly reduces the control that you have over the system and puts your entire drivetrain at risk. Instead, the ideal connection is at 45° with a smooth transition.

There are two connection possibilities for signal line:

- Connect a line from the compressor outlet (not manifold - vacuum) to the actuator
- Connect a line from the compressor outlet to a boost controller (PWM valve) and then to the actuator

Again, manifold pressure is limited by spring rate of actuator.

4. Common Causes of Oil Leakage

A properly installed turbo should NOT leak oil.

There are, however, instances where oil leaks occur. The most common causes, depending on the location of the leak, are:

Leakage from compressor and turbine seals

- Excessively high oil pressure
- Inadequate drain – drain is too small, does not go continuously downhill, drain is below the oil level in the pan or the location of the drain inside the oil pan is located in a section that has oil slung from the crank causing oil to back up in drain tube. Always place oil drain into oil pan in a location that oil from crank is blocked by windage tray.
- Improper venting of crankcase pressure.
- Excessive crankcase pressure.
- Oil drain rotated past the recommended 35°.

Leakage from compressor seal

Excessive pressure across the compressor housing inlet caused by:

- Air filter is too small.
- Charge air tubing too small or has too many bends between the air filter and compressor housing .
- Clogged air filter.

Leakage from Turbine seal

- Collapsed turbine piston ring from excessive EGT's.
- Turbo tilted back on its axis past recommended 15°.

5. System Testing and Monitoring

Testing

Many problems with turbo systems can be solved before the catastrophic happens through simple system testing.

Pressurize system to test for leaks

- Clamps
 - Check tightness
- Couplers
 - Check for holes or tears
- CAC core / end tanks
 - Check for voids in welds

Monitoring

The turbo system in your car should be monitored to insure that every aspect is functioning properly to give you trouble-free performance.

Instrumentation used to monitor / optimize system

1. Oil Pressure (Required to monitor engine operation)
2. Oil Temperature (Required to monitor engine operation)
3. Water Temperature (Required to monitor engine operation)
4. A/F Ratio (such as a wideband sensor; required to monitor engine operation)
5. Manifold Pressure
6. Turbine Inlet Pressure
7. Exhaust Gas Temperature
8. Turbo Speed Sensor
 - The most accurate way to calibrate and optimize a system is through datalogging!

Manifold Pressure

- Calibrate actuator setting to achieve manifold pressure required to meet hp target
- Detect over-boost condition
- Detect damaged actuator diaphragm

Back Pressure

- Monitor pressure changes in turbine housing inlet
- Affect of different turbine housing A/R's
- Increased back pressure decreases Volumetric Efficiency thus decreasing ultimate power

Pyrometer

- Monitor exhaust gas temperature (EGT) in manifold / turbine housing
- Adjust calibration based on temperature rating of turbine housing material or other exhaust components

Turbo Speed

- Determine operating points on compressor map
- Determine if the current turbo is correct for the application and target hp
- Avoid turbo over-speed condition, which could damage turbo

6. 11 Point Checklist

1. Application Information – target horsepower, intended use of vehicle, etc.
2. Air filter sizing - determine size for application needs
3. Oil Supply - restrictor for ball-bearing turbo
4. Oil Drain – proper size and routing
5. Water Lines - set up for greatest thermal siphon effect
6. Charge Tubing – determine diameter for application needs
7. Charge-Air-Cooler - determine core size for application needs, design manifolds for optimal flow, mount for durability
8. BOV – VTA for MAP engines and by-pass for MAF engines
9. Wastegate – connect signal line to compressor outlet, smooth transition to external wastegate
10. System Testing – pressurize system to check for leakage, periodically check clamp tightness and the condition of couplers
11. System Monitoring – proper gauges/sensors to monitor engine for optimal performance and component durability

Troubleshooting

Nearly all turbocharger-related problems are the result of a handful of causes. Knowing how to recognize the symptoms of these issues early and link them with causes will help you save (down) time and money.

The chart below outlines the probable causes and noticeable conditions of the most common turbocharger maladies as well as what you can do to solve them.

Garrett by Honeywell		Symptoms										Turbocharger Troubleshooting		
		Excessive Oil Consumption	Black Smoke	Blue Smoke	Noise	Damaged Compressor Wheel	Drag or Bind in Rotating Assembly	Excessive Oil - Compressor End	Damaged Turbine Wheel	Excessive Oil - Turbine End	Damaged Rotating Assembly	Engine Lacks Power	Probable Cause	Solutions
Possible Causes												Probable Cause	Solutions	
	Dirty air cleaner element													Clean or replace filter element
	Plugged crankcase breathers													Clean obstruction per manufacturer's manual
	Air cleaner element missing, leaking, or loose connections to turbo													Replace, repair or reconnect air cleaner element per manufacturer's manual
	Collapsed or restricted air pipe before turbocharger													Inspect pipe for damage or obstruction, replace or repair
	Restricted or damaged cross-over pipe - turbo to inlet manifold													Inspect pipe for damage or obstruction, replace or repair
	Foreign object between cleaner and turbocharger													Inspect air intake piping, remove foreign object
	Foreign object in exhaust system (from engine, check engine)													Inspect exhaust piping ONLY when engine is NOT running and cold, remove foreign object
	Turbocharger flanges, clamp or bolts loose													Inspect all connecting hardware for damage, ensure tight fits per installation instructions
	Inlet manifold cracked, gaskets loose or missing, connections loose													Remove and inspect inlet manifold for damage to castings and gaskets, replace if needed
	Exhaust manifold cracked, burned, gasket loose, blown or missing													Remove exhaust manifold ONLY when engine is cold and NOT running and inspect for damage to castings and gaskets, replace if needed
	Restricted exhaust system													Inspect exhaust system ONLY when engine is cold, NOT running, remove obstruction
	Oil lag at start-up													Inspect lubrication system lines, filters and oil for obstruction, remove obstruction
	Insufficient lubrication													Inspect lubrication system lines, filters and oil for obstruction, remove obstruction
	Lubricating oil contaminated with dirt or other material													Replace all filters and lubricating oil with new per manufacturer's manual
	Improper lubricating oil type used													Replace lubricating oil with correct grade
	Restricted oil feed line													Remove and inspect oil line, remove obstruction
	Restricted oil drain line													Remove and inspect oil line, remove obstruction
	Turbine housing damaged or restricted													Remove turbine housing, inspect for cracks or wear, replace if needed
	Turbocharger seal leakage													Inspect for proper oil feed/drain line installation. Contact Garrett distributor for rebuild
	Worn journal bearings													Contact a Garrett Performance Distributor or Garrett Master Distributor
	Excessive dirt build-up behind turbine wheel													Inspect air cleaner element and intake piping for damage or leaks, replace if needed. Clean compressor wheel and housing
	Excessive carbon build-up on compressor housing													Inspect crankcase ventilation system
	Too fast acceleration at initial start													Decrease acceleration at initial start
	Too little warm-up time													Extend warm-up period
	Fuel pump malfunction													Refer to engine manufacturer's manual and replace if needed
	Worn or damaged injectors													Inspect injectors for damage and replace if needed
	Valve timing													Refer to engine manufacturer's manual and replace if needed
	Burned valves													Refer to engine manufacturer's manual and replace if needed
	Worn piston rings													Refer to engine manufacturer's manual and replace if needed
	Burned pistons													Refer to engine manufacturer's manual and replace if needed
	Leaking oil feed line													Remove and inspect oil line, remove obstruction
	Excessive engine pre-oil													Refer to engine manufacturer's manual and replace if needed
	Excessive engine idle													Refer to engine manufacturer's manual and replace if needed
	Coked or sludged center housing													Contact a Garrett Performance Distributor or Garrett Master Distributor
	Oil pump malfunction													Refer to engine manufacturer's manual and replace if needed
	Oil filter plugged													Refer to engine manufacturer's manual and replace if needed
	Oil bath cleaner: air inlet screen restricted / dirty air cleaner													Replace air inlet screen
	Oil bath air cleaner: oil pull-over / oil viscosity too low or high													Replace lubricating oil with correct grade
	Boost control malfunction: wastegate													Inspect for damage, leaks or obstructions; replace or repair if needed
	Boost control malfunction: VNT													Contact a Garrett Performance Distributor or Garrett Master Distributor
	Boost control malfunction: engine management system													Refer to manufacturer's manual and adjust as needed

By using this chart, most turbocharger problems can be easily identified and rectified. However, if a problem falls outside of your comfort level for service, contact a Garrett[®] Performance Distributor or a Garrett[®] Master Distributor for assistance.

Garrett® Turbocharger Displacement Chart

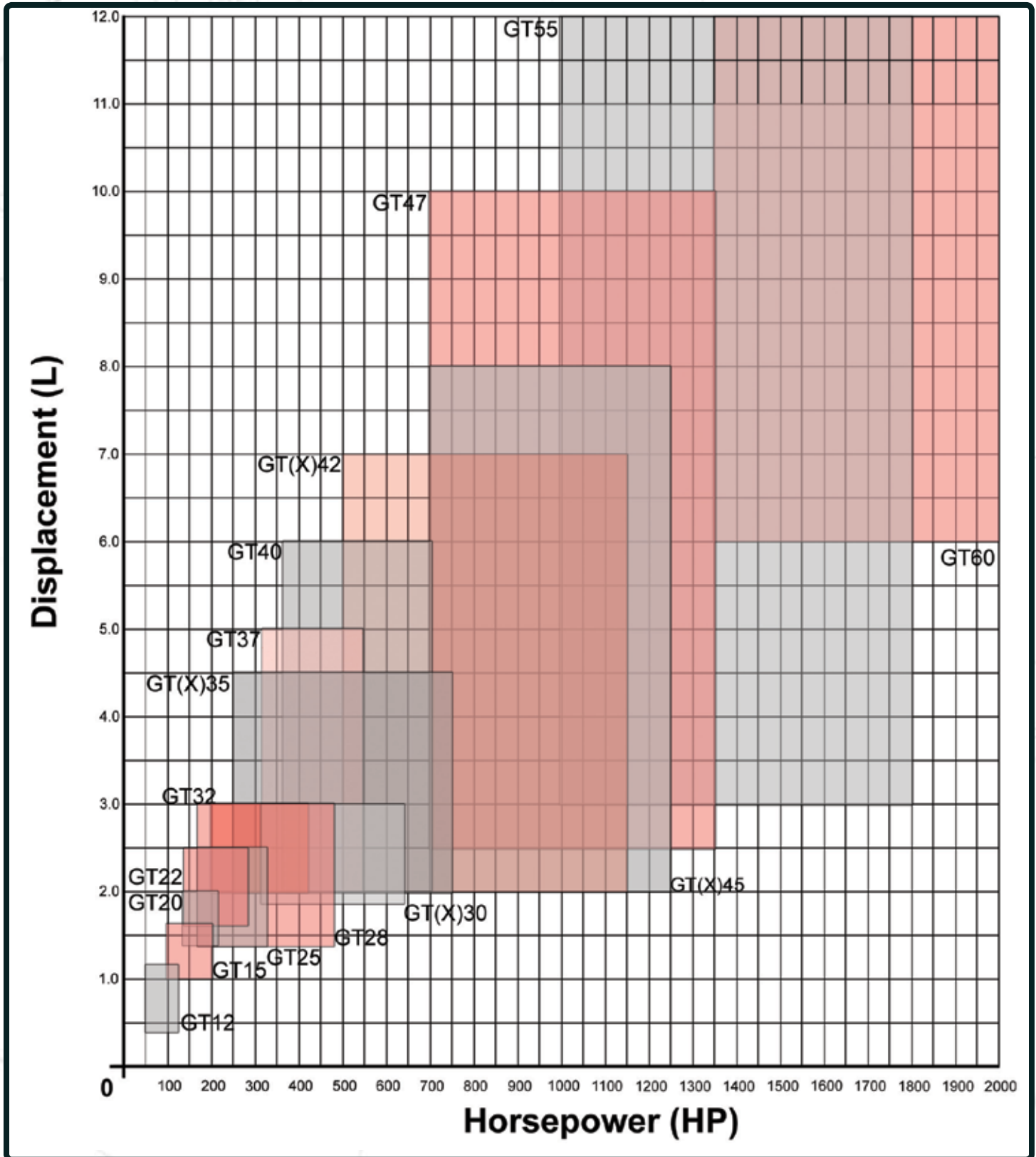


Chart represents approximations. See your Garrett® distributor for proper sizing.

TURBOCHARGERS

Proven performance

The Garrett® dual ball bearing cartridge has proven its worth in the highest level of motorsports where it has been the bearing system of choice in everything from the 24 Hours of Le Mans to drag racing. These premier racing customers demand no less than the best in durability, reliability, and power on demand. One key contributor to this performance lies in the ball bearing cartridge where it is, by design, surrounded by a thin film of oil. The oil film damps out destructive vibrations that would otherwise compromise turbo durability.

A clear demonstration of the inherent superiority of the Garrett® ball bearing design is in the launch of a turbocharged drag race car. The two-step rev limiters used to build boost on the line expose the turbo to the harshest imaginable conditions of pressure spikes and scorching temperatures. Where lesser turbos often fail catastrophically, Garrett® ball bearing turbos regularly shrug off these brutal conditions time after time. In fact, many drag racers running Garrett® ball bearing turbos have not needed to rebuild or replace their turbos for multiple seasons. Can you say that about your turbo?

Combined with the aerodynamically advanced Garrett® GT and all-new GTX wheel designs, Garrett® ball bearing turbos provide improved drivability and power on demand.

Garrett® GT & GTX-Series Turbochargers - the standard by which all others are judged.

Small Frame

GT12 - GT15 - GT20 - GT22

The fun starts here. A range of modern wastegated turbochargers ideally suited for small-displacement applications including motorcycles, snowmobiles and more.

Medium Frame

GT25 - GT28 - GT30 - GTX30 - GT32
- GT35 - GTX35

A huge selection of journal bearing turbos, housing options, and our proven, patented ball-bearing turbos. Wastegated or free-floating; from the quick-spooling GT2560R to the competition-crushing GTX3582R, you'll find your best options here whether you want 170 hp or 600 hp.

Large Frame

GT37 - GT40 - GT42 - GTX42 - GT45
- GTX45 - GT47 - GT55 - GT60

Best suited for large-displacement engines, drag racing vehicles, and other applications that require significant airflow. There are wastegated or free-floating units here, plus our exclusive large-frame ball-bearing CHRAs.

Using the Garrett® Turbo Catalog

This catalog provides images and descriptions of a representative of each family in the Garrett® lineup. Compressor maps are provided to assist in sizing your Garrett® turbo to your engine and turbine maps are provided at www.TurboByGarrett.com. This guide also gives you the inlet and outlet geometry drawings for every turbo represented. Be aware that some turbo family members not appearing in this catalog may have different flanges. References to these drawings are found in the Flange Dimensions table on each page and are linked to the Sizes & Dimensions index beginning on page 47 by the numbering system of page number - drawing number.

Ball Bearing Service Program

A great deal of pride is taken in the quality of Garrett® turbochargers and they are tested extensively. However, sometimes the unthinkable happens and a turbo fails. There is now an option for the exchange of a failed or used Garrett® CHRA on credit toward a new CHRA at an affordable price!

The program requires you take the following steps:

1. Make sure your unit is covered by the program by contacting a Garrett® Performance Distributor.
2. Send your damaged CHRA* to a Garrett® Performance Distributor for inspection.
3. Purchase a new CHRA at a discounted price!

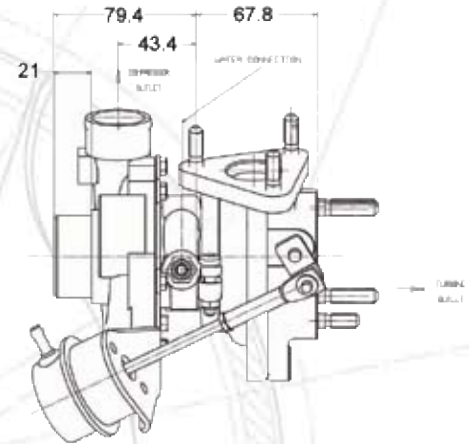
*At a minimum, the center housing must be re-usable to qualify for this program. The Garrett® Performance Distributor will determine the condition upon receiving the CHRA and has final say in the applicability of a CHRA for this program.

Visit www.TurboByGarrett.com to see the entire Garrett® GT-Series and GTX-Series line of turbochargers and to get the latest turbo product, tutorials and racing updates.

2000	DISPLACEMENT 0.4L - 1.2L
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	

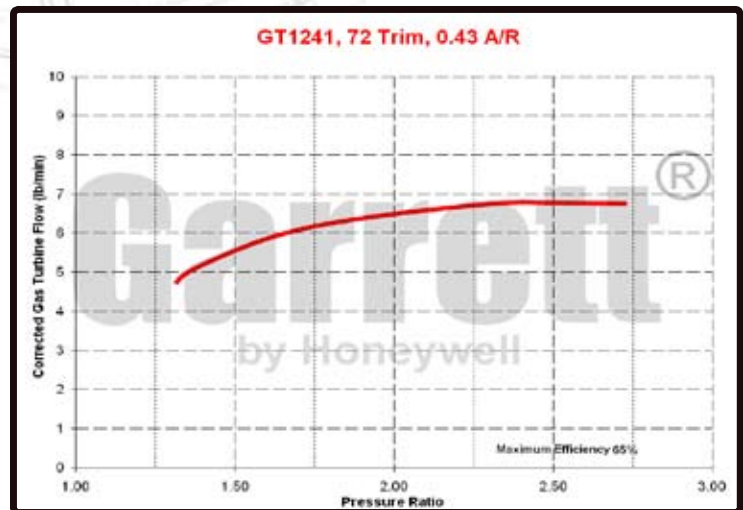
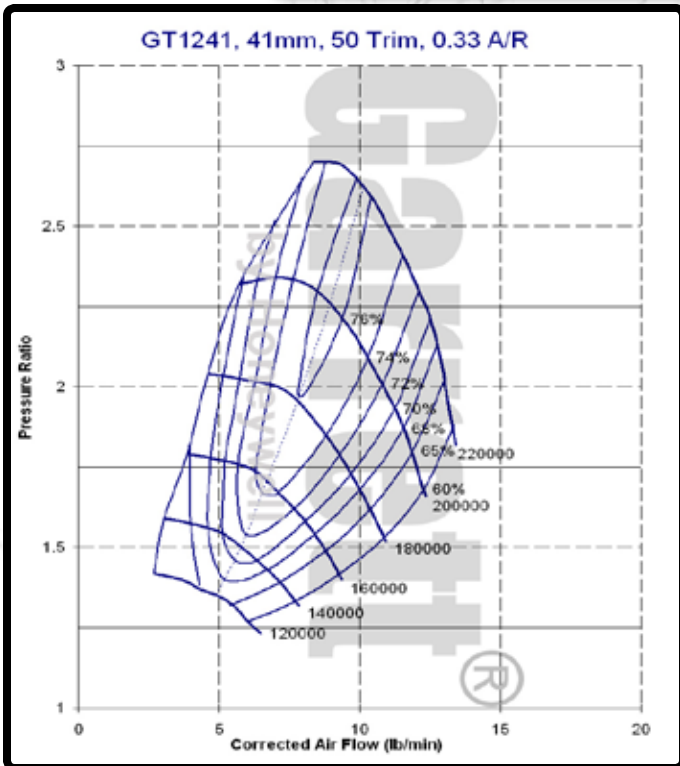


- Journal bearing, oil & water-cooled CHRA
- Smallest Garrett® turbocharger available
- Excellent for motorcycles or other small displacement engines
- Internally wastegated turbine housing, complete with actuator

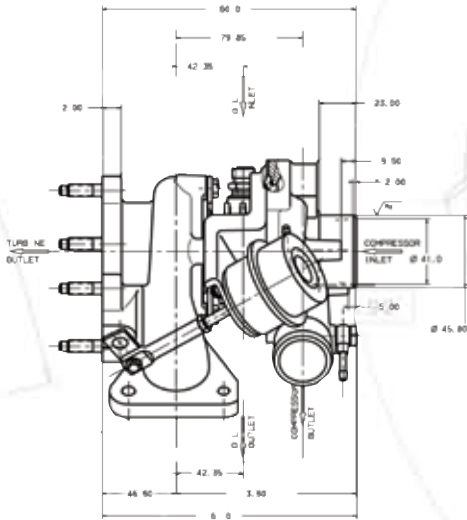


FLANGE	INLET		OUTLET	
	Component	Page	Diagram	Page
Compressor	82	13	82	09
Turbine	83	07	85	02
Oil	84	10	84	10
Water	86	12	86	12

GT1241		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
756068-1	757864-1	29.0mm	41.0mm	50	0.33	35.5mm	72	0.43



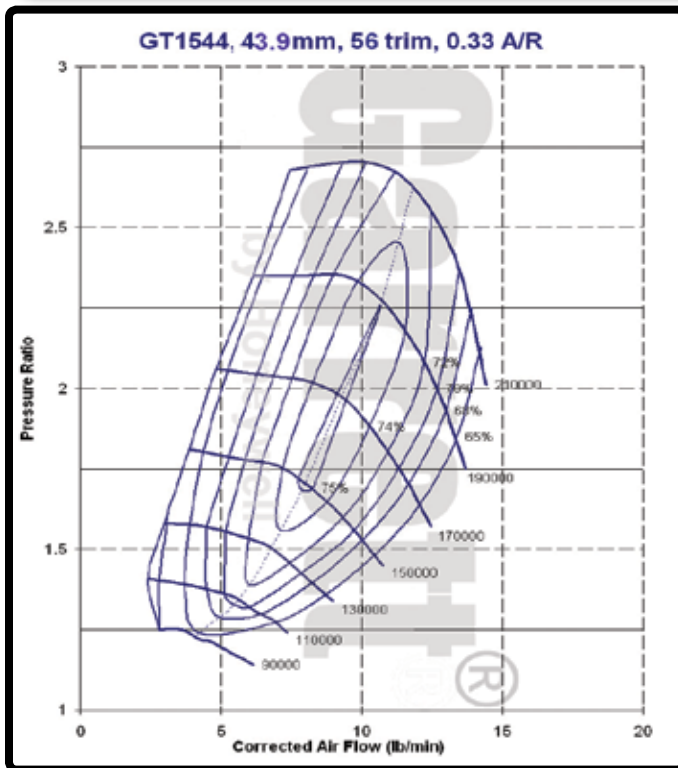
- Journal bearing, oil-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Three bolt 34mm turbine inlet



DISPLACEMENT 1.0L - 1.6L	HORSEPOWER 100 - 150	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
400		
300		
200		
100		
0		

Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	12	See Note	
Turbine	See Note		85	05
Oil	See Note		84	16
Water	-	-	-	-

GT1544		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
454082-2	433289-116	32.9mm	43.9mm	56	0.33	42.2mm	58	0.34
454083-2	433289-50	32.9mm	43.9mm	56	0.33	42.2mm	58	0.35



Dimension Note:
 Compressor Outlet: 454082-2: Page 82, Diagram 11
 454083-2: Page 82, Diagram 10
 Turbine Inlet: 454082-2: Page 83, Diagram 08
 454083-2: Page 83, Diagram 09
 Oil inlet: Both PN - M10x1.0 (F) or M14x1.5 (M)

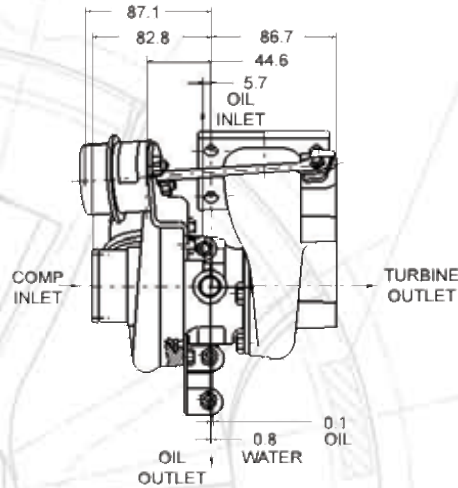


2000	DISPLACEMENT 1.0L - 1.6L HORSEPOWER 100 - 200
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	

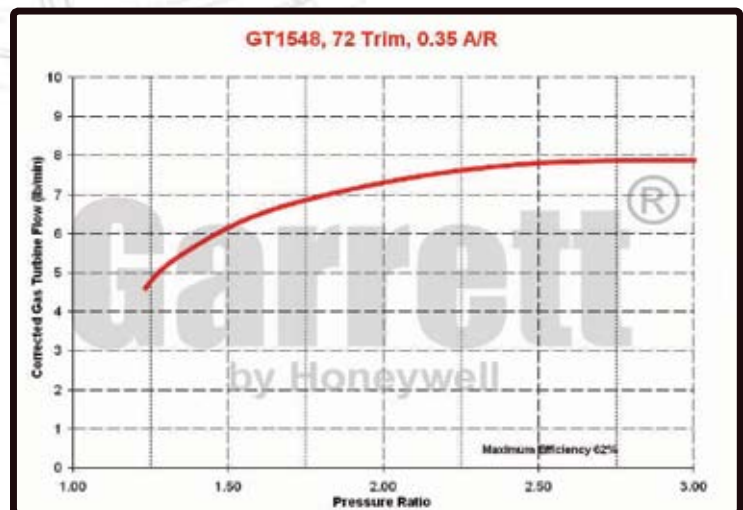
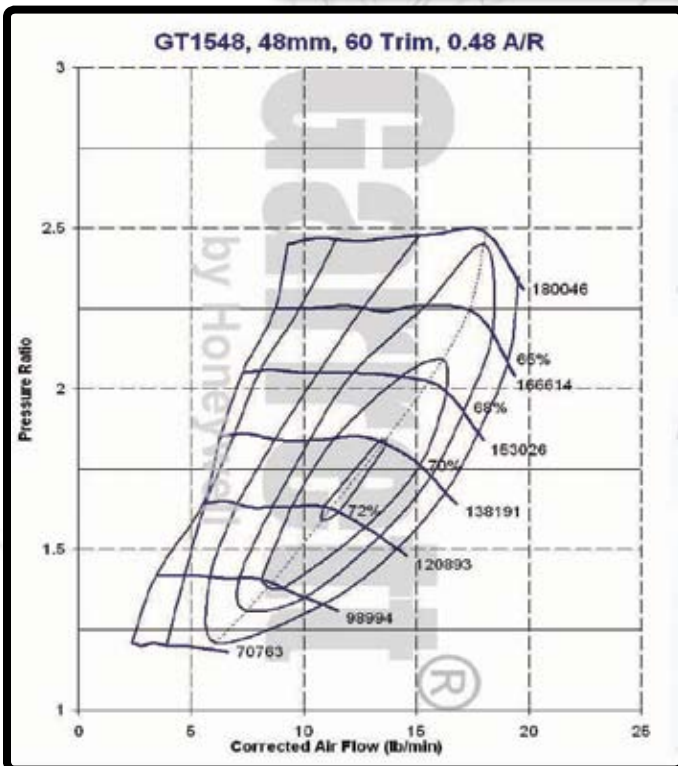


- Journal bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Excellent for motorcycles and other small displacement engines

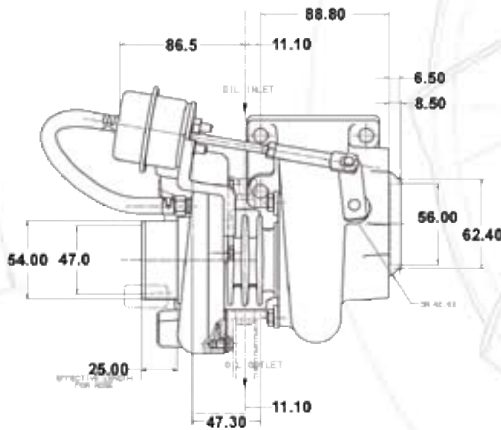
Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	15	82	15
Turbine	83	01	85	03
Oil	84	11	84	15
Water	86	13	86	13



GT1548		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
466755-3	431876-93	37.2mm	48.0mm	60	0.48	41.2mm	72	0.35



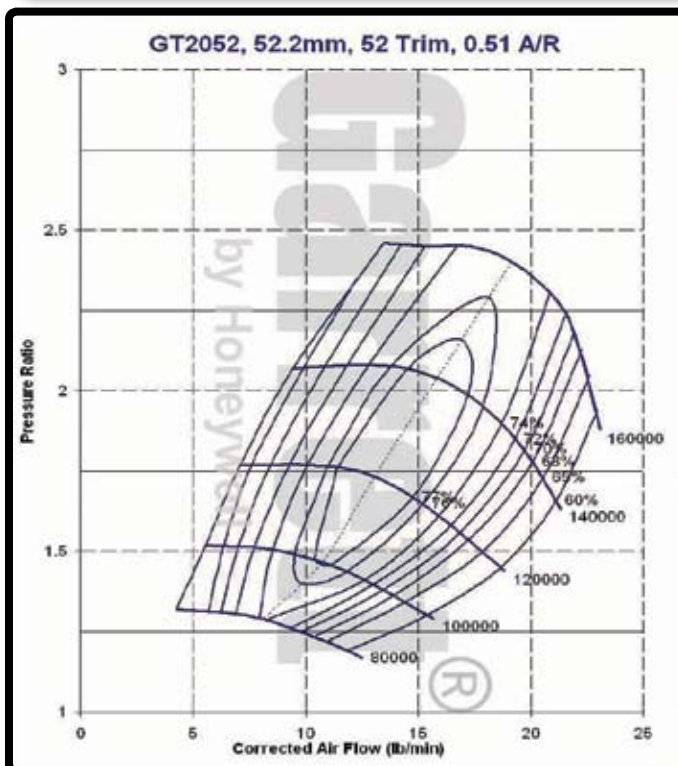
- Journal bearing, oil-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Two orientations available



Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	20	82	15
Turbine	83	06	85	01
Oil	See Note		84	16
Water	-	-	-	-

DISPLACEMENT 1.4L - 2.0L	HORSEPOWER 140 - 230	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
	400	
	300	
	200	
	100	
	0	

GT2052		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
727264-1	451298-43	37.6mm	52.2mm	52	0.51	47.0mm	72	0.50
727264-2	451298-43	37.6mm	52.2mm	52	0.51	47.0mm	72	0.50



Dimension Note:
Oil inlet: Both PN - M10x1.0 (F) or M10x1.0 (M)



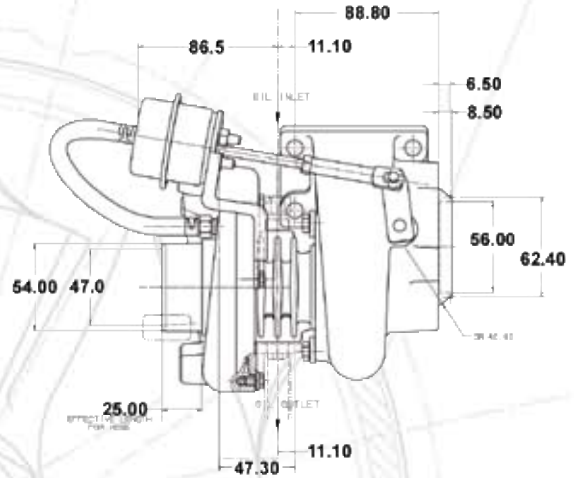
DISPLACEMENT 1.4L - 2.0L

HORSEPOWER 140 - 220

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

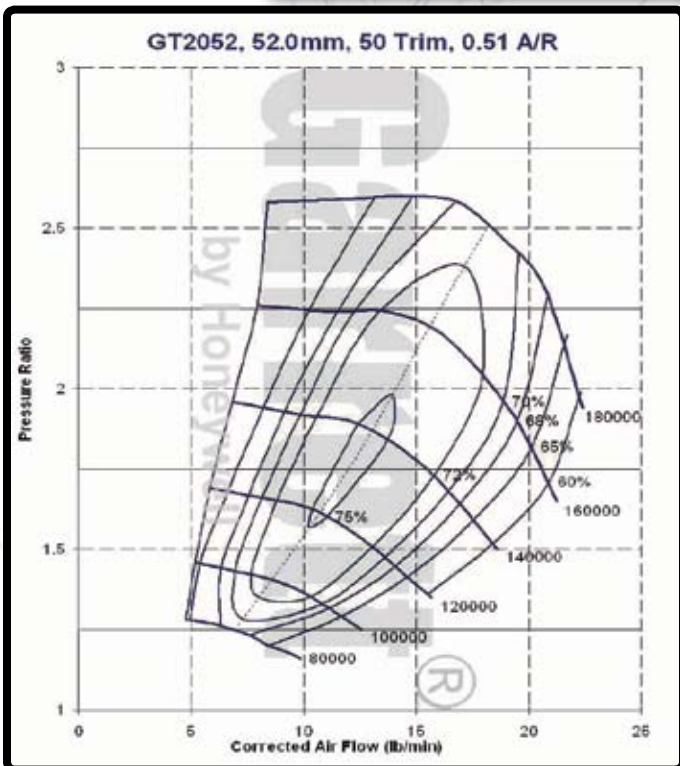


- Journal bearing, oil-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Two orientations available



Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	20	82	15
Turbine	83	06	85	01
Oil	See Note		84	16
Water	-	-	-	-

GT2052		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
727264-4	451298-45	36.8mm	52.0mm	50	0.51	47.0mm	72	0.50
727264-5	451298-45	36.8mm	52.0mm	50	0.51	47.0mm	72	0.50

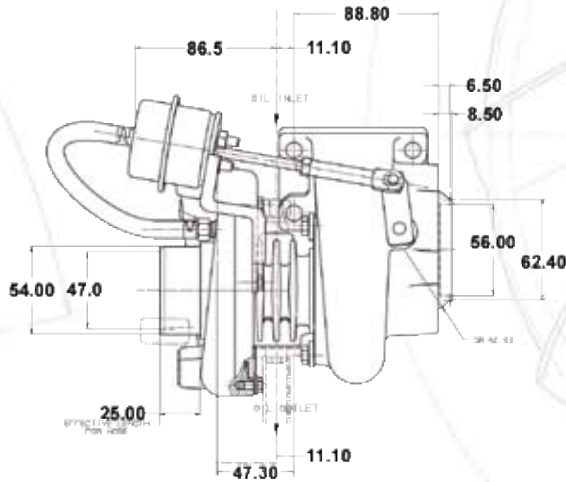


Dimension Note:
Oil Inlet: Both PN - M10x1.0 (F) or M10x1.0 (M)



DISPLACEMENT 1.4L - 2.0L
HORSEPOWER 140 - 210

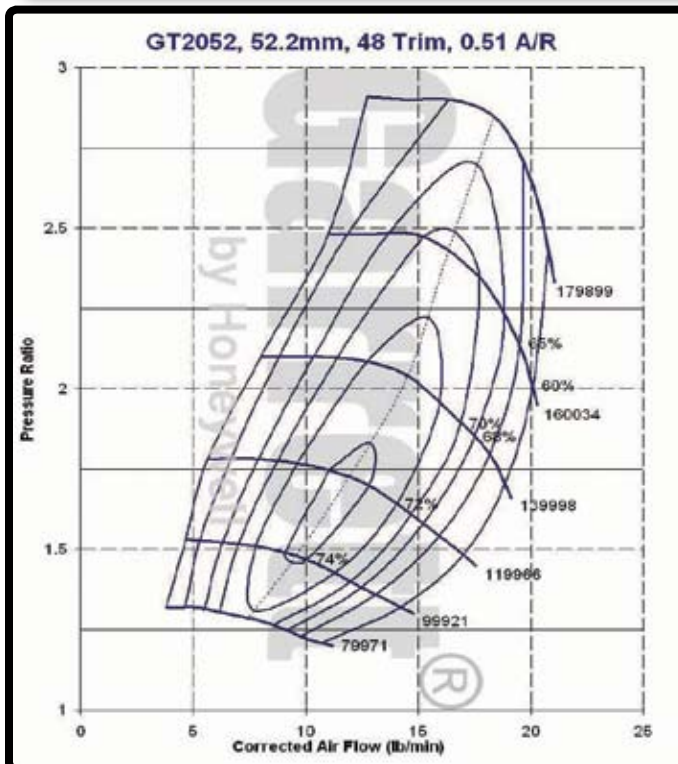
- Journal bearing, oil-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Two orientations available



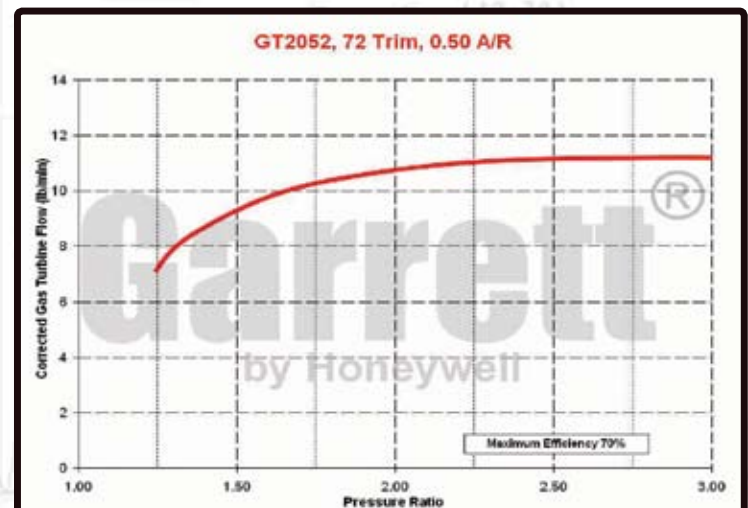
FLANGE Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	20	82	15
Turbine	83	06	85	01
Oil	See Note		84	16
Water	-	-	-	-

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

GT2052		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
727264-3	451298-44	36.1mm	52.2mm	48	0.51	47.0mm	72	0.50
727264-7	451298-44	36.1mm	52.2mm	48	0.51	47.0mm	72	0.50



Dimension Note:
Oil Inlet: Both PN - M10x1.0 (F) or M10x1.0 (M)

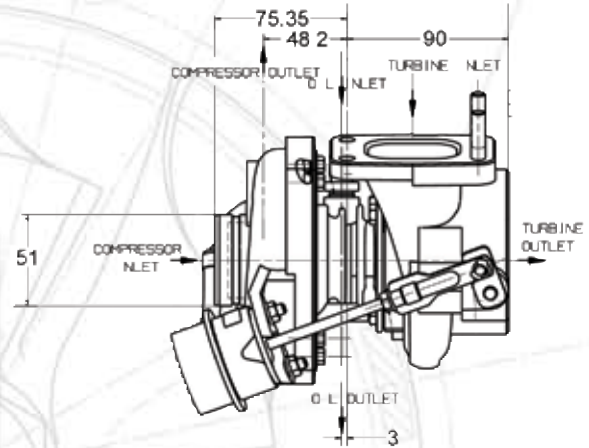


2000	DISPLACEMENT 1.4L - 2.0L
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	

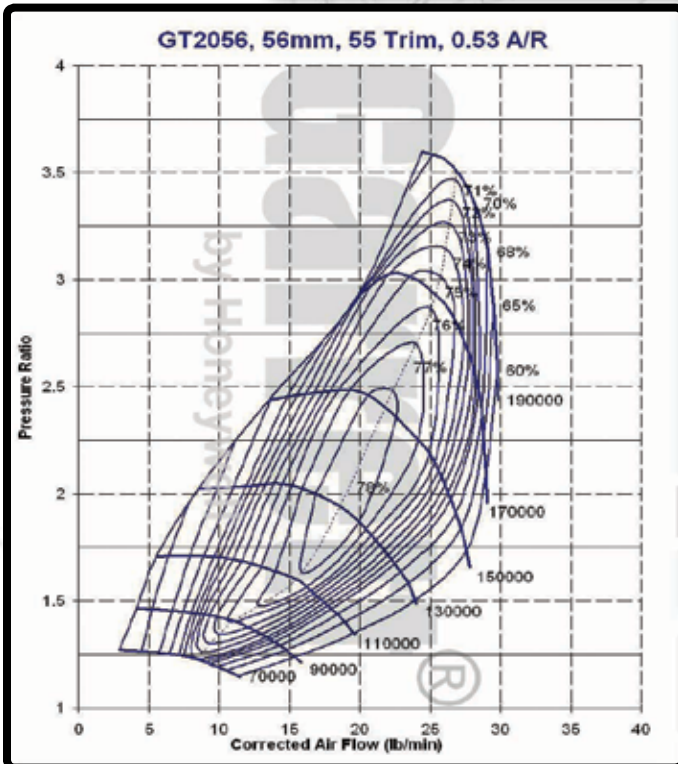


- Journal bearing, oil-cooled CHRA
- Internally wastegated turbine housing, complete with actuator

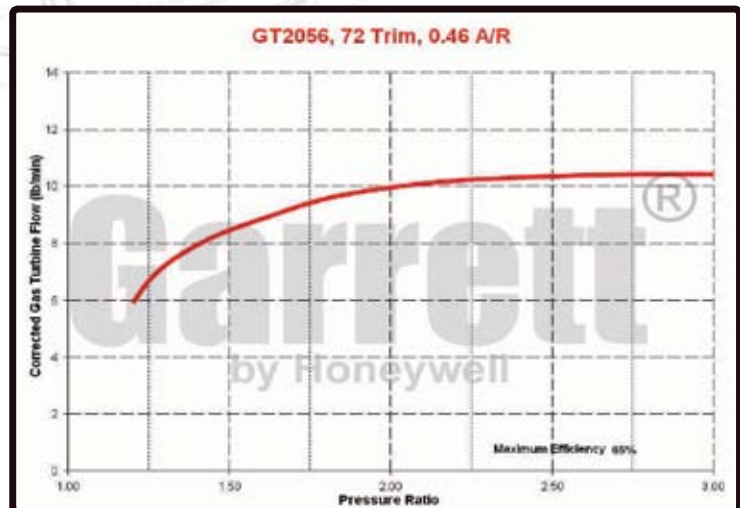
FLANGE	INLET		OUTLET	
	Component	Page	Diagram	Page
Compressor	82	18	82	16
Turbine	83	03	85	08
Oil	See Note		84	16
Water	-	-	-	-



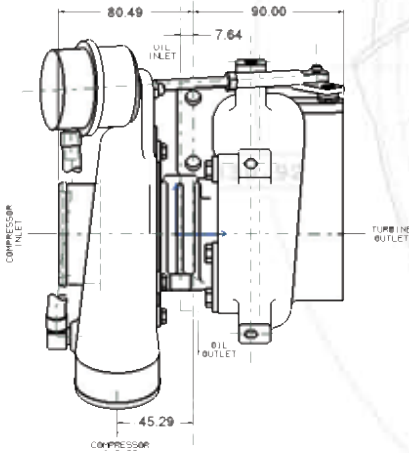
GT2056		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
751578-2	433289-234	41.5mm	56.0mm	55	0.53	47.0mm	72	0.46



Dimension Note:
Oil Inlet: Both PN - M10x1.0 (F) or M14x1.5 (M)



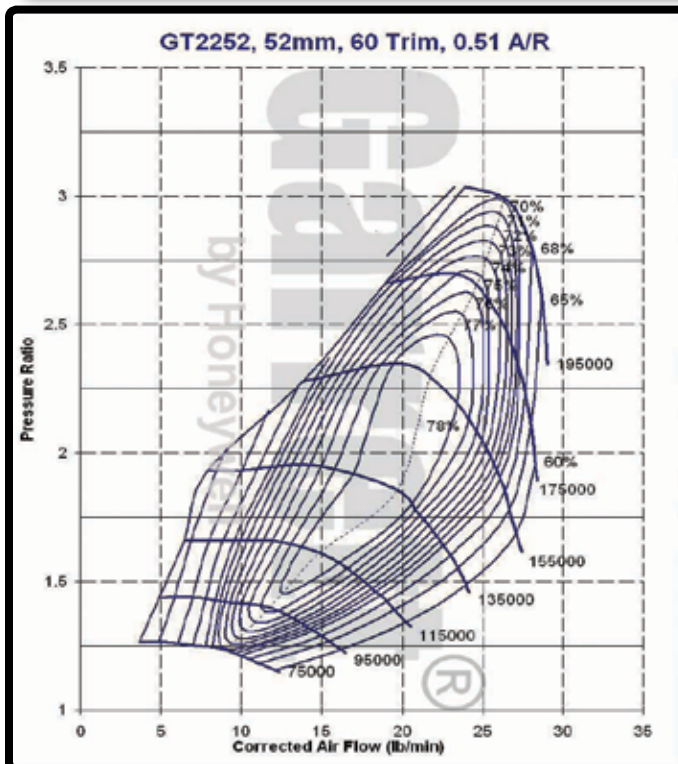
- Journal bearing, oil-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Free float turbine housing (451503-1) option available
- Extremely efficient turbo



DISPLACEMENT 1.7L - 2.5L	HORSEPOWER 150 - 260	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
	400	
	300	
	200	
	100	
	0	

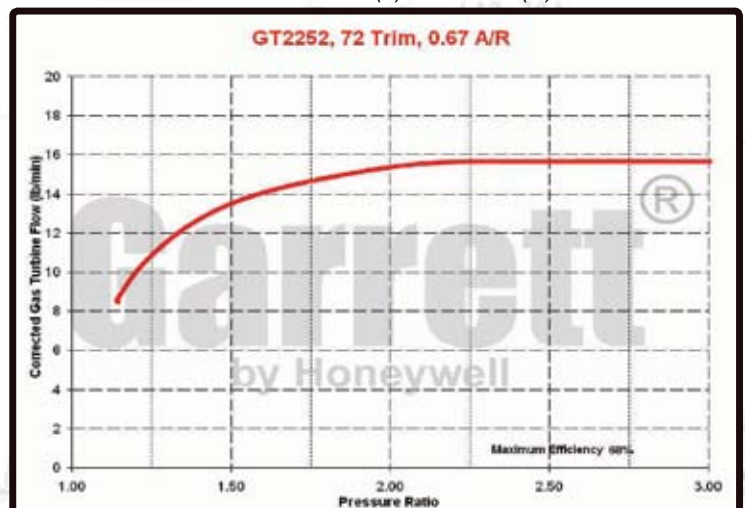
FLANGE	INLET		OUTLET	
	Component	Page	Page	Diagram
Compressor	82	21	82	15
Turbine	83	01	85	10
Oil	See Note		84	16
Water	-	-	-	-

GT2252		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
452187-6	451298-6	40.2mm	52.0mm	60	0.51	50.3mm	72	0.67



TURBINE HOUSING OPTIONS	
PN	A/R
451503-1	0.56

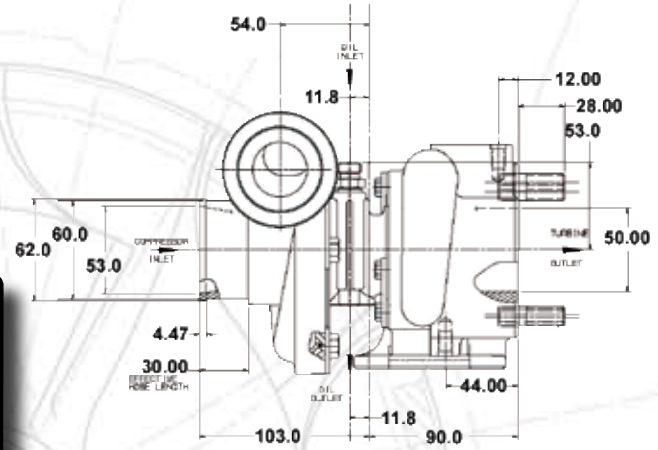
Dimension Note:
Oil Inlet: Both PN - M10x1.0 (F) or M10x1.0 (M)



2000	DISPLACEMENT 1.7L - 2.5L
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	



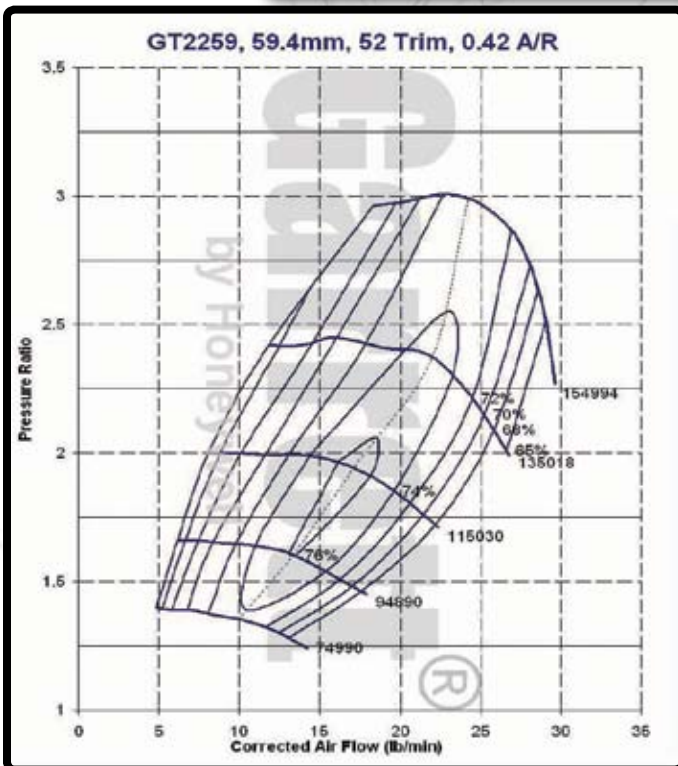
- Journal bearing, oil-cooled CHRA
- Free floating, non-wastegated turbine housing
- Internally wastegated turbine housing available (PN 436313-6)
- Extremely efficient turbo



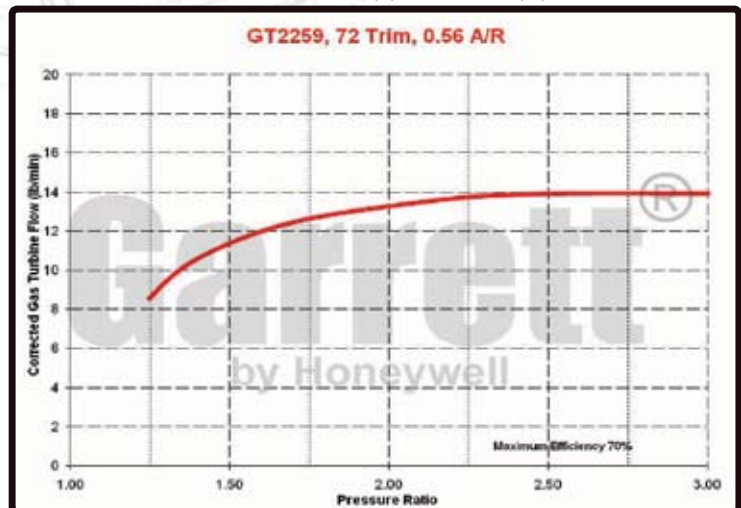
FLANGE	INLET		OUTLET	
Component	Page	Diagram	Page	Diagram
Compressor	82	22	82	05
Turbine	83	01	85	06
Oil	See Note		84	16
Water	-	-	-	-

GT2259		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
452214-3	451298-9	42.8mm	59.4mm	52	0.42	50.3mm	72	0.56

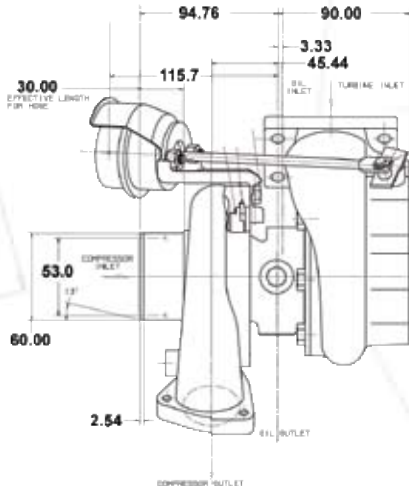
TURBINE HOUSING OPTIONS	
PN	A/R
436313-6	0.67



Dimension Note:
Oil Inlet: Both PN - M10x1.0 (F) or M14x1.0 (M)



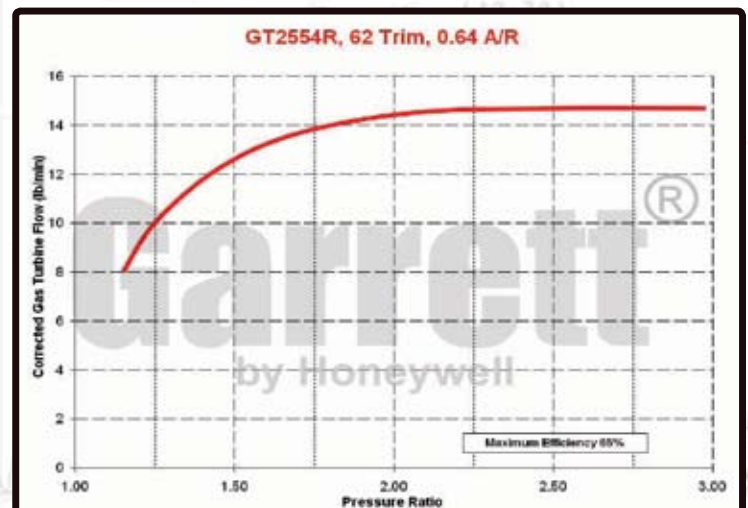
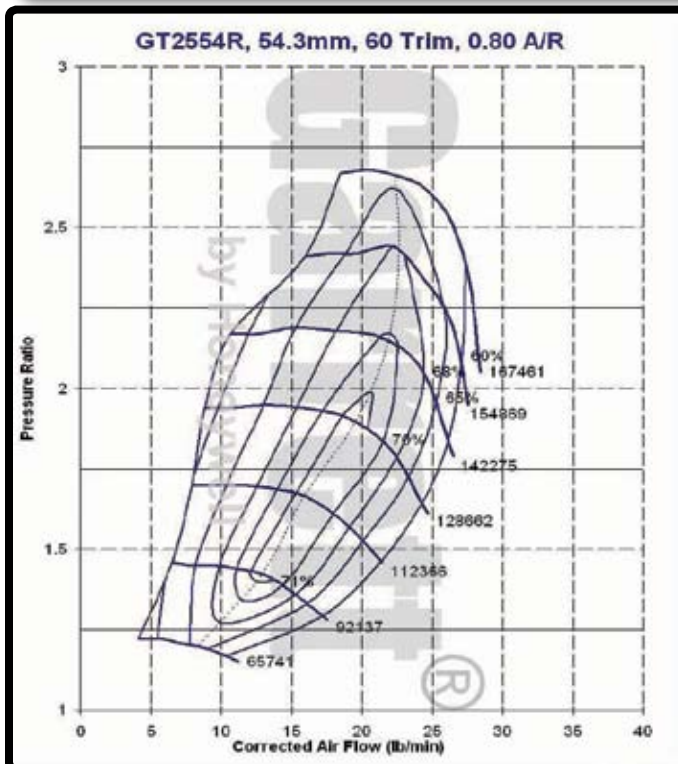
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Smallest ball bearing turbocharger
- Great size for applications with packaging constraints



DISPLACEMENT 1.4L - 2.2L	HORSEPOWER 170 - 270	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
	400	
	300	
	200	
	100	
	0	

Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	22	82	04
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

GT2554R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
471171-3	446179-24	42.1mm	54.3mm	60	0.80	53.0mm	62	0.64



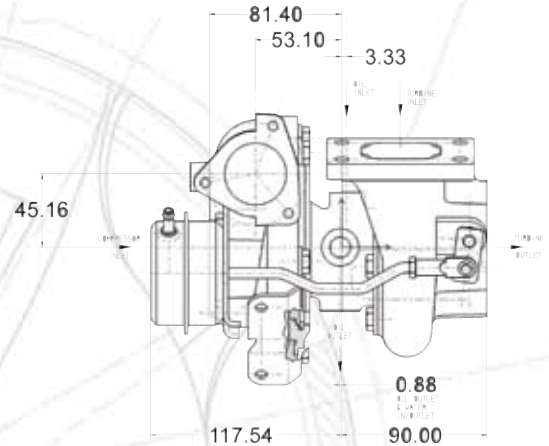
DISPLACEMENT 1.6L - 2.5L
HORSEPOWER 200 - 330

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

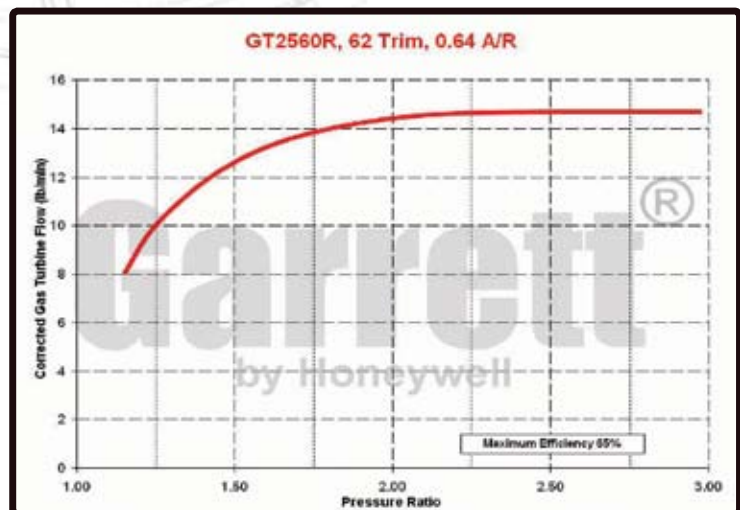
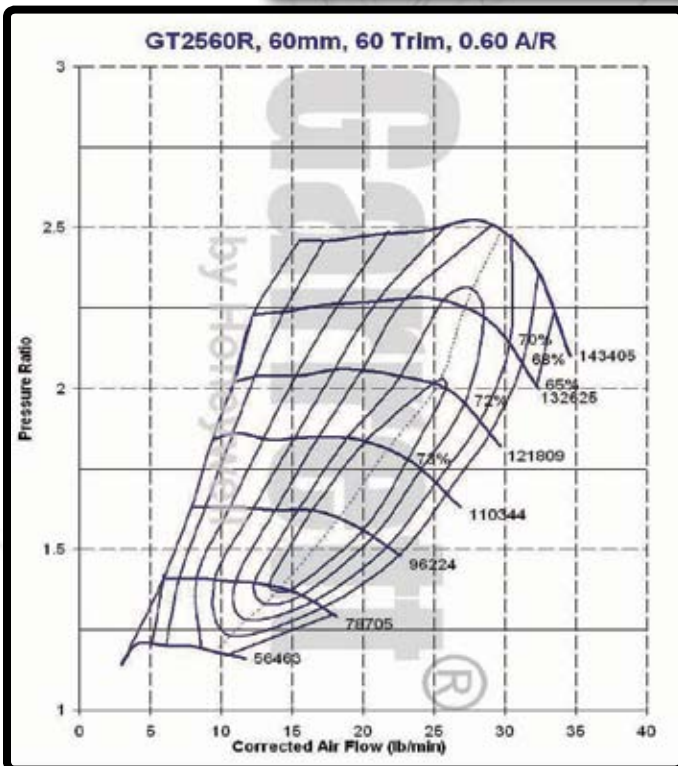


- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Turbine housing is cast from high-nickel "Ni-Resist" material (466541-4 only)
- Turbine wheel is cast from "Inconel" material for extreme applications (466541-4 only)
- OEM turbocharger on Nissan SR20DET engine
- Upgrade for GT2554R (471171-3), outline interchangeable except compressor inlet

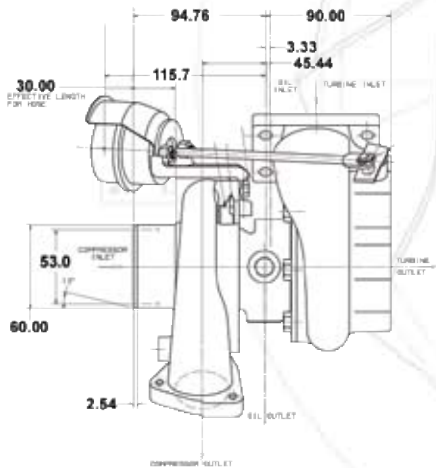
FLANGE	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	02	82	04
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13



GT2560R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
466541-1	446179-12	46.5mm	60.1mm	60	0.60	53.0mm	62	0.64
466541-4	446179-38	46.5mm	60.1mm	60	0.60	53.0mm	62	0.64



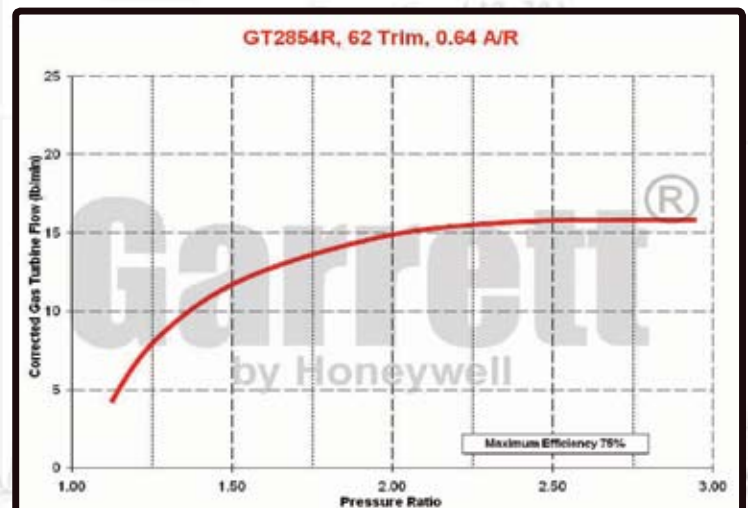
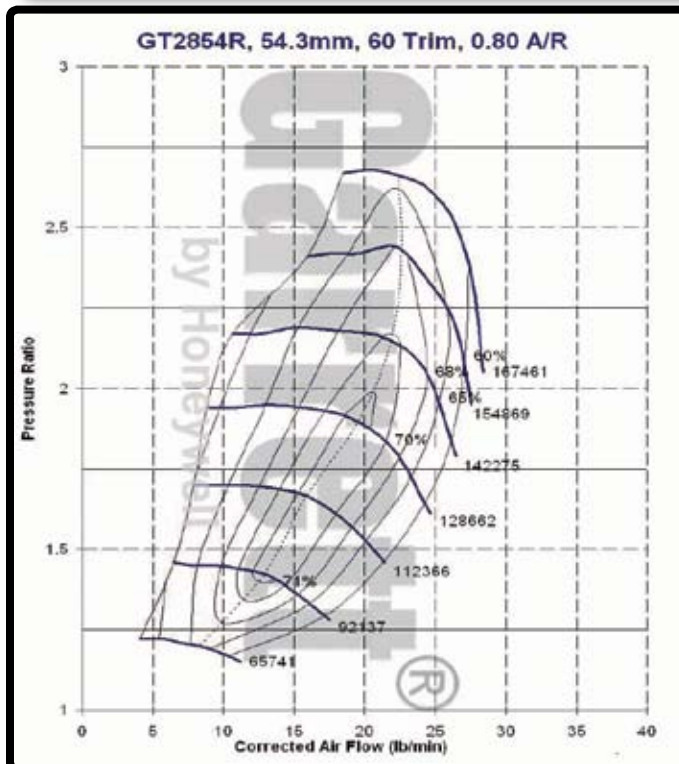
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Turbine housing is cast from high-nickel “Ni-Resist” material
- Turbine wheel is cast from “Inconel” material for extreme applications
- Similar to GT2554R (471171-3) except for slightly larger turbine wheel, different turbine housing and wheel materials



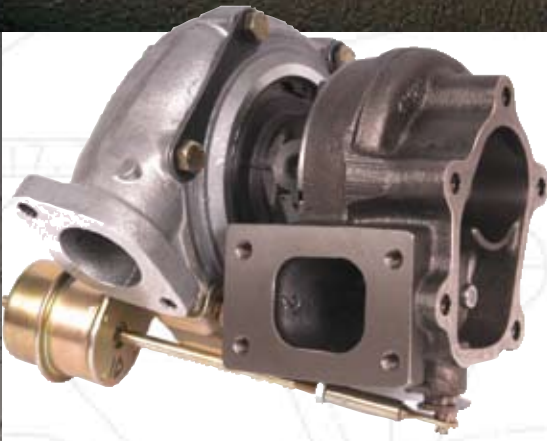
Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	22	82	04
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

DISPLACEMENT 1.4L - 2.2L	2000
	1900
	1800
	1700
	1600
	1500
	1400
	1300
	1200
	1100
	1000
	900
	800
	700
	600
	500
	400
300	
200	
100	
0	

GT2854R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
471171-9	446179-47	42.1mm	54.3mm	60	0.80	53.9mm	62	0.64

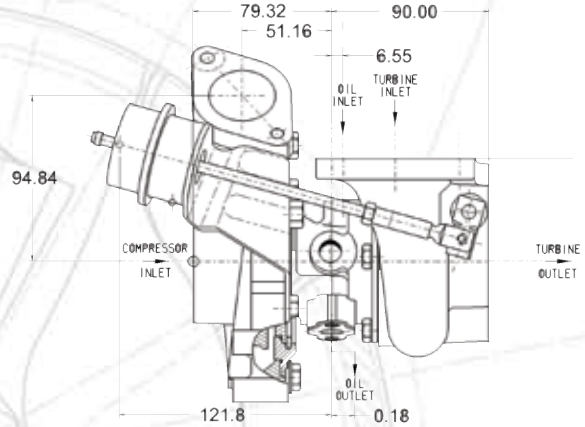


2000	DISPLACEMENT 1.8L - 3.0L
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	



- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing; 780371-1 complete with actuator, 707160-9 does NOT include actuator
- Turbine housing has a unique “compact” 5-bolt outlet that is not interchangeable with traditional T25 5-bolt outlets
- Turbine housing cast from high-nickel “Ni-Resist” material
- Turbine wheel is cast from “Inconel” material for extreme applications
- Bolt-on upgrade for Nissan RB26DETT

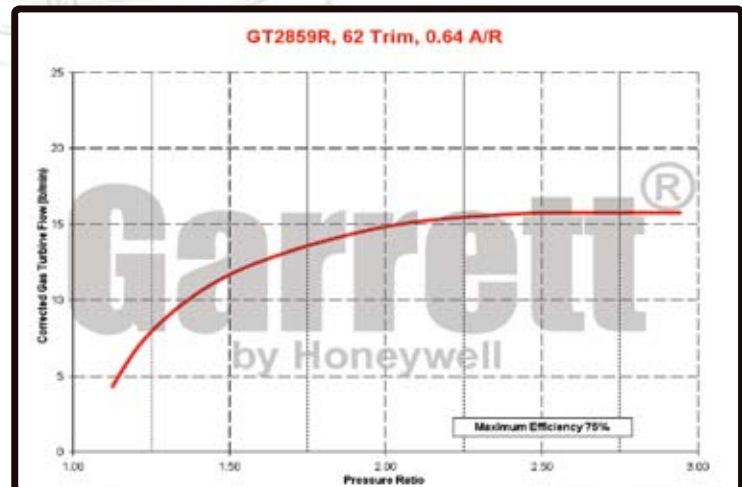
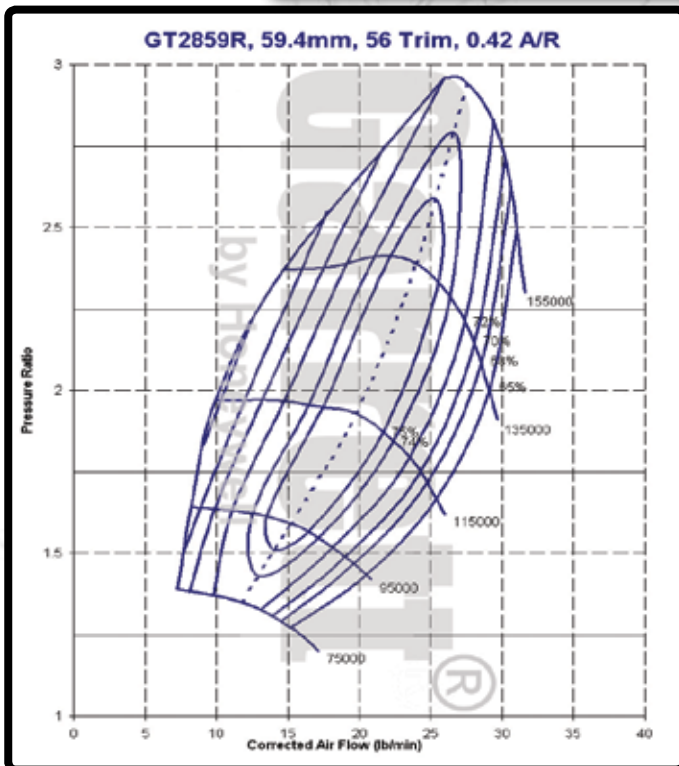
FLANGE	INLET		OUTLET	
	Component	Page	Diagram	Page
Compressor	82	02	82	01
Turbine	83	02	85	09
Oil	84	11	84	15
Water	86	13	86	13



GT2859R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
780371-1	446179-65	44.5mm	59.4mm	56	0.42	53.9mm	62	0.64
707160-9	446179-65	44.5mm	59.4mm	56	0.42	53.9mm	62	0.64

TURBINE HOUSING OPTIONS	
PN	A/R
430609-230*	0.64
430609-231*	0.86

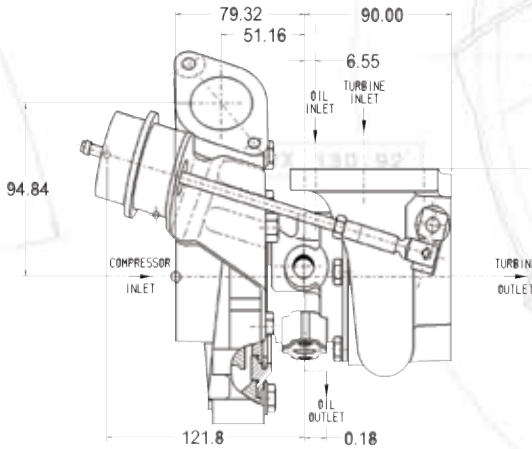
* Note: allows turbo to be outline interchangeable with other turbos using the traditional 5-bolt turbine housing (Diagram 85-11) Housing fits over turbine wheel but actuator/wastegate fitment may need to be adjusted



- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Turbine housing has a unique “compact” 5-bolt outlet that is not interchangeable with traditional T25 5-bolt outlets
- Turbine housing cast from high-nickel “Ni-Resist” material
- Turbine wheel is cast from “Inconel” material for extreme applications
- Bolt-on turbo for Nissan RB26DETT

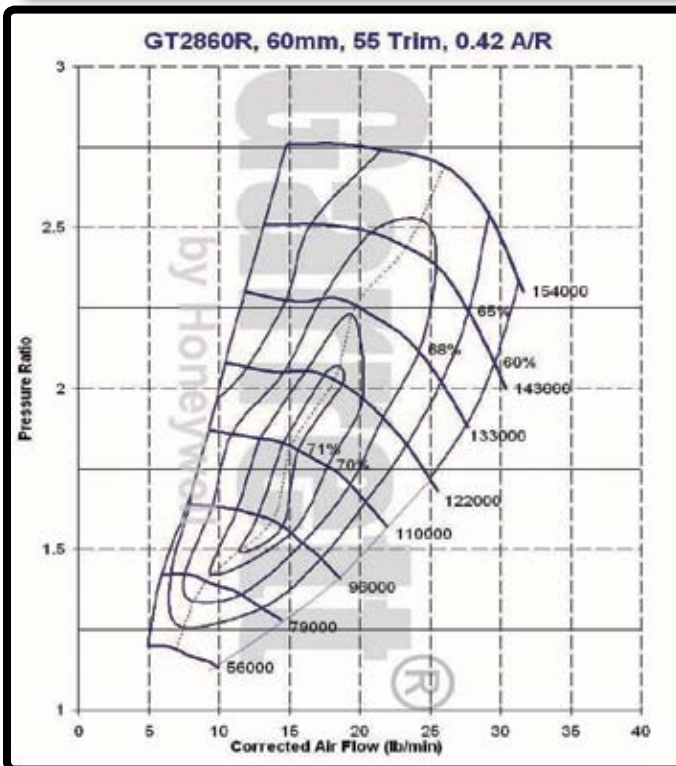


DISPLACEMENT 1.8L - 3.0L	HORSEPOWER 150 - 310	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
	400	
	300	
	200	
	100	
	0	

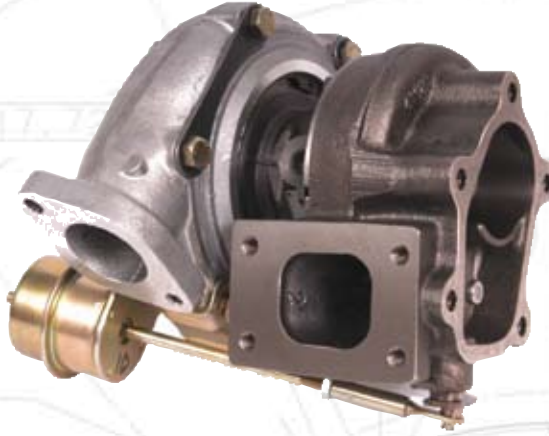


FLANGE	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	02	82	01
Turbine	83	02	85	09
Oil	84	11	84	15
Water	86	13	86	13

GT2860R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
707160-7	446179-54	44.6mm	60.1mm	55	0.42	53.9mm	62	0.64

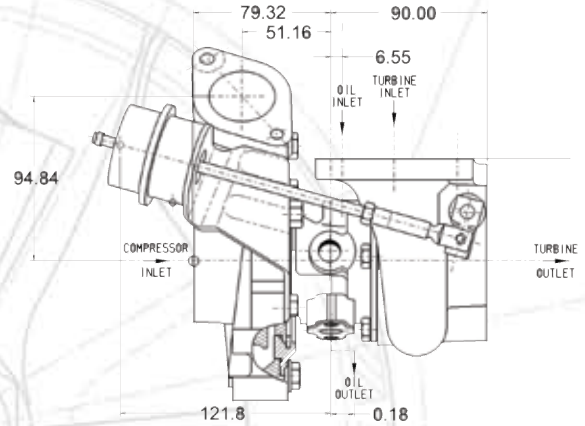


2000	DISPLACEMENT 1.8L - 3.0L HORSEPOWER 250 - 360
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	



- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Turbine housing has a unique “compact” 5-bolt outlet that is not interchangeable with traditional T25 5-bolt outlets
- Bolt-on upgrade for Nissan RB26DETT
- Turbine housing cast from “Ni-Resist”
- Turbine wheel is cast from “Inconel” material for extreme applications

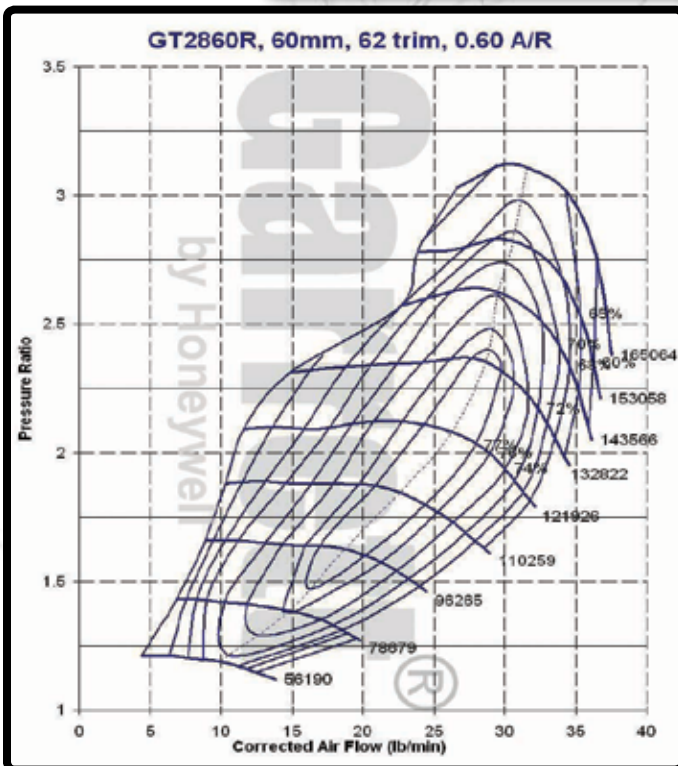
FLANGE	INLET		OUTLET	
Component	Page	Diagram	Page	Diagram
Compressor	82	02	82	01
Turbine	83	02	85	09
Oil	84	11	84	18
Water	86	13	86	13



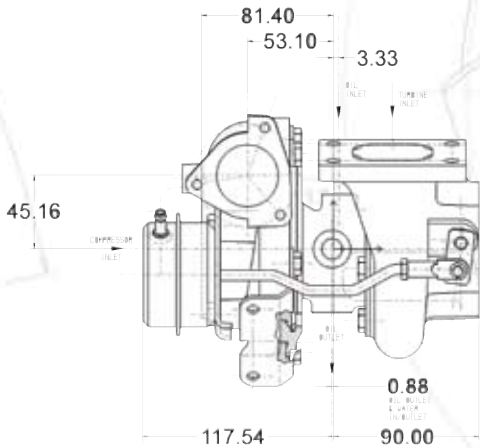
GT2860R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
707160-5	446179-51	47.2mm	60.1mm	62	0.60	53.9mm	76	0.64

TURBINE HOUSING OPTIONS	
PN	A/R
430609-230*	0.64
430609-231*	0.86

* Note: allows turbo to be outline interchangeable with other turbos using the traditional 5-bolt turbine housing (Diagram 85-11). Housing fits over turbine wheel but actuator/wastegate fitment may need to be adjusted



- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Upgrade turbocharger for GT2554R (471171-3) and GT2854R (471171-9)
- Essentially, a GT2860RS Disco Potato turbo with a GT2560R compressor housing
- Turbine wheel is cast from "Inconel" material for extreme applications



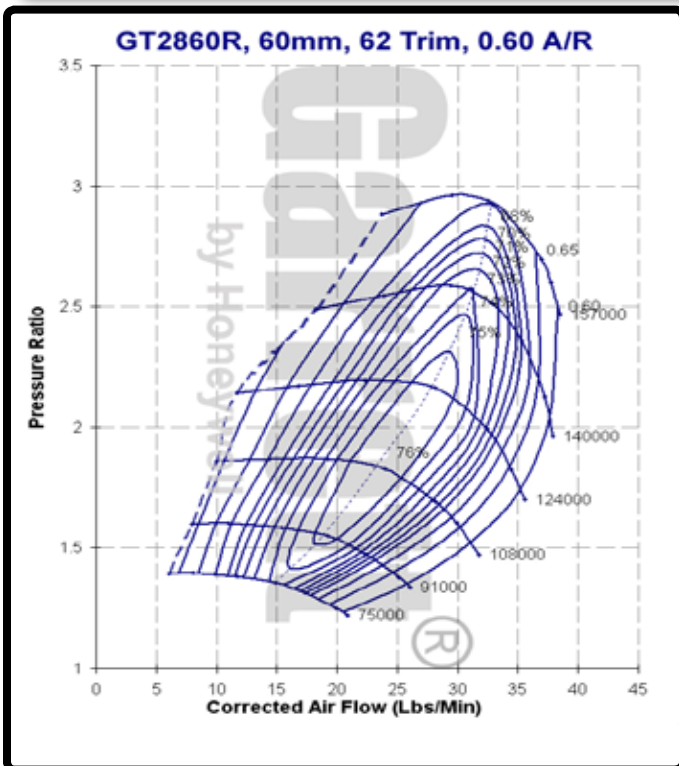
Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	02	82	04
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

DISPLACEMENT 1.8L - 3.0L

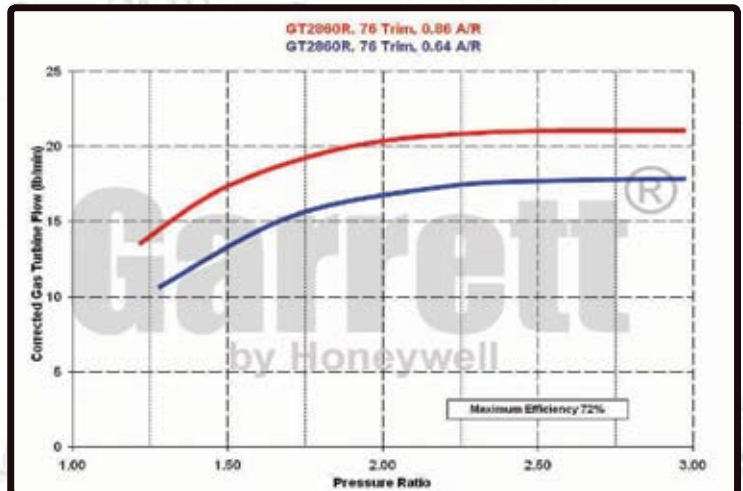
HORSEPOWER 250 - 360

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

GT2860R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
739548-9	446179-66	47.2mm	60.1mm	62	0.60	53.9mm	76	0.86



TURBINE HOUSING OPTIONS	
PN	A/R
430609-230	0.64
430609-231	0.86



GT2860RS

The "Disco Potato"

Garrett®
by Honeywell

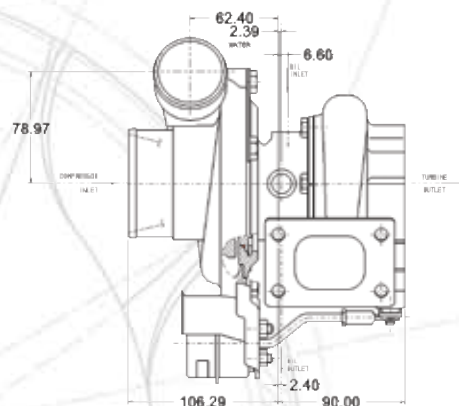
DISPLACEMENT 1.8L - 3.0L
HORSEPOWER 250 - 360

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

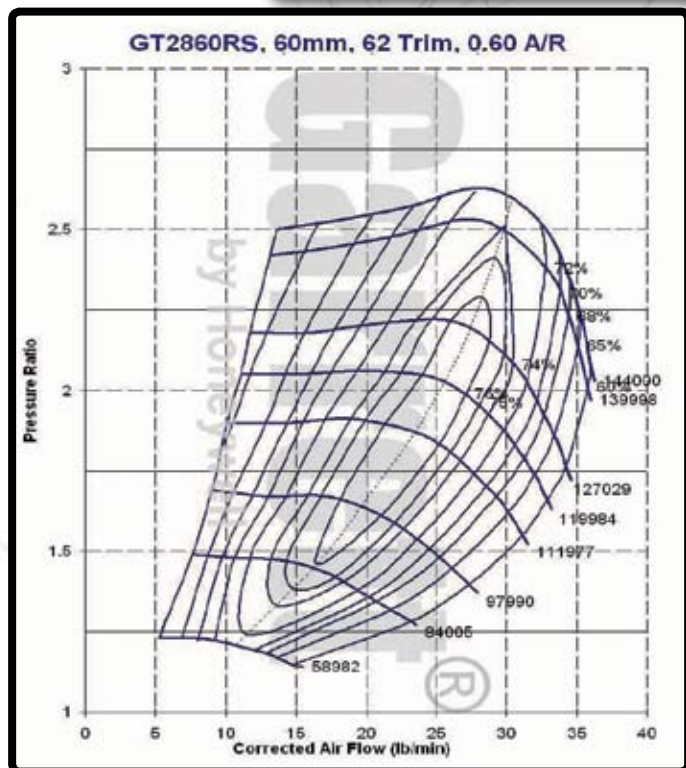


- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Upgrade turbocharger for GT2554R (471171-3) and GT2560R (466541-1); turbine housing flanges are outline interchangeable
- Turbine wheel is cast from "Inconel" material for extreme applications
- "Disco Potato" refers to the Nissan Sentra (potato-shaped body) with psychedelic color-change paint (disco) that was fitted with one of the first GT2860RS' in a project car build. The name stuck.

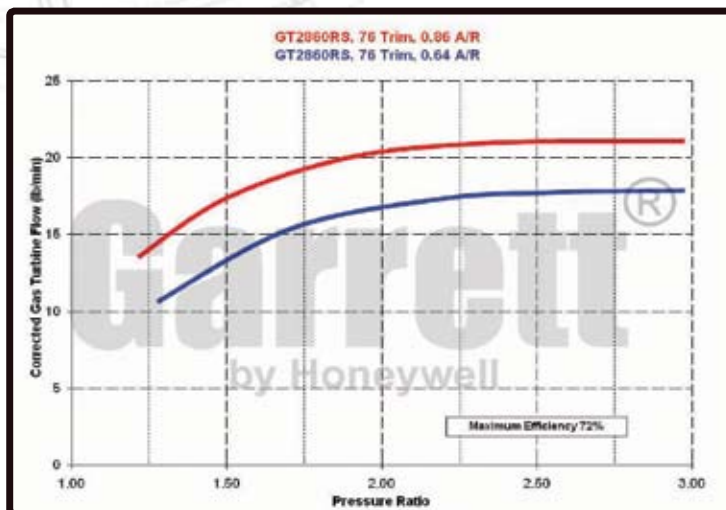
FLANGE	INLET		OUTLET	
Component	Page	Diagram	Page	Diagram
Compressor	82	28	82	19
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13



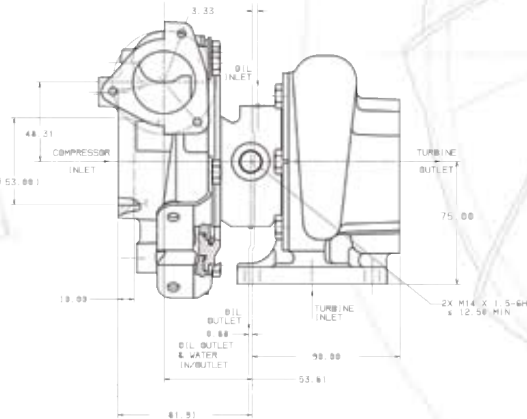
GT2860RS		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
739548-1	446179-66	47.2mm	60.1mm	62	0.60	53.9mm	76	0.86
739548-5	446179-66	47.2mm	60.1mm	62	0.60	53.9mm	76	0.64



TURBINE HOUSING OPTIONS	
PN	A/R
430609-230	0.64
430609-231	0.86



- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing; 771847-1 complete with adjustable actuator, 472560-15 does NOT include actuator
- Provides better boost response than turbochargers 743347-1 & 743347-2
- Direct replacement upgrade for GT2560R (466541-1 & 4) used on Nissan SR20DET engine
- Turbine housing cast from “Ni-Resist” material
- Turbine wheel is cast from “Inconel” material for extreme applications



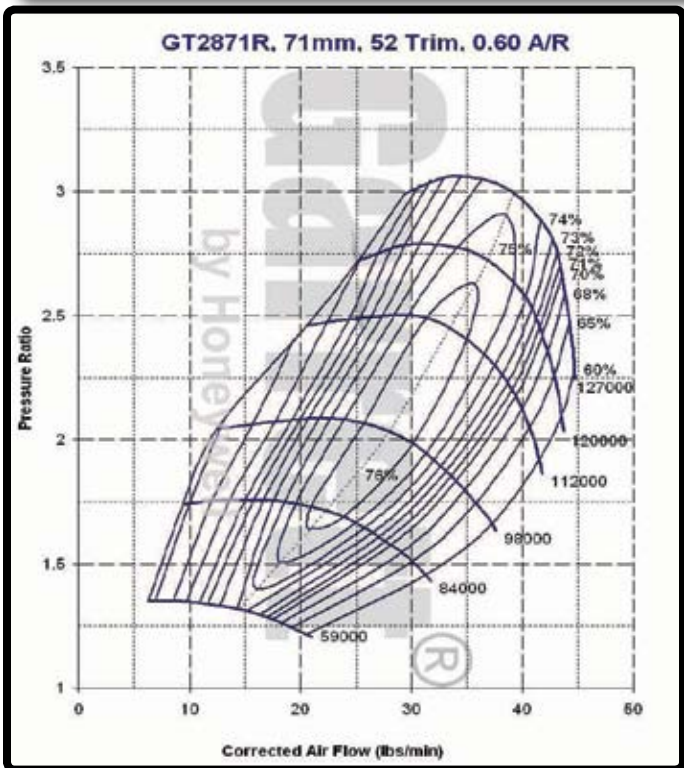
DISPLACEMENT 1.8L - 3.0L

HORSEPOWER 280 - 460

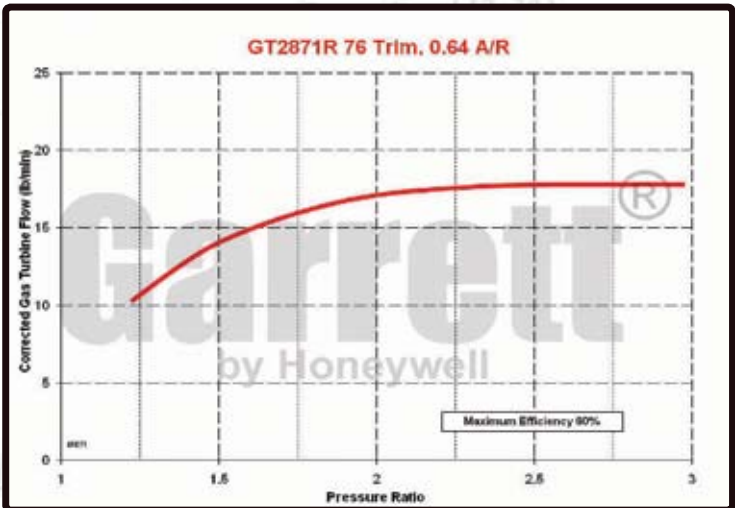
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	02	82	04
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

GT2871R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
472560-15	446179-67	51.2mm	71.0mm	52	0.60	53.9mm	76	0.64
771847-1	446179-67	51.2mm	71.0mm	52	0.60	53.9mm	76	0.64

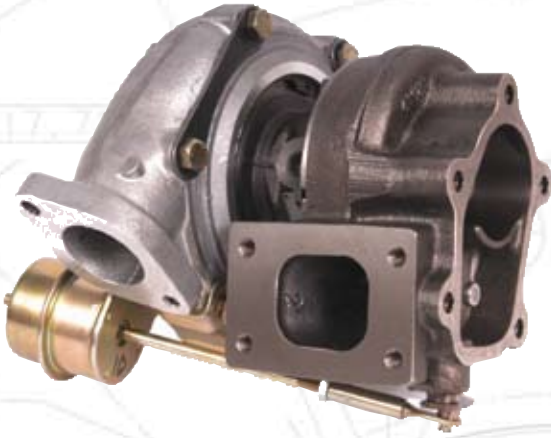


TURBINE HOUSING OPTIONS	
PN	A/R
430609-231	0.86

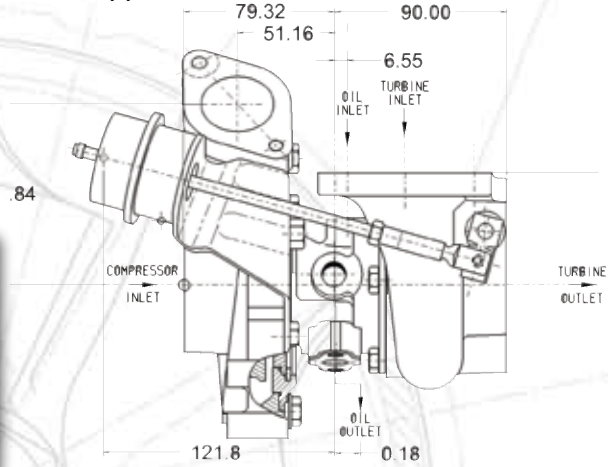


DISPLACEMENT 1.8L - 3.0L
HORSEPOWER 280 - 475

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0



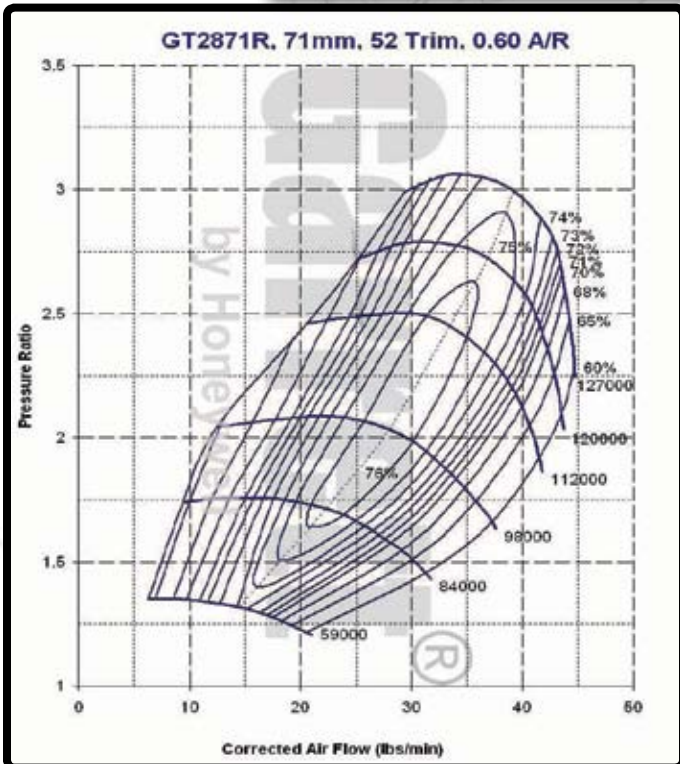
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Internally wastegated turbine housing; 780371-2 includes actuator, 707160-10 does NOT include actuator
- Turbine housing cast from high-nickel "Ni-Resist" material
- Turbine wheel is cast from "Inconel" material for extreme applications



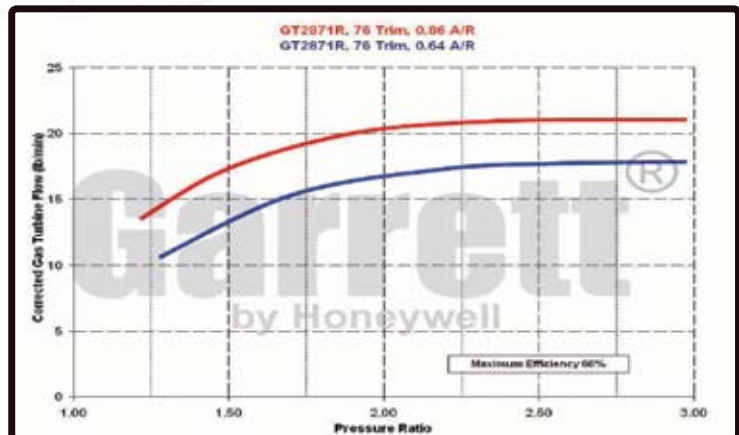
Component	FLANGE		INLET		OUTLET	
	Page	Diagram	Page	Diagram	Page	Diagram
Compressor	82	02	82	01		
Turbine	83	02	85	09		
Oil	84	11	84	18		
Water	86	13	86	13		

GT2871R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
780371-2	446179-67	51.2mm	71.0mm	52	0.60	53.9mm	76	0.64
707160-10	446179-67	51.2mm	71.0mm	52	0.60	53.9mm	76	0.64

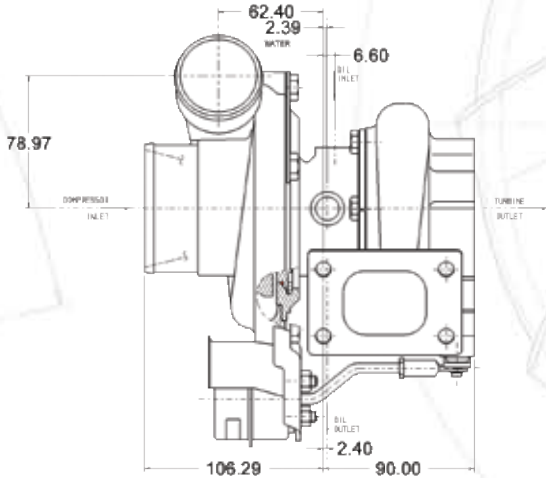
TURBINE HOUSING OPTIONS	
PN	A/R
430609-230*	0.64
430609-231*	0.86



* Note: allows turbo to be outline interchangeable with other turbos using the traditional 5-bolt turbine housing. Housing fits over turbine wheel but actuator/wastegate fitment may need to be adjusted



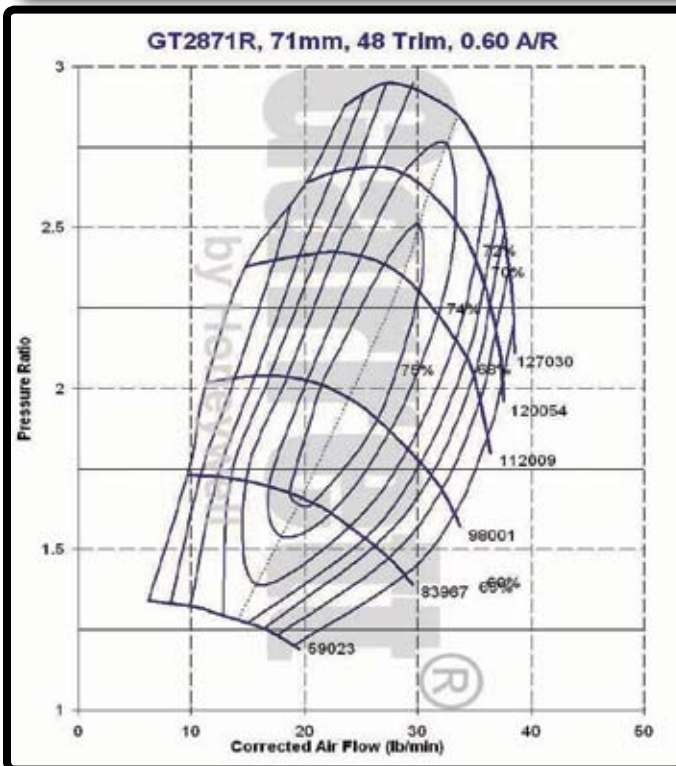
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing complete with actuator
- Upgrade turbocharger for GT2860RS (739548-1)
- 743347-1 features a high boost actuator adjustable down to 12 psi
- 743347-3 features a low boost actuator adjustable down to 6 psi
- Turbine wheel is cast from "Inconel" material for extreme applications



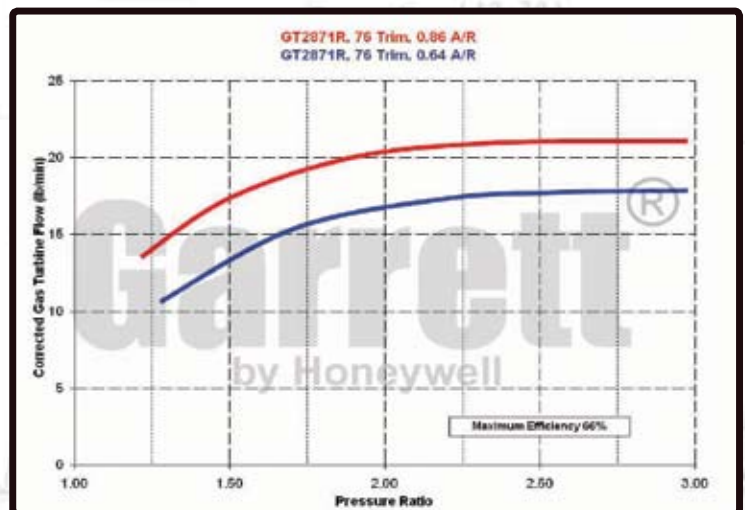
DISPLACEMENT 1.8L - 3.0L	HORSEPOWER 250 - 400	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
400		
300		
200		
100		
0		

Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	28	82	19
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

GT2871R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
743347-1	446179-31	49.2mm	71.0mm	48	0.60	53.9mm	76	0.86
743347-3	446179-31	49.2mm	71.0mm	48	0.60	53.9mm	76	0.64



TURBINE HOUSING OPTIONS	
PN	A/R
430609-230	0.64
430609-231	0.86

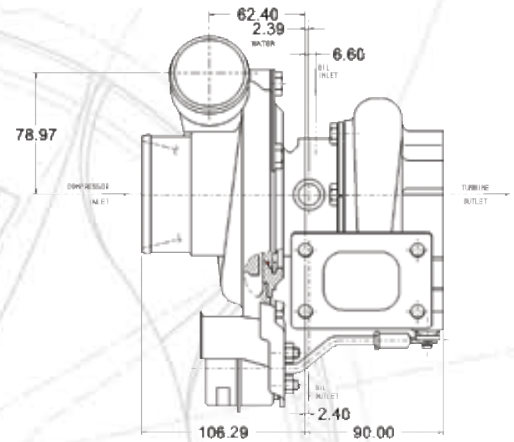


2000	DISPLACEMENT 1.8L - 3.0L
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	



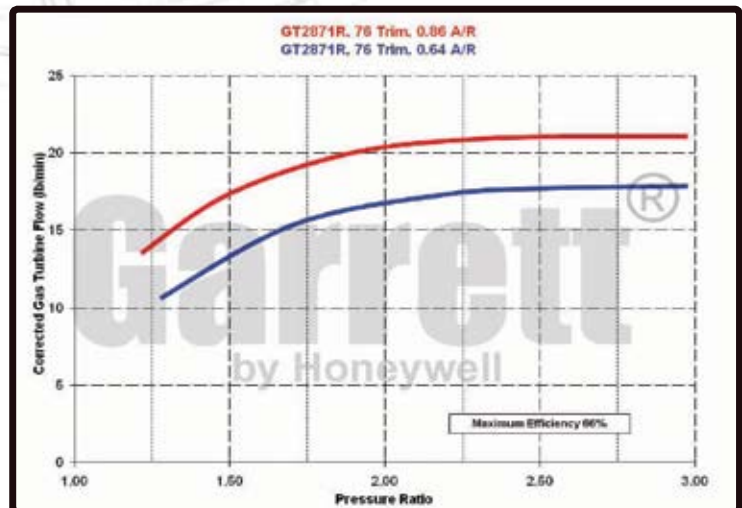
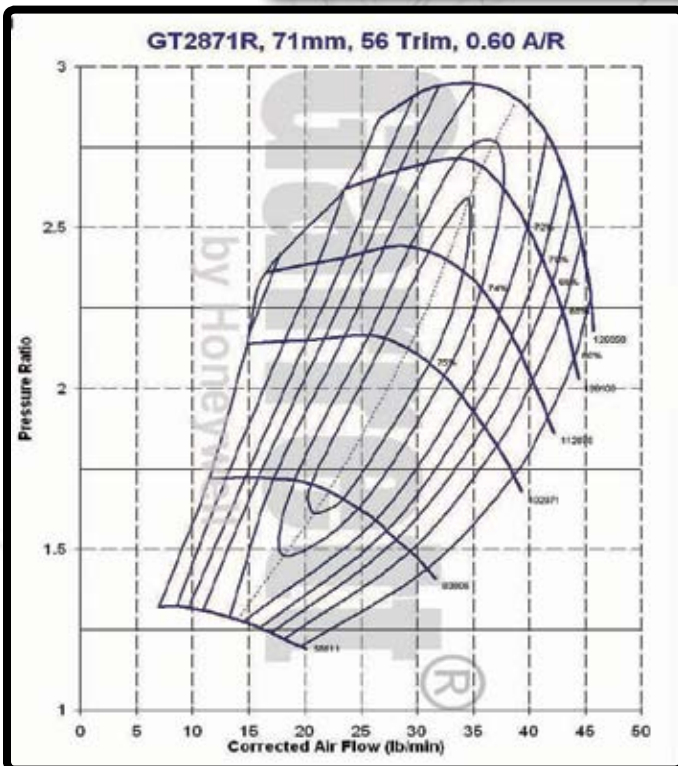
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, complete with actuator
- Direct bolt-on upgrade turbocharger for GT2860RS (PN 739548-1)
- 743347-2 features a high boost actuator adjustable down to 12 psi
- 743347-4 features a low boost actuator adjustable down to 6 psi
- Turbine wheel is cast from "Inconel" material for extreme applications

FLANGE	INLET		OUTLET	
Component	Page	Diagram	Page	Diagram
Compressor	82	28	82	19
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

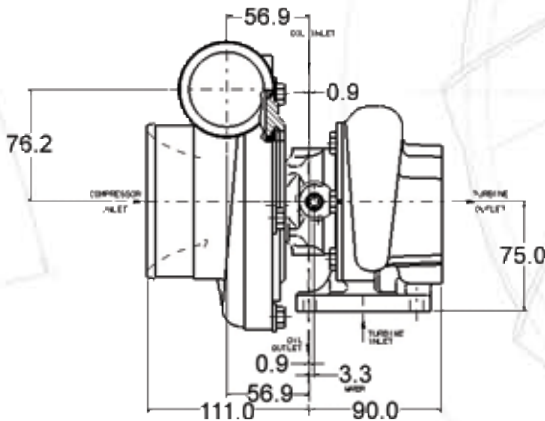


GT2871R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
743347-2	446179-32	53.1mm	71.0mm	56	0.60	53.9mm	76	0.86
743347-4	446179-32	53.1mm	71.0mm	56	0.60	53.9mm	76	0.64

TURBINE HOUSING OPTIONS	
PN	A/R
430609-230	0.64
430609-231	0.86



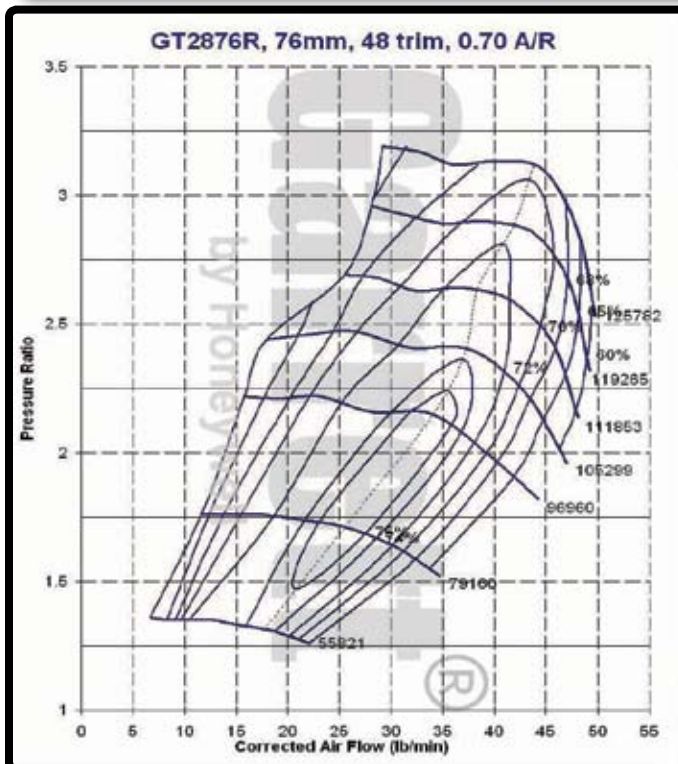
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, actuator NOT included
- Turbine wheel is cast from "Inconel" material for extreme applications



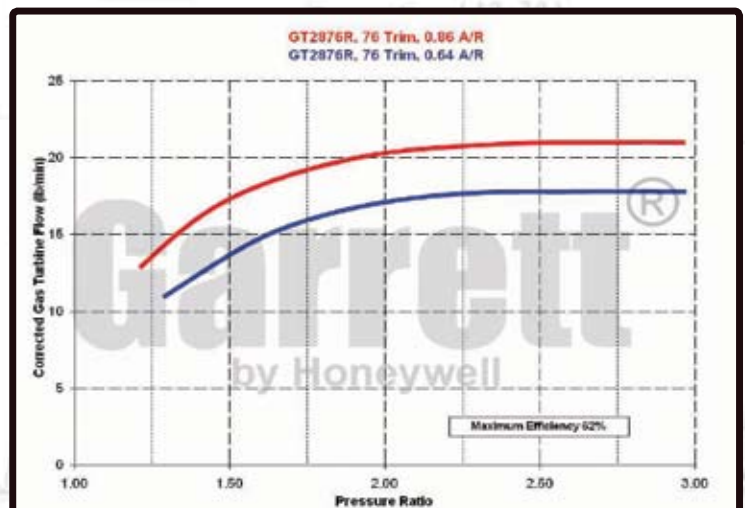
DISPLACEMENT 1.8L - 3.0L	HORSEPOWER 280 - 480	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
		400
	300	
	200	
	100	
	0	

Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	82	35	82	24
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

GT2876R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
705330-1	446179-18	52.8mm	76.1mm	48	0.70	53.9mm	76	0.64
705330-2	446179-18	52.8mm	76.1mm	48	0.70	53.9mm	76	0.86



TURBINE HOUSING OPTIONS	
PN	A/R
430609-230	0.64
430609-231	0.86

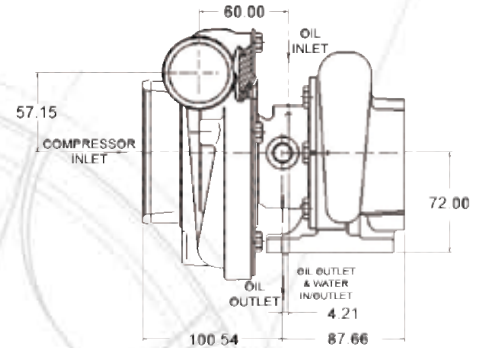


2000	DISPLACEMENT 1.8L - 3.0L
1900	
1800	
1700	
1600	
1500	
1400	
1300	
1200	
1100	
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
0	



- Dual ball bearing, oil & water-cooled CHRA
- Compressor and turbine housings sold separately
- Customizable with compressor and free float turbine housing kits
- Unit is interchangeable on turbine side with GT3076R
- Turbine wheel is cast from "Inconel" material for extreme applications

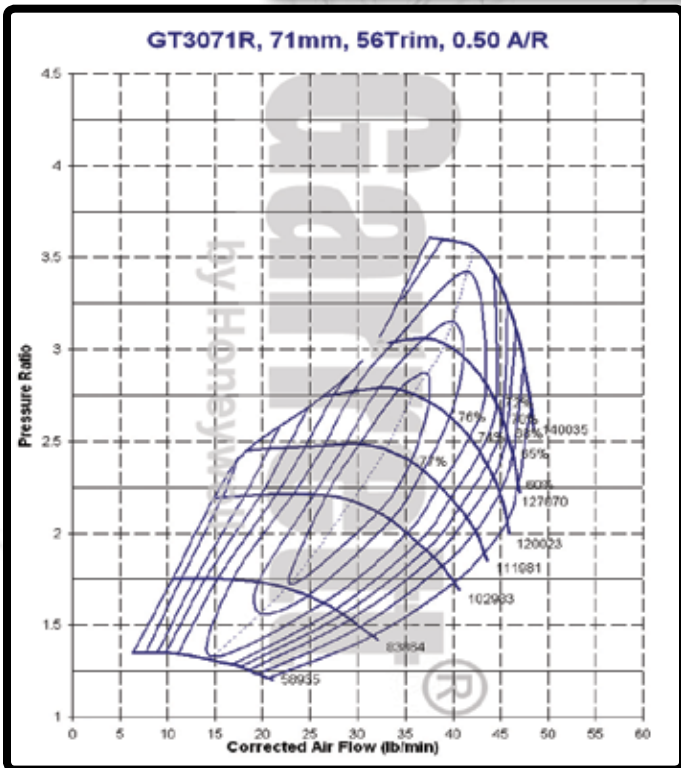
FLANGE	INLET		OUTLET	
	Component	Page	Diagram	Page
Compressor	See Note		82	17
Turbine	See Note		See Note	
Oil	84	11	84	18
Water	86	13	86	13



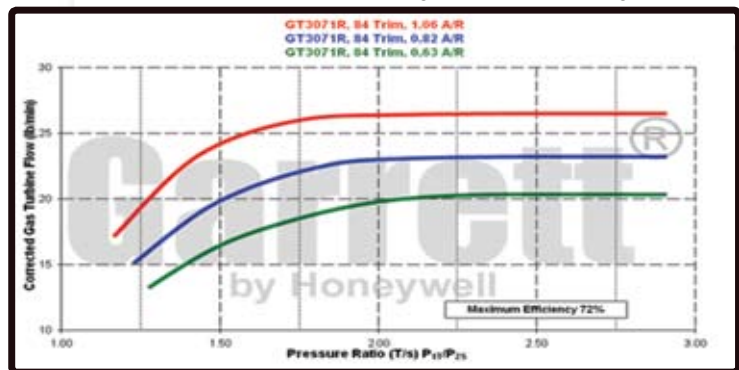
GT3071R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
-	700177-23	53.1mm	71.0mm	56	-	60.0mm	84	-

COMPRESSOR HOUSING OPTIONS			
PN	Inlet Dia	Outlet Dia	A/R
756021-1	2.75" Hose	2.00" Hose	0.50
756021-2	4.00" Hose	2.00" Hose	0.50

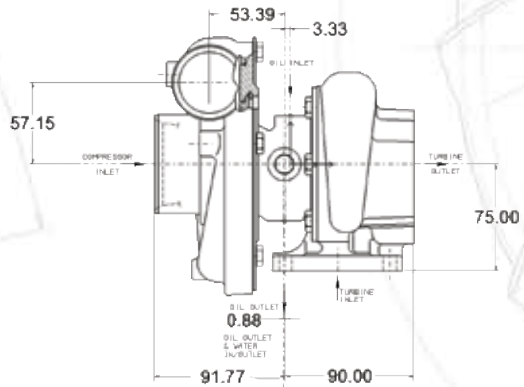
TURBINE HOUSING OPTIONS			
PN	A/R	Inlet	Outlet
740902-1*	1.06	T3	4 Bolt
740902-2*	0.82	T3	4 Bolt
740902-3*	0.63	T3	4 Bolt
740902-7 ⁺	1.06	T3	V Band
740902-8 ⁺	0.82	T3	V Band
740902-9 ⁺	0.63	T3	V Band
740902-13 [^]	1.06	T4	V Band
740902-14 [^]	0.82	T4	V Band
740902-15 [^]	0.63	T4	V Band



Dimension Note: Turbine Housing Options
 * Note: Inlet flange: 83-04; Outlet flange: 85-07
⁺ Note: Inlet flange: 83-04; Outlet flange: 86-13
[^] Note: Inlet flange: 83-10; Outlet flange: 86-13



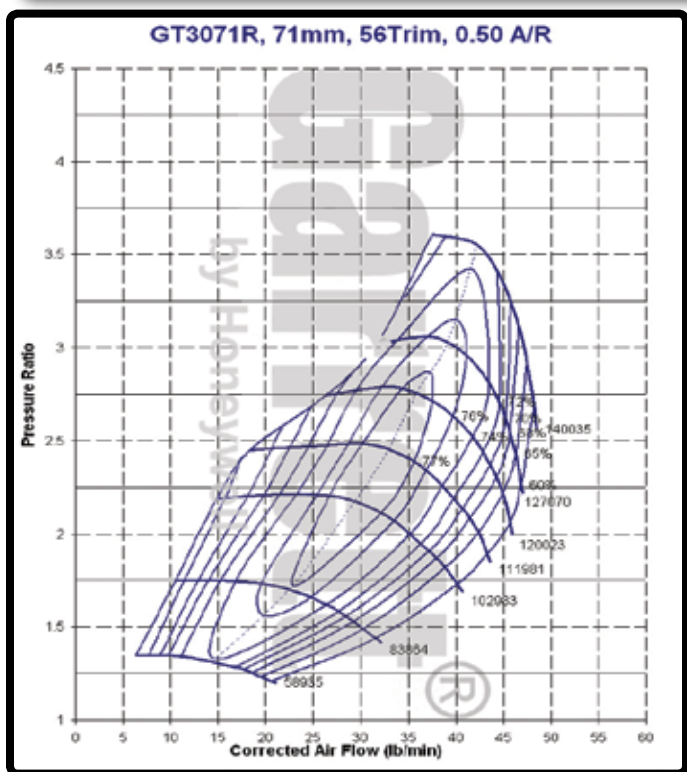
- Dual ball bearing, oil & water-cooled CHRA
- Internally wastegated turbine housing, actuator NOT included
- Wastegated version of the GT3071R uses specifically-modified GT30 turbine wheels for use in the T25-style turbine housing
- Turbine housing flanges are outline interchangeable with GT2554R (471171-3), GT2560R (466541-1) & GT2860RS (739548-1)
- Turbine wheel is cast from "Inconel" material for extreme applications



Component	INLET		OUTLET	
	Page	Diagram	Page	Diagram
Compressor	See Note		82	17
Turbine	83	01	85	11
Oil	84	11	84	18
Water	86	13	86	13

DISPLACEMENT 1.8L - 3.0L	HORSEPOWER 280 - 480	2000
		1900
		1800
		1700
		1600
		1500
		1400
		1300
		1200
		1100
		1000
		900
		800
		700
		600
		500
		400
300		
200		
100		
0		

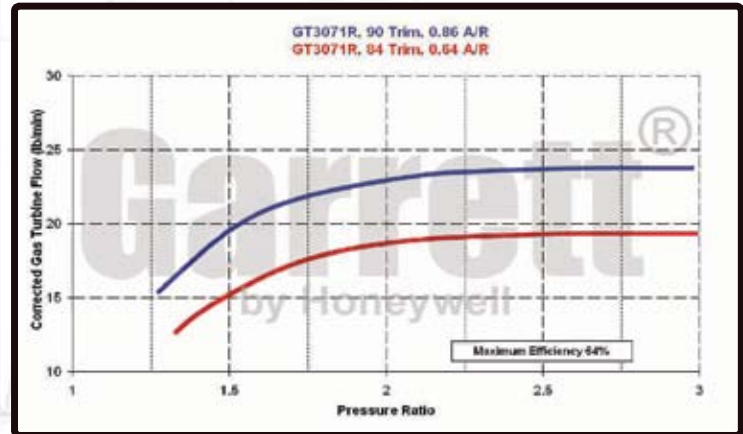
GT3071R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
700382-3	700177-3	53.1mm	71.0mm	56	0.50	56.5mm	84	0.64
700382-20	700177-4	53.1mm	71.0mm	56	0.50	56.5mm	90	0.86



COMPRESSOR HOUSING OPTIONS			
PN	Inlet Dia	Outlet Dia	A/R
756021-1*	2.75" Hose	2.00" Hose	0.50
756021-2+	4.00" Hose	2.00" Hose	0.50

*Note: allows 700382-20 to use 2.75" hose inlet instead of 4.00"
 +Note: allows 700382-3 to use 4.00" hose inlet instead of 2.75"

Dimension Note: Compressor Inlet
 700382-3: flange 82-26 ; 756021-1: flange 82-26
 700382-20: flange 82-34; 756021-2: flange 82-34



DISPLACEMENT 1.8L - 3.0L

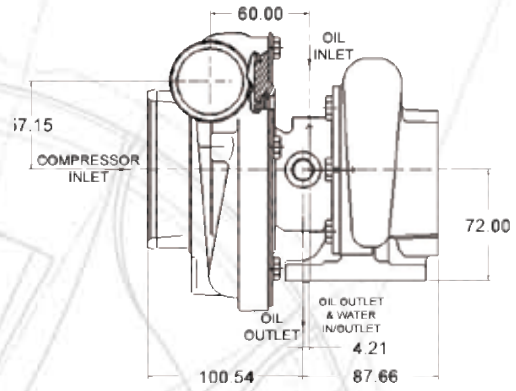
HORSEPOWER 340 - 560

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0



- Forged, fully-machined compressor wheel featuring next generation aerodynamics
- Dual ball bearing, oil & water-cooled CHRA
- Free float, non-wastegated turbine housing
- Ported shroud compressor housing to increase surge resistance
- Outline interchangeable with GT3071R
- GTX3071R is sold without turbine housing, includes CHRA & compressor housing. Turbine housing kits are available

FLANGE	INLET		OUTLET	
	Component	Page	Diagram	Page
Compressor	See Note		82	17
Turbine	See Note		See Note	
Oil	84	11	84	18
Water	86	13	86	13



GTX3071R		COMPRESSOR				TURBINE		
Turbo PN	CHRA PN	Ind Whl Dia	Exd Whl Dia	Trim	A/R	Whl Dia	Trim	A/R
803712-1	700177-46	54.1mm	71.4mm	58	0.60	60.0mm	84	-

TURBINE HOUSING OPTIONS

PN	A/R	Inlet	Outlet
740902-1*	1.06	T3	4 Bolt
740902-2*	0.82	T3	4 Bolt
740902-3*	0.63	T3	4 Bolt
740902-7 ⁺	1.06	T3	V Band
740902-8 ⁺	0.82	T3	V Band
740902-9 ⁺	0.63	T3	V Band
740902-13 [^]	1.06	T4	V Band
740902-14 [^]	0.82	T4	V Band
740902-15 [^]	0.63	T4	V Band

GTX

Dimension Note: Turbine Housing Options
 * Note: Inlet flange: 83-04; Outlet flange: 85-07
⁺ Note: Inlet flange: 83-04; Outlet flange: 86-13
[^] Note: Inlet flange: 83-10; Outlet flange: 86-13

