

A blurred red sports car is shown in motion, moving from left to right across the frame. The background is a soft, hazy sunset or sunrise sky with horizontal bands of color. The car's headlights and front grille are visible, though blurred due to the motion effect.

Garrett®

PERFORMANCE PRODUCTS CATALOG

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Garrett®

PERFORMANCE PRODUCTS

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GENERAL INFORMATION



THE GARRETT PERFORMANCE PRODUCTS CATALOG

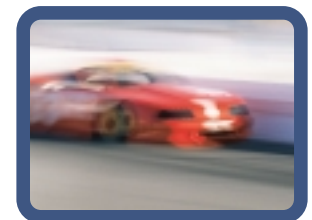
Welcome to the new Performance Products Catalog! You are about to encounter some of the most innovative turbochargers in the industry today. Whether it is the advanced aerodynamic wheel design or our enhancement of the GT product line, you will see many exciting turbocharging additions within this catalog. One of the most evident modifications to our catalog has been the name itself. The “Ballistic Concepts” title has been changed to reflect our renewed emphasis on performance, and so all future product introductions will be under the “Garrett Performance Products” title.

Here are some more reasons to investigate the Garrett Performance Products Catalog:

- ▶ The catalog design approach - our team has uniquely modeled this catalog to provide all turbocharger information on one page in an “easy to interpret” manner.
- ▶ Application flexibility - kits are now being offered to allow you to choose the optimal turbocharger for your individual application and provide you the flexibility to upgrade now or in the future. Mixing and matching has never been easier!
- ▶ **Turbine maps!** The Garrett team is thrilled to be the first to provide ALL of the data necessary to ensure the best performance for your vehicle!
- ▶ Garrett is where you want to be! We have engineering teams on 5 continents that are continually innovating to bring the most up-to-date technology to the industry. And, with some of the most rigorous functional testing in the field you know you are buying the superior product.

The Garrett Aftermarket team has a lot in store for the future, so this catalog design will allow for the addition of product pages and other information as we grow our performance product line - so stay tuned for further updates!

-The Garrett Performance Team



▶ *We are also interested in hearing about your turbocharging opportunities, so please feel free to drop us a line at garrett.performance@honeywell.com.*

Garrett is the leading innovator of turbochargers in the world, providing engine boosting systems that save fuel and reduce emissions while providing an increase to engine performance.

Garrett's turbocharging business traces its roots to an aerospace company established in California by entrepreneur Cliff Garrett. Over time, the turbocharging business spun off to establish itself as a serious player in the engine boosting industry. Through names such as AiResearch, AlliedSignal, and the Honeywell of today, Garrett has sustained its reputation for innovating turbocharger technologies generation after generation. From its long list of industry firsts to its leading-edge ball bearing turbos for racecars, Garrett develops and manufactures the same cutting-edge boosting expertise that goes into all Garrett products. Most of the world's top engine and car manufacturers employ Garrett turbochargers to boost their engines, and with 27,000 turbos produced EVERY DAY you know the Garrett name is one you can trust. Finally, through the Garrett network of Master and Performance Distributors listed on the next page, Garrett's turbocharging product line is readily available in the aftermarket for you to install on your vehicle!

MEET GARRETT'S NEWEST TECHNOLOGIES



Garrett's newest turbocharger line delivers these benefits and more over our competitors:

Looking for an efficient, reliable turbocharger that can handle higher boost pressure? Your search ends with the new Garrett Performance Products Catalog. As the industry leader in turbocharging innovation, Garrett turbochargers incorporate the latest advances in boosting technology and aerodynamic design. Whether you're looking to install a new turbocharger or need to upgrade an existing one, you've come to the right place.

► Improved Efficiency

New, efficient turbine stages deliver more power to your engine and allow Garrett turbochargers to spool up faster than ever. Garrett engineers have eliminated old efficiency killers, including on-center turbine housings*, clipped turbine wheels, and antiquated aerodynamics with the new GT product line.

► Increased Boost Capacity

Garrett's new turbochargers feature compressor wheels that can handle a higher boost pressure. So go ahead—increase the PSI. Your Garrett turbocharger can take it!

► True Ball-Bearing Turbochargers

Thanks to our single-cartridge ball-bearing technology, Garrett turbochargers generate far less frictional drag and are 10 times more durable than traditional journal-bearing turbochargers. While first developed for racing, over 100,000 ball-bearing turbos have been produced for OE applications, and are now available in a range of sizes for the street.

► Proven Durability

The Garrett engineering team puts our turbochargers through more than 20 durability and performance tests before they reach consumers. And since Garrett is the global leader in manufacturing turbochargers, producing more than 7.1 million units every year, you can be assured a Garrett turbo is a dependable one.

* See Turbo Terms in Appendix

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APPLICATIONS & DISTRIBUTORS

GARRETT APPLICATIONS

Garrett Performance Houses provide a wide range of applications using Garrett turbochargers, cartridges, and component parts.

Make	Model	Performance Specialist
Audi	1.8L	Audi Performance Racing Innovative Turbo Systems Tial Products
	S4, A6	Tial Products
Buick	Grand National	Innovative Turbo Systems Limit Engineering Precision Turbo & Engine
Chevrolet	Corvette, Camaro, Light Duty Truck	Lingenfelter
Dodge	5.9L Light Duty Truck	Advanced Turbo Systems BD Power
Ford/Navistar	6.9L, 7.3L - Light Duty Truck	Advanced Turbo Systems Gale Banks Engineering
	Focus	Precision Turbo & Engine
	Mustang	Lee Performance Products Limit Engineering Precision Turbo & Engine
Honda	Civic	Edelbrock
Mazda	Protégé	Callaway / Mazda Speed
Nissan	300ZX, Sentra, 240	Jim Wolf Technology Turbo Engineering Corp.
Porsche	911, 944	Tial Products
Subaru	Imprenza	Turbo Engineering Corp.
	WRX	Tial Products
Toyota	Pickup, 4 Runner, Supra	Turbo Engineering Corp.
Volkswagon	1.8L - Golf, Passat, Jetta, Beetle	Innovative Turbo Systems Tial Products

PERFORMANCE HOUSES

Garrett Performance Houses supply upgrade and hybrid turbochargers, Garrett component parts for a wide variety of turbocharger models, and the expertise to repair and rebuild the Garrett line of Performance Turbochargers.

Lee Performance Prod., Inc.

555 Birch Street
Lake Elsinore, CA 92530
909-674-8171
909-245-6883 (fax)
sales@leeperformanceproducts.com
www.leeperformanceproducts.com

Turbonetics Inc.

2255 Agate Court
Simi Valley, CA 93065
805-581-0333
805-581-1913 (fax)
info@turboneticsinc.com
www.turboneticsinc.com

T.E.C. Turbocharger Engineering

17222 S. Golden Road
Golden, CO 80401
800-950-8872
303-271-3927 (fax)
jlatour@turboengineering.com
www.turboengineering.com

Hypermax Engineering, Inc.

255 East Route 72
Gilberts, IL 60136
847-428-5655
847-428-5682 (fax)
hypermax@ais.net
www.cl.ais.net/hypermax/index.htm

Limit Engineering

885 Kiowa Ave.
Lake Havasu City, AZ 86406
928-453-7321
928-453-0789 (fax)
craig@redrivernet.com
www.limitengineering.com

Precision Turbo & Engine Rebuilders

616A South Main Street
PO Box 425
Hebron, IN 46341-8904
219-996-7832
219-996-7749 (fax)
turbo@netnitco.net
www.precisionte.com

Innovative Turbo Systems

845 Easy Street, Unit 102
Simi Valley, CA 93065
805-526-5400
802-526-9240 (fax)
rick@innovativeturbo.com
www.innovativeturbo.com

Turbo & Electric

2408 Grand Avenue
Phoenix, AZ 85009
602-253-6817
602-253-6841 (fax)
turboguy@swlink.net

ENGINEERING HOUSES

Garrett Engineering House accounts provide the performance market with retro fit turbocharger kits, complete systems and upgrade turbochargers.

Ford, GM & Dodge Trucks

Advance Turbo Systems, Inc.
5919 South 350 West
Murray, UT 84107
801-263-0900
801-265-1253 (fax)
ats@xmission.com
www.atsturbo.com

Gale Banks Engineering
546 Duggan Avenue
Azusa, CA 91702
800-483-7693
626-334-1743 (fax)
sales@bankspower.com
www.galebanks.com

BD Brake
Unit A10-33733 King Road
Abbotsford, BC V2S 7M9
800-887-5030
604-853-8749
info@bd-power.com
www.bd-power.com

GM

Lingenfelter
1557 Winchester Road
Decatur, IN 46733
260-724-2552
260-724-0422 (fax)
sales@lingenfelter.com
www.lingenfelter.com

Audi & Volkswagon

TIAL Products
510 S. Washington, Suite 16
Owosso, MI 48867
989-729-8553
517-729-9973 (fax)
tialinc@earthlink.net
www.tialsupport.com

Audi Performance Racing
1027-B Opelika Road
Auburn, AL 36830
800-680-7921
334-502-5180 (fax)
brett@goapr.com
www.goapr.com

Advanced Tuning Products
44777 South Grimmer Blvd.
Fremont, CA 94538
510-445-1682
510-445-1692 (fax)
info@vwturbo.com
www.vwturbo.com

Honda

Edelbrock Corp.
2700 California Steet
Torrance, CA 90503
310-781-2222
310-320-1187 (fax)
edelbrock@edelbrock.com
www.edelbrock.com

Nissan

Jim Wolf Technology
212 Millar Ave.
El Cajon, CA 92020
619-442-0680
619-442-8160 (fax)
jim@jimwolfttechnology.com
www.jimwolfttechnology.com

MASTER DISTRIBUTORS

Garrett Master Distributors supply the market with the complete offering of the Garrett Aftermarket product line.

ADP Distributors Inc. (Canada)

105-18935 9th Avenue
Surrey, BC CANADA V4N3P3
800-663-6308
604-888-5389 (fax)
rgw@adpdist.com
www.adpdist.com

ADP Distributors Inc. (USA)

18854 72nd Avenue South
South Kent, WA 98032
800-663-6308
425-656-1571 (fax)
cek@adpdist.com
www.adpdist.com

Area Diesel Service Inc.

North on University
Carlinville, IL 62626
800-637-2658
217-854-8972 (fax)
ads@areadiesel.com
www.areadiesel.com

Central Motive Power, Inc.

6301 North Broadway
Denver, CO 80216
800-822-4332
303-428-6785 (fax)
gsmith@centralmotivepower.com
www.centralmotivepower.com

D&W Diesel & Electric

1508 Clark Street Road
Auburn, NY 13021
315-253-7740
315-282-0031 (fax)
r.banas@dwdiesel.com

Diesel Injection & Electric Co.

231 Main Street
Forest Park, GA 30297
800-241-4389
404-361-1701 (fax)
dijection@mindspring.com

Diesel Injection Service Co., Inc.

4724 Allmond Avenue
Louisville, KY 40209-0389
502-361-1181
502-364-3200 (fax)
tombrown@dieselusa.com

Magneto & Diesel Service

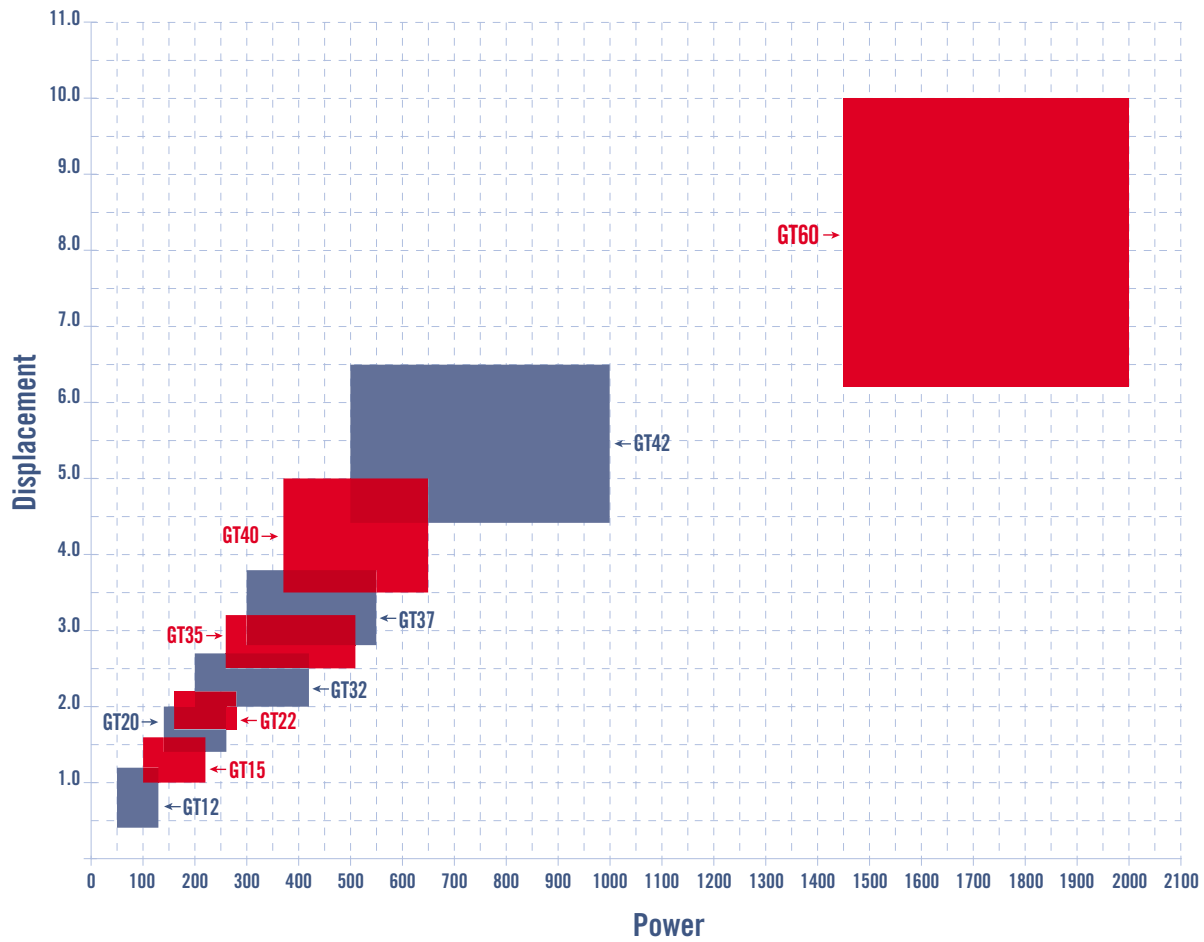
6931 Navigation Boulevard
Houston, TX 77011
800-392-5517
713-928-8154 (fax)
tingram@mddistributors.com
www.mddistributors.com

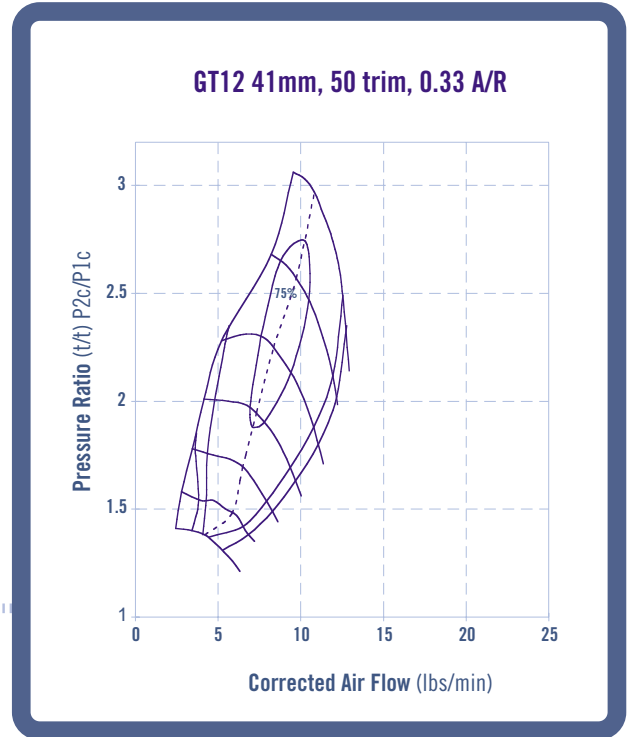
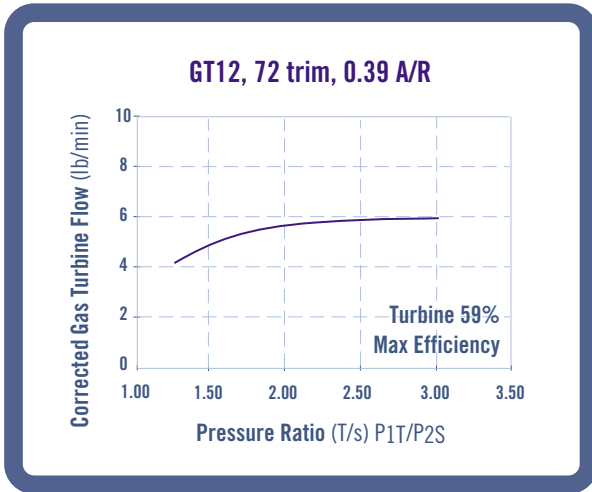
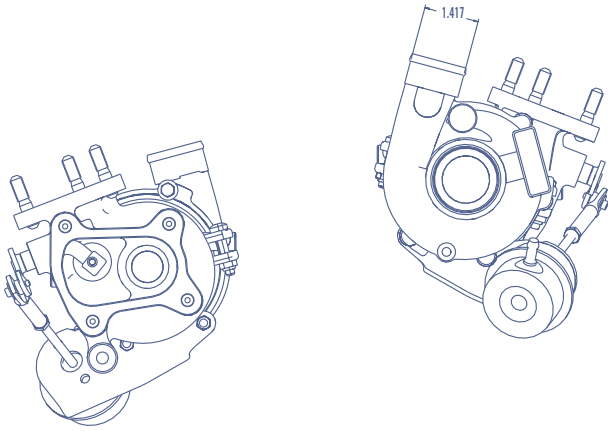
Garrett®

PERFORMANCE PRODUCTS

Garrett

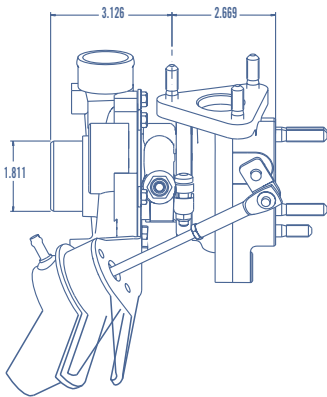
TURBOCHARGERS



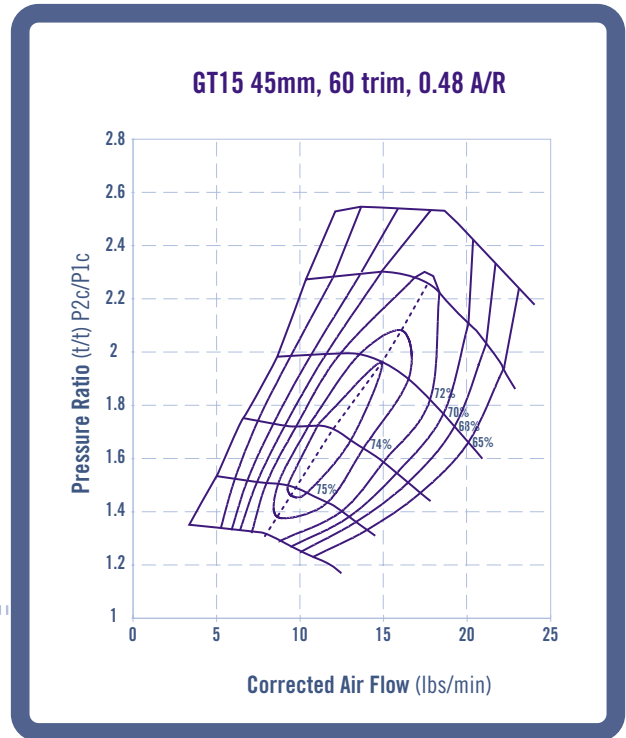
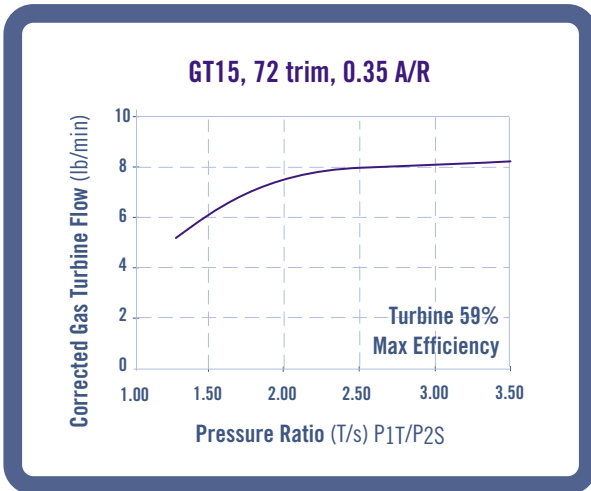
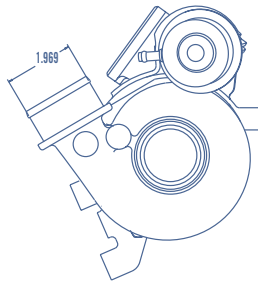
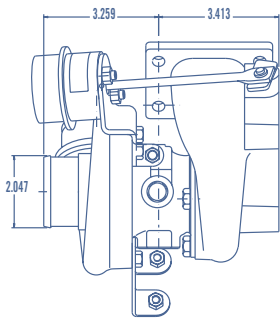


POWERSHIFT

Horsepower 50 - 130
Displacement .4L - 1.2L

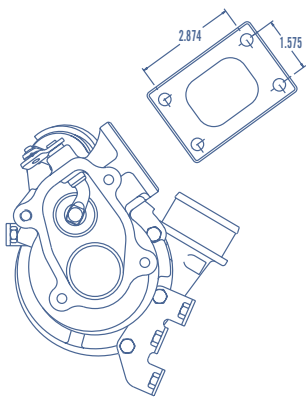


			COMPRESSOR			TURBINE			
	Turbo	CHRA	Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
GT12	708001-1	708247-7	41mm	50	0.38	35.5mm	72	0.43	Wastegated

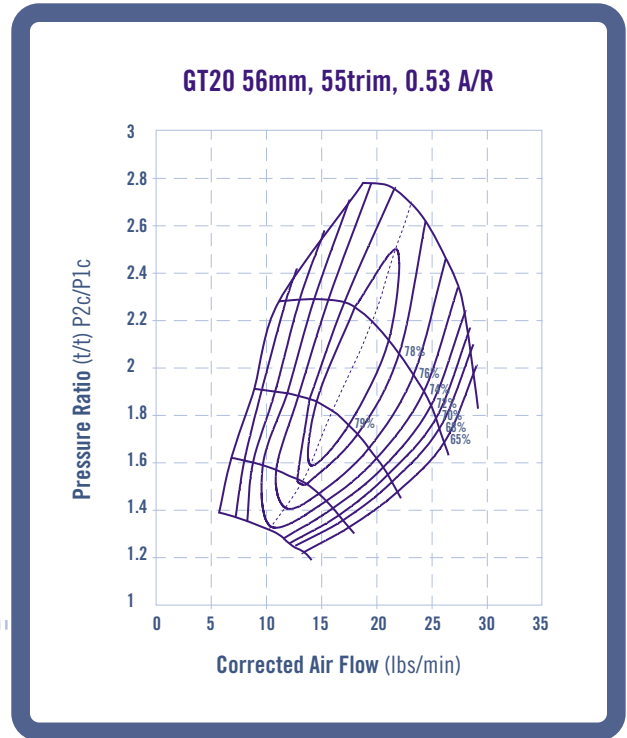
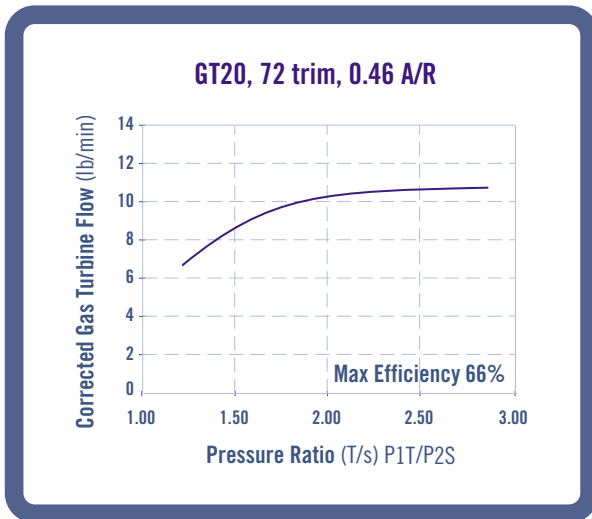
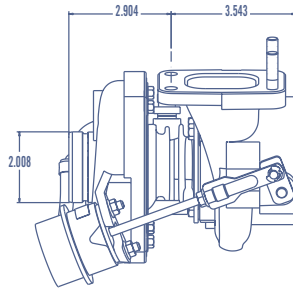
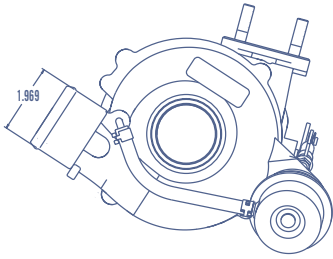


POWERSHIFT

Horsepower 100 - 220
Displacement 1.0 - 1.6L

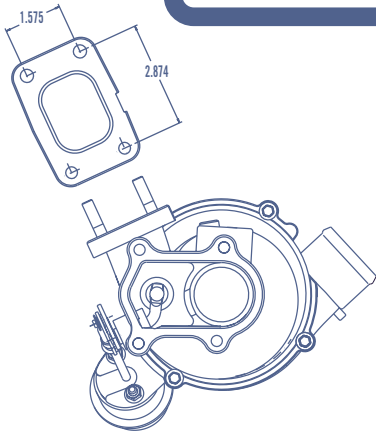


	COMPRESSOR			TURBINE					
	Turbo	CHRA	Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
GT15	466755-3	431876-93	45mm	60	0.48	41.2mm	72	0.35	Wastegated



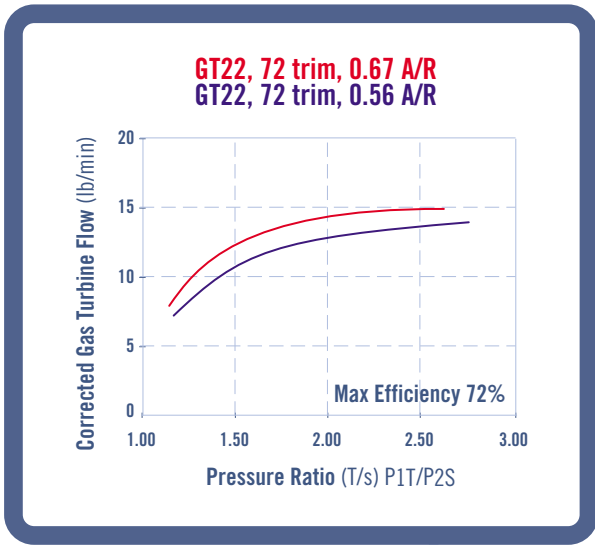
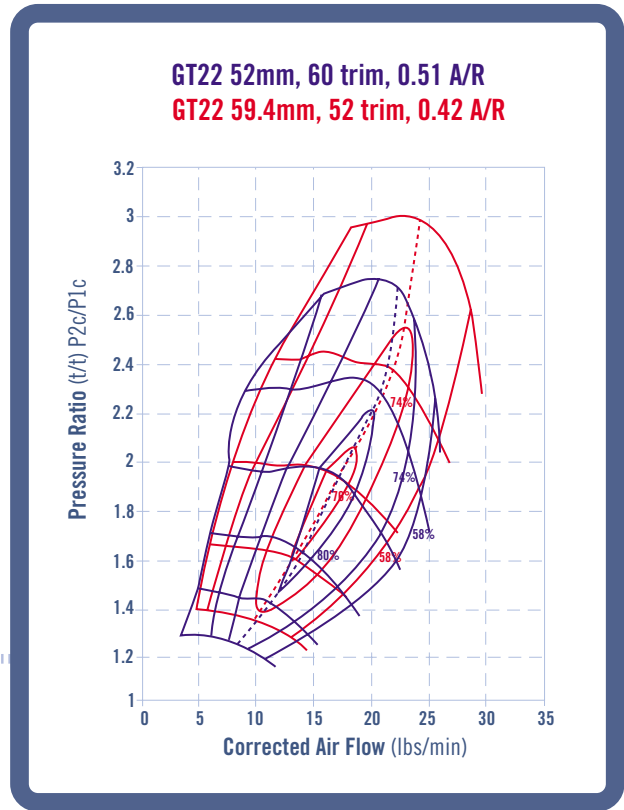
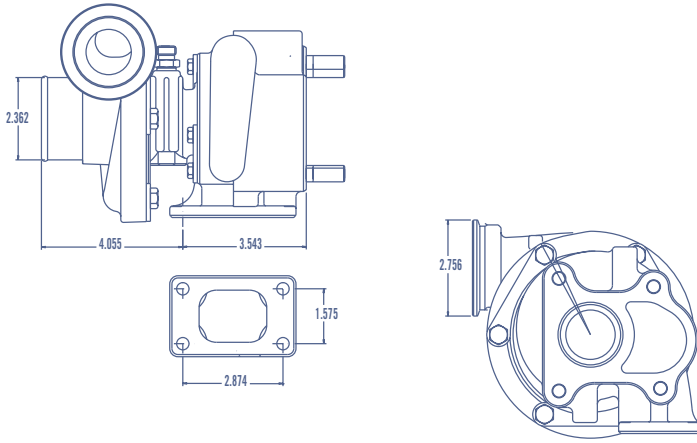
POWERSHIFT

Horsepower 140 - 260
Displacement 1.4 - 2.0L



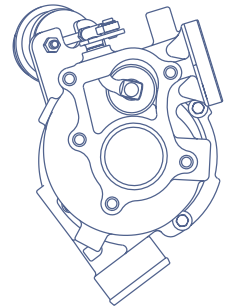
GT20

Turbo	CHRA	COMPRESSOR			TURBINE			
		Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
454126-2	433289-96	56mm	55	0.53	47mm	72	0.46	Wastegated

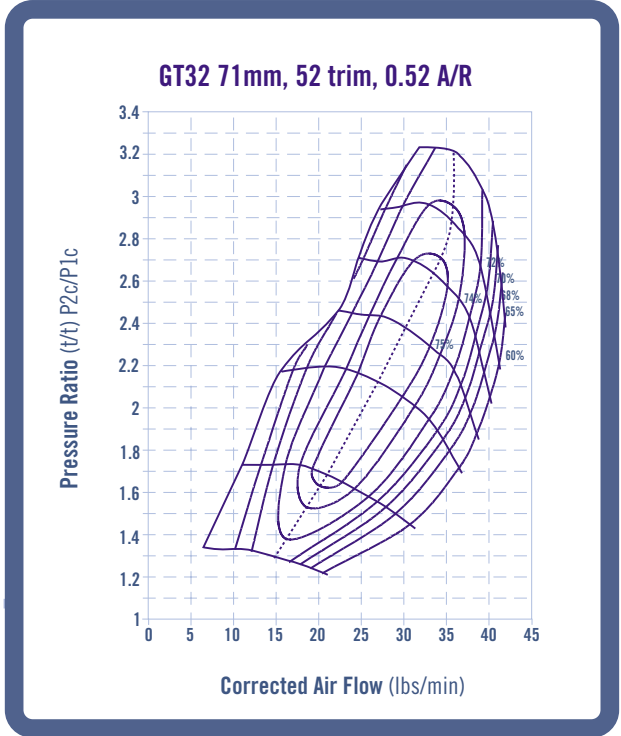
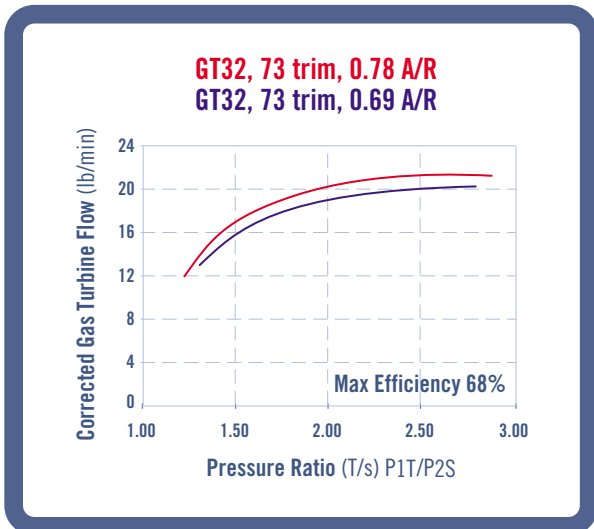
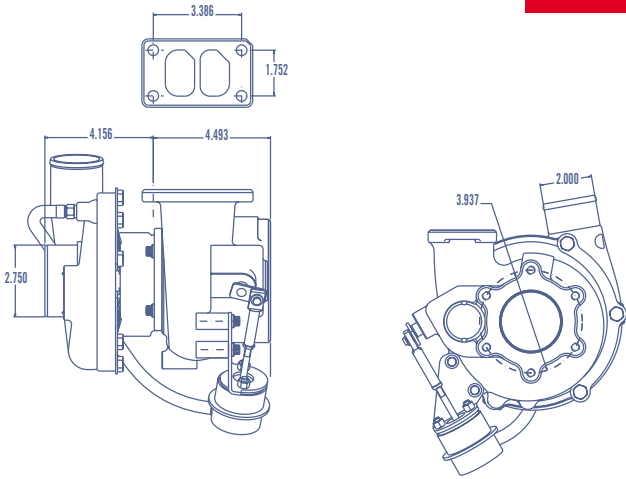


POWERSHIFT

Horsepower 160 - 280
 Displacement 1.7 - 2.2L



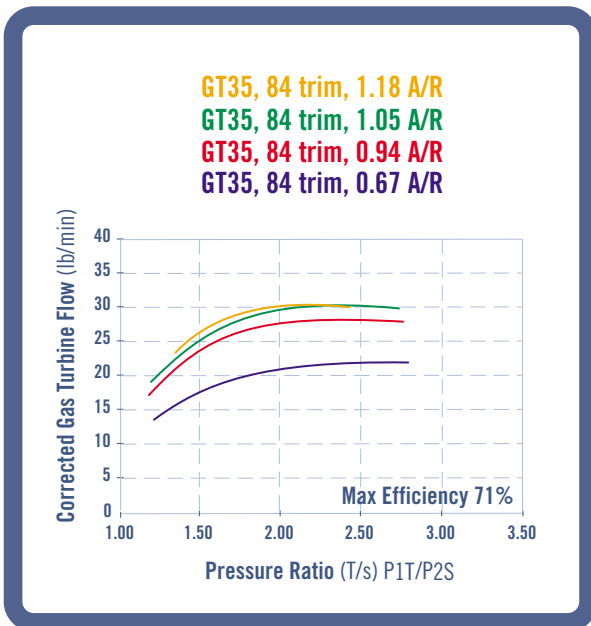
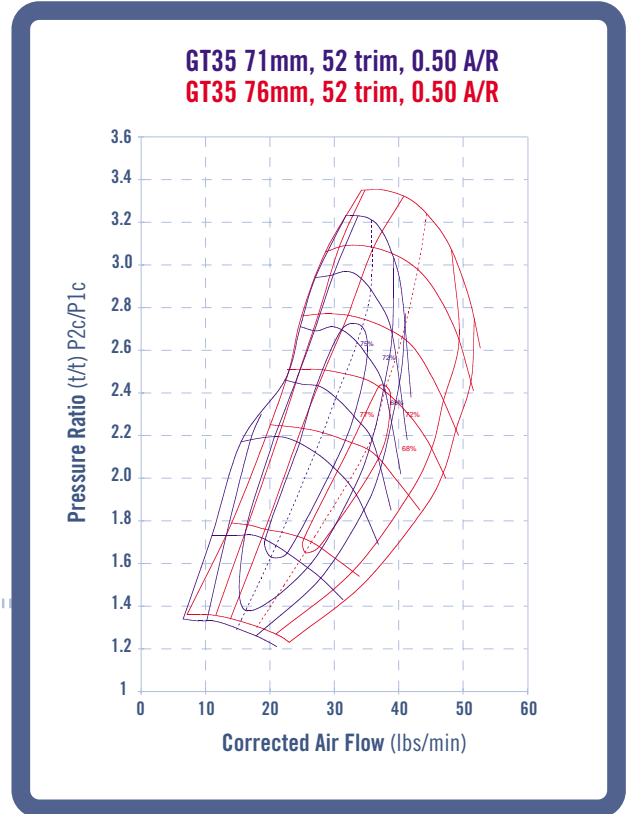
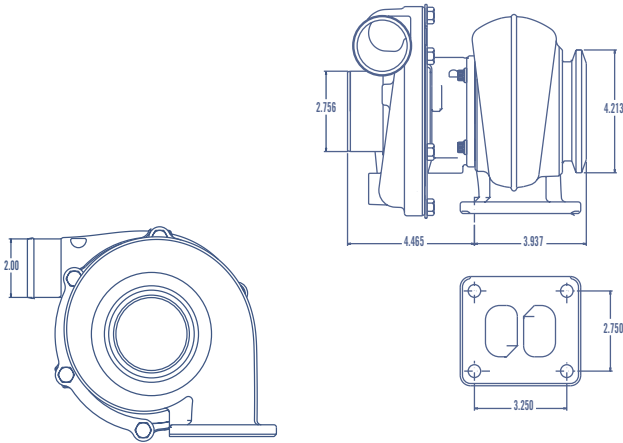
Turbo	CHRA	COMPRESSOR			TURBINE			
		Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
GT22 452187-6	451298-6	52mm	60	0.51	50.3mm	72	0.67	Wastegated
452214-3	451298-9	59.41mm	52	0.42	50.3mm	72	0.56	Free Float
TURBINE OPTION								
					436313-6	72	0.67	Wastegated
					451503-1	72	0.56	Free Float



POWERSHIFT

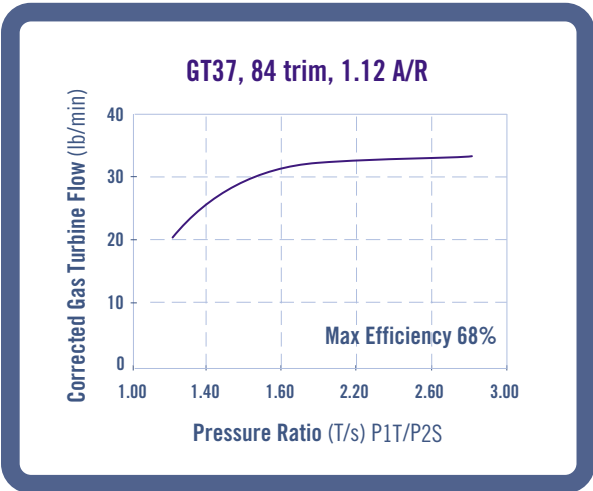
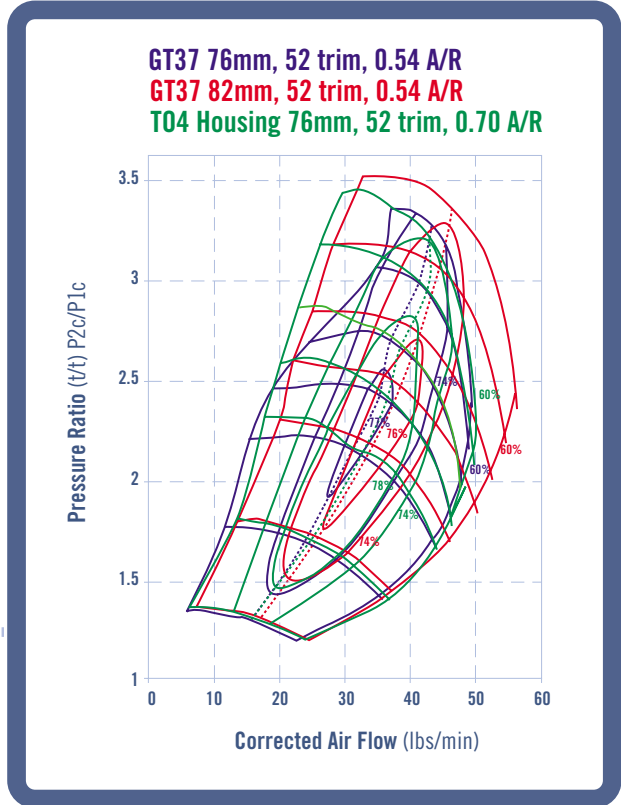
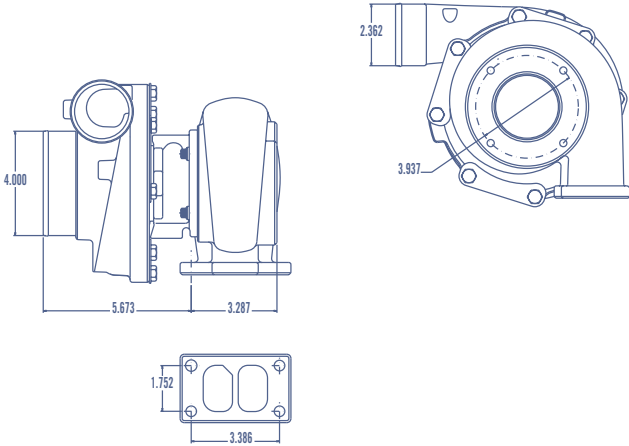
Horsepower 200 - 420
 Displacement 2.0 - 2.7L

Turbo	CHRA	COMPRESSOR			TURBINE				
		Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type	
GT32	452203-1	436058-3	71mm	52	0.5	64mm	73	0.78	Wastegated
TURBINE OPTION									
						451225-26	73	0.78	Free Float
						435066-32	73	0.69	Wastegated



POWERSHIFT
 Horsepower 260 - 510
 Displacement 2.5L - 3.2L

Turbo	CHRA	COMPRESSOR			TURBINE			
		Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
GT35 731413-1	436058-11	71mm	52	0.6	68mm	84	1.18	Free Float
		COMPRESSOR OPTION			TURBINE OPTION			
	731428-1	76mm	52	0.5	714690-13	84	1.05	Free Float
					700889-3	84	0.94	Free Float
					700889-15	84	0.67	Free Float

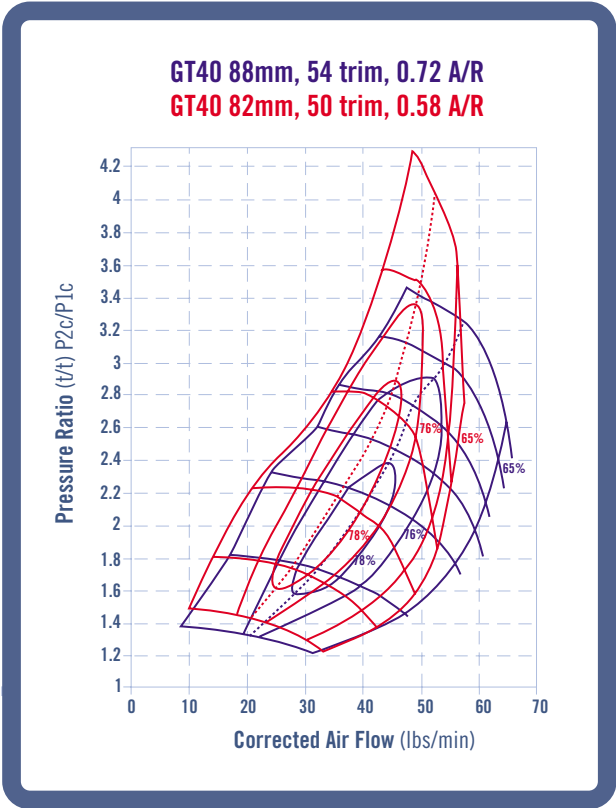
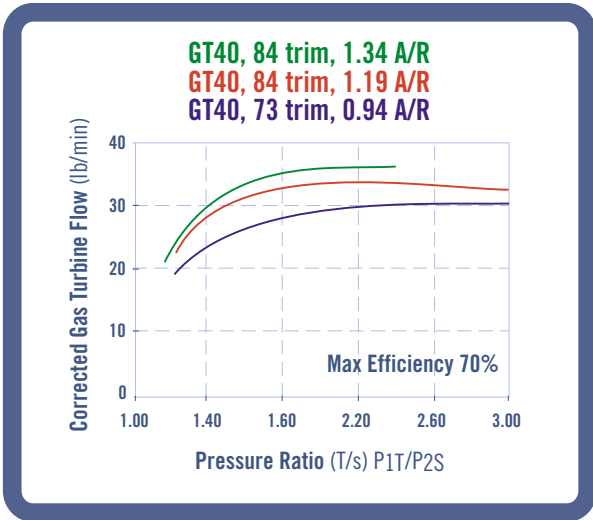
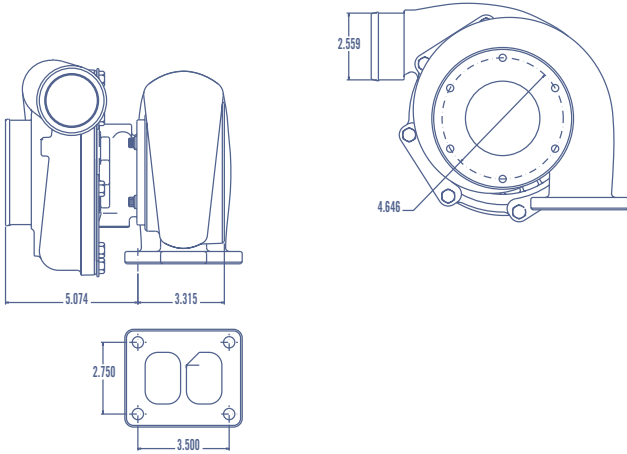


POWERSHIFT

Horsepower 300 - 550
Displacement 2.8 - 3.8L

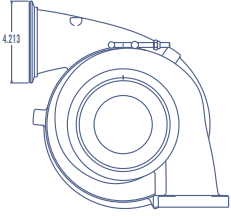
Turbo	CHRA	COMPRESSOR			TURBINE			
		Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
GT37 452159-1	436085-1	76mm	52	0.54	72.5mm	84	1.12	Free Float
452159-3	436085-5	82mm	52	0.54	72.5mm	84	1.12	Free Float

COMPRESSOR OPTION				
731428-2	76mm	52	0.7	
731428-3	82mm	52	0.54	



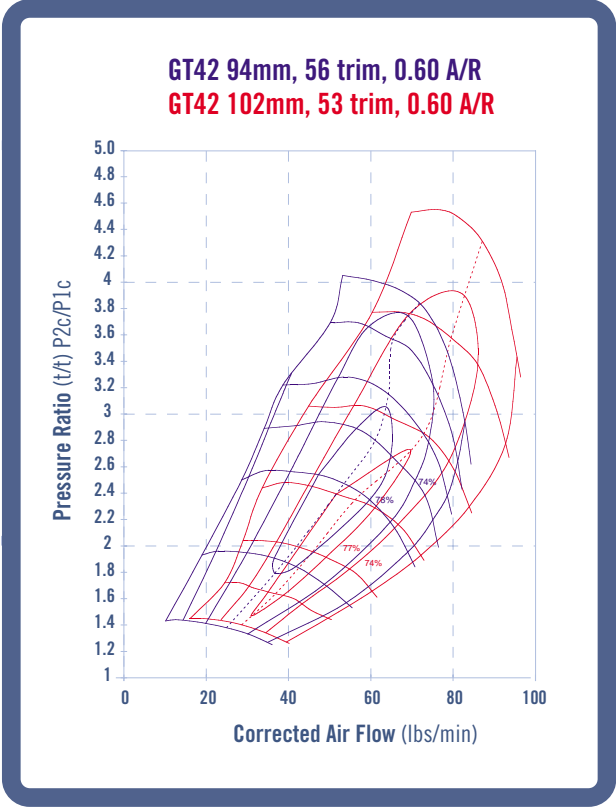
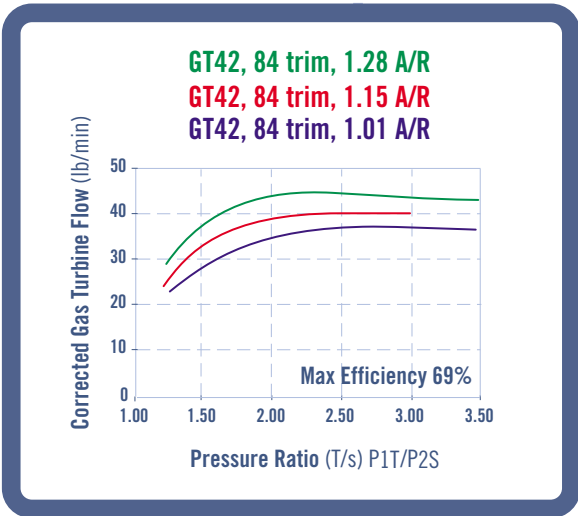
POWERSHIFT
 Horsepower 370 - 650
 Displacement 3.5 - 5.0L

			COMPRESSOR			TURBINE			
	Turbo	CHRA	Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
GT40	452232-5	449739-10	82mm	50	0.58	77mm	73	0.94	Free Float
	703457-1	449739-12	88mm	54	0.72	77mm	84	1.34	Free Float
			TURBINE OPTION						
			434309-88	84	1.19	Free float			



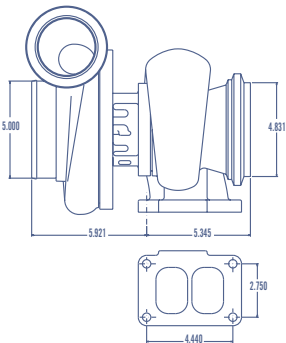
POWERSHIFT

Horsepower 500 - 1000
Displacement 4.4L - 6.5L



Turbo	CHRA	COMPRESSOR			TURBINE				
		Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type	
GT42	731376-1	712402-7	94mm	56	0.6	82mm	84	1.15	Free Float
	731376-2	712402-8	102mm	53	0.6	82mm	84	1.15	Free Float

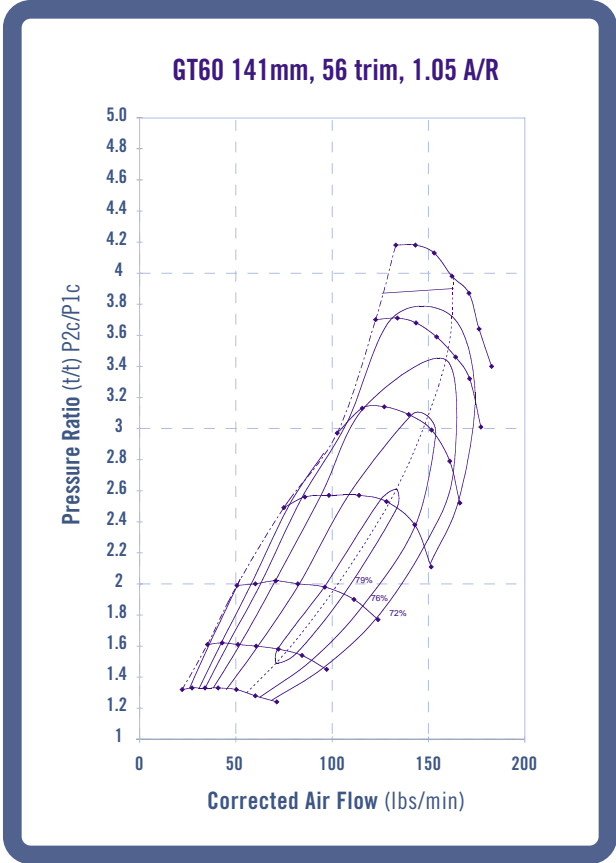
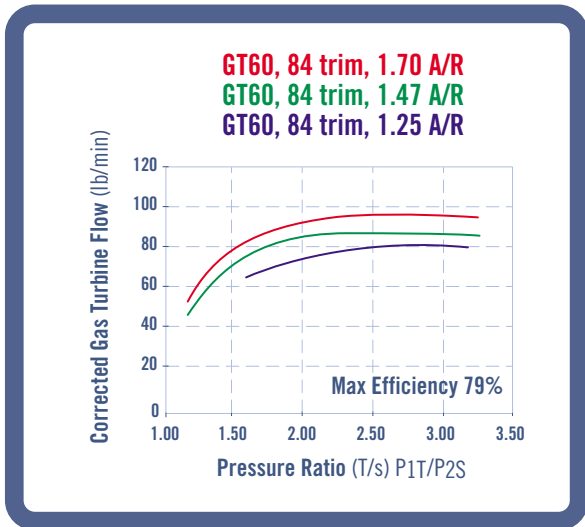
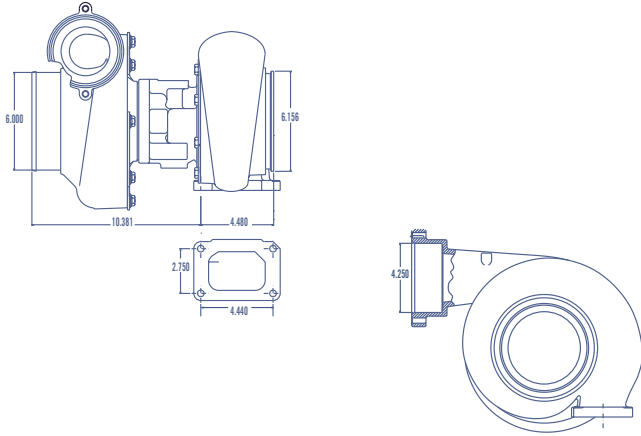
TURBINE OPTION			
448925-12*	84	1.28	Free Float
448925-13*	84	1.15	Free Float
448925-14*	84	1.01	Free Float



Ball Bearing CHRA Options

451888-9	94mm	56	82mm	84
451888-11	102mm	53	82mm	84

* future product addition



POWERSHIFT

Horsepower 1450 - 2000
 Displacement 6.2L - 10L

GT60	Turbo	CHRA	COMPRESSOR			TURBINE			
			Wh Dia	Trim	A/R	Wh Dia	Trim	A/R	Type
	731377-1	730496-1	141mm	56	1.05	130mm	84	1.47	Free Float
TURBINE OPTION									
						441319-97	84	1.25 A/R	Free Float
						441319-95*	84	1.70 A/R	Free Float

* future product addition

In addition to the GT products contained in the 2002 Garrett Performance catalog, Garrett provides coverage for a broad selection of traditional turbocharger models. These models are serviced with two product segments.

Component Parts

The component product segment provides the ability to service and/or make available component parts to Garrett customers who service performance turbochargers that have failed. This product also provides the ability to assemble standard or hybrid turbocharger or cartridge configurations.

Traditional Assemblies

The traditional assembly product segment is comprised of turbocharger and cartridge assemblies that have been applied to a broad spectrum of existing performance applications.

These components and/or assemblies may provide coverage for the following models:

BTG55	T28	TA31	TBB25	TMF55	TV92
BTV75	T300	TA34	TB03	TP38	TV94
BTV85	T31	TA45	TB05	TV45	TV95
BTW75	T350	TA51	TB06	TV51	TW41
T2	T35R	TA03	TBP404	TV61	TW81
T3	T45	TB02	TC43	TV63	UTG75
T4	T51	TB03	TC04	TV70	UTV71
T6	T52	TB22	TH08A	TV71	UTV75
T12	T04	TB25	TL75	TV75	UTV94
T18A	T04B	TB28	TL92	TV80	UTV95
T25	T04E	TB34	TM54	TV81	UTW75
T25R	T04S	TB41	TMF51	TV84	UTW83

Contact Your Authorized Garrett Distributor for technical data and product availability.

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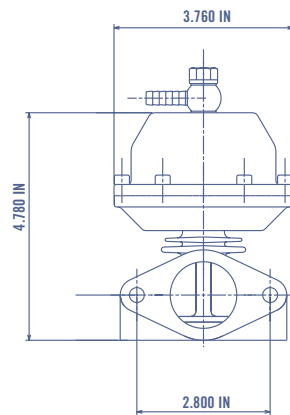
Garrett

ANCIILLARY PRODUCTS

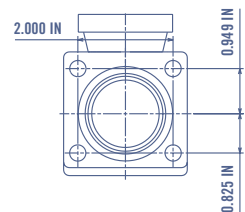
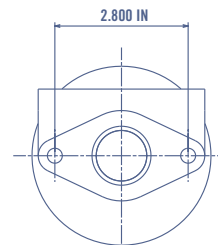
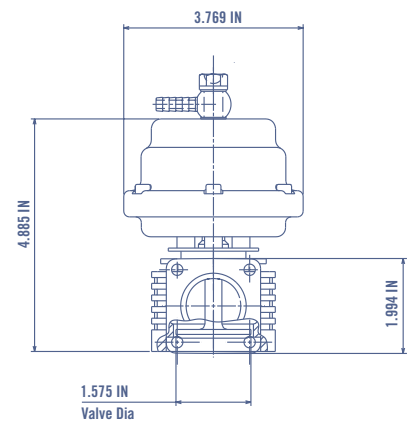
High-Performance Stainless Steel Wastegate Assemblies: Garrett Performance Products is pleased to carry TiAl Products 35, 40, and 46mm wastegate assemblies. All wastegate assemblies are constructed with stainless steel valves and valve bodies. Actuator housings are CNC machined billet aluminum, with an optimal actuator to valve ratio of 2.2:1 for maximum flow capacity. The units are also designed with high temperature Nomex diaphragms and oxidation resistant Super Alloy components.

Valve Size (diameter)	Part Number	Spring Rate (bar/psig)
35mm	721490-0002	.36/5.2
	721490-0003	.47/6.8
	721490-0004	.59/8.6
40mm	721491-0004	.55/8.0
	721491-0005	.66/9.6
	721491-0006	.77/11.2
46mm	721492-0005	.60/8.7
	721492-0006	.70/10.2
	721492-0007	.80/11.6

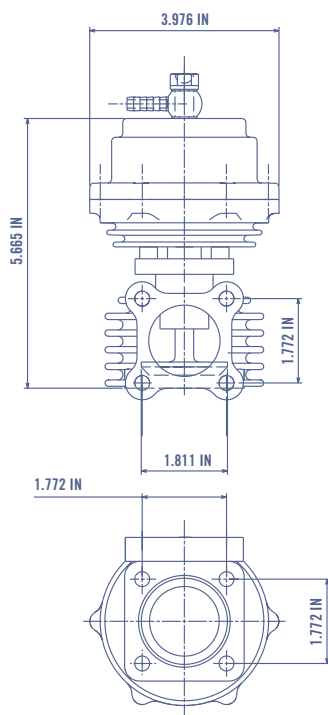
35mm



40mm



46mm



Stainless Steel CNC Wastegate Flanges

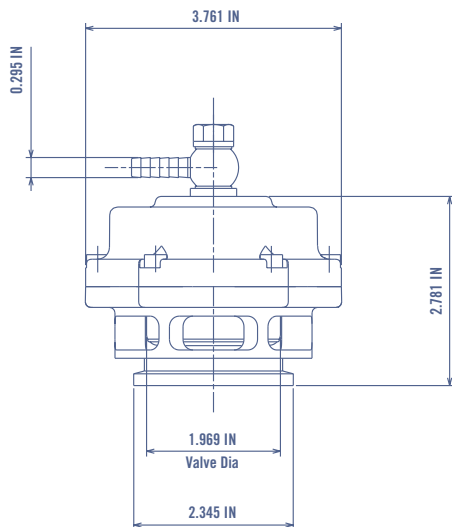
Model	Part Number	Type	Configuration
35mm	776463-0001	Outlet Flange	2 x thru hole
	776463-0002	Inlet Flange	2 x M8-1.25
40mm	776466-0001	Inlet Flange	4 x M8-1.25
	776464-0001	Outlet Flange	4 x thru hole
46mm	716465-0001	Inlet or Outlet Flange	4 x thru hole

BLOW-OFF VALVE

50mm Compressor Blow Off Valve Assemblies: The Garrett (TiAl) Blow-Off valve design is the result of extensive development and testing. The 50mm compressor bypass valve is a vital component of any turbocharged blow-through induction system. This custom TiAl manufactured blow-off valve will improve throttle (time to boost) response as well as help relieve the damaging effects of compressor “surge loading”. The CNC machined housings are available in several high luster anodized colors.

Note: Blow-off Valve Assemblies include fitting and V-band clamp.

Blow-Off Valve

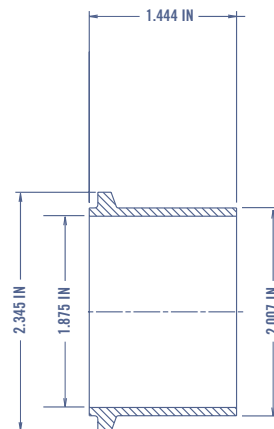


Part Number	Color
714341-0001	Red
714341-0002	Blue
714341-0003	Gray
714341-0004	Violet
714341-0005	Machined Aluminum

Blow-off Valve Flanges

Part Number	Material
722783-0001	Aluminum (6061)
722783-0002	Steel (1018)
722783-0003	Stainles Steel (304L)

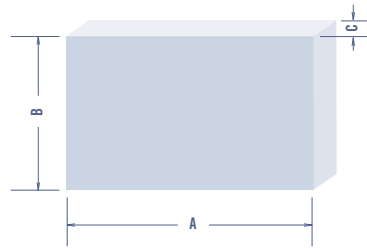
Blow-Off Valve Flange



The **Garrett Performance Intercoolers** (also known as Charge Air Coolers) work together with the turbocharger as a part of the total induction system. When air is compressed in the turbocharger it gains a great deal of heat. The heated air has lower oxygen density and therefore is not able to produce as much energy when fed into the cylinders. The job of the intercooler is to remove heat added by compression in the turbocharger and in turn promote more thorough combustion yielding more power, less emissions, and greatly reducing detonation.

Performance estimates made under the following conditions:

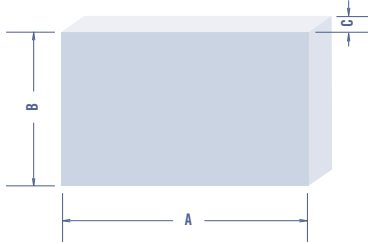
- charge air inlet temperature = 250 degrees F
- pressure ratio = 2.0 (approximately 14.7psi)
- cooling air temperature = 75 degree F
- cooling air flow rate set with 1 in. H₂O pressure drop



AIR TO AIR INTERCOOLER CORES (tube-header construction)

Part Number	CORE ENVELOPE			Weight (lbs.)	Estimated Power (hp)	Charge Air ΔP (psi)	Charge Air ΔT (F)	Effectiveness (%)
	A Hot Flow Length (in)	B No Flow Length (in)	C Cold Flow Length (in)					
485257-6001	24	15.5	2.2	29.4	450	1	138	79
485643-6003	26	18.5	2.8	33	600	0.94	142	81
485740-6002	26.5	12	2.8	15.3	400	1	141	80
485980-6002	30.3	16	2.8	21.8	480	0.9	150	86
487085-6002	20	11	3	15.2	420	1	119	68

(continued)



AIR TO AIR INTERCOOLER CORES (bar-plate construction)

Part Number	CORE ENVELOPE			Weight (lbs.)	Estimated Power (hp)	Charge Air ΔP (psi)	Charge Air ΔT (F)	Effectiveness (%)
	A Hot Flow Length (in)	B No Flow Length (in)	C Cold Flow Length (in)					
713372-0001	16	10.3	2.8	8.8	320	0.96	123	70
713447-0001	16	5.4	2.8	5	205	1	109	62
703517-6001	6	11.7	3	7.1	175	0.2	92	53
703517-6002	8	11.7	3	8	200	0.29	104	60
703517-6003	10	12	3	8.7	225	0.36	113	65
703518-6001	12	12	3	9.8	300	0.49	115	66
703518-6002	14	12	3	10.8	325	0.57	118	67
703518-6003	16	12	3	12.6	350	0.64	121	69
703518-6004	18	12	3	13.9	375	0.95	126	72
703518-6005	24	12	3	18.5	450	0.79	127	73
703519-6001	6	12	3.5	7.3	150	0.12	99	57
703519-6002	8	11.7	3.5	8.9	185	0.14	104	59
703519-6003	10	11.7	3.5	10.6	265	0.32	105	60
703520-6001	12	12	3.5	11.8	300	0.31	113	65
703520-6002	14	12	3.5	13.4	350	0.42	115	65
703520-6003	16	12	3.5	15.3	400	0.52	112	64
703520-6004	18	12	3.5	16.4	465	0.89	117	67
703520-6005	24	12	3.5	21.1	500	1	127	72
486827-6002	24	12	4	25.1	520	0.82	129	74
700618-6001	16	10	4	24.4	400	0.42	105	60
703521-6001	6	12.4	5	9.2	150	0.1	90	51
703521-6002	8	11.7	4.5	11.4	165	0.08	100	57
703521-6003	10	11.7	4.5	13.3	225	0.16	112	64
703522-6001	12	12	4.5	14.4	275	0.17	120	69
703522-6002	14	12	4.5	16.6	300	0.23	125	72
703522-6003	16	12	4.5	18.5	345	0.29	124	71
703522-6004	18	12	4.5	20.2	420	0.45	120	69
703522-6005	24	12	4.5	26.6	480	0.65	129	74
701596-6001	27.8	12.8	5	31.4	575	0.42	132	76

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TECHNICAL INFORMATION

The following section includes information that is found in several reference books. The Garrett Engineering team is including this information as a quick reference to help you match a Garrett turbocharger to your engine. Examples are incorporated to help walk you through the matching process.

Turbine Maps

1. Turbine Expansion Ratio – The degree of exhaust expansion as it passes through the turbine.

Example:

Exhaust manifold pressure (EMP) = 15 psi

Turbine outlet pressure (Outlet P) = 1 psi

Atmosphere (Atmos) = 14.7 psi at sea level

$$ER = \frac{EMP + Atmos}{Outlet P + Atmos} = \frac{15 + 14.7}{1 + 14.7} = 1.89$$

2. Turbine Corrected Flow – The turbine flow is also corrected for temperature and pressure at the turbine inlet (exhaust manifold).

Example:

Engine air flow (Actual Flow) = 50 lb/min

Exhaust manifold pressure (EMP) = 25 psi

Exhaust temperature (Gas Temp) = 1500° F

Barometric Pressure (Baro) = 14.7 psi

$$Corrected\ Flow = \frac{Actual\ Flow \sqrt{[(Gas\ Temp + 460)/519]}}{(Baro + EMP)/14.7}$$

$$Corrected\ Flow = \frac{50 * \sqrt{[(1500 + 460)/519]}}{(14.7 + 25)/14.7} = 36\ lb/min$$

(continued)

Compressor Maps:

1. Pressure Ratio – Ratio of ABSOLUTE outlet pressure divided by ABSOLUTE inlet pressure.

Example:

Intake manifold pressure (Boost) = 12 psi

Pressure drop, intercooler ($\Delta P_{\text{Intercooler}}$) = 2 psi

Pressure drop, air filter ($\Delta P_{\text{Air Filter}}$) = 0.5 psi

Atmosphere (Atmos) = 14.7 psi at sea level

$$PR = \frac{\text{Boost} + \Delta P_{\text{Intercooler}} + \text{Atmos}}{\text{Atmos} - \Delta P_{\text{Air Filter}}}$$

$$PR = \frac{12 + 2 + 14.7}{14.7 - .5} = 2.02$$

2. Corrected Airflow – Represents the corrected mass flow rate of air, taking into account air density (ambient temperature and pressure).

Example:

Air Temperature (Air Temp) = 60° F

Barometric Pressure (Baro) = 14.7 psi

Engine air consumption (Actual Flow) = 50 lb/min

$$\text{Corrected Flow} = \frac{\text{Actual Flow} \sqrt{([\text{Air Temp} + 460]/545)}}{\text{Baro}/13.95}$$

$$\text{Corrected Flow} = \frac{50 * \sqrt{([60 + 460]/545)}}{14.7/13.95} = 46.3 \text{ lb/min}$$

- 3. Efficiency Contours** – The efficiency contours depict the regional efficiency of the compressor set. This efficiency is simply the percentage of turbo shaft power that converts to actual air compression. When sizing a turbo, it is important to maintain the proposed lugline with a high efficiency range on the map.
- 4. Surge Line** – The surge region, located on the left-hand side of the compressor map, is an area of flow instability typically caused by compressor inducer stall. The turbo should be sized so that the engine does not operate in the surge range. When turbochargers operate in surge for long periods of time, bearing failures may occur.
- 5. Choke Line** – The choke line is on the right hand side of the compressor map and represents the flow limit. When a turbocharger is run deep into choke, turbo speeds will increase dramatically while compressor efficiency will plunge (very high compressor outlet temps), and turbo durability will be compromised.

WHAT IT TAKES TO BECOME A GARRETT TURBOCHARGER!

Do you know what tests your turbo has endured??? Garrett is one of the few turbocharging manufacturers that subjects our turbo's to several OE qualification tests. These turbocharging "qual tests" ensure Garrett produces a safe and reliable turbo for OE applications. When you buy a Garrett turbo you can be sure it is a reliable one!

- ▶ **On-Engine Durability** – A 1,000-hour general turbocharger durability test that is run on-engine in one of Garrett's engineering laboratories. Some engines die before our turbos do!
- ▶ **Gas Stand Cyclic Durability** (aka The Non-Sissy Test) – A 500 hour general turbocharger durability test. This is basically a "beat the crap out of the turbo" test. Survive this one and you've got one tough turbo!
- ▶ **Compressor & Turbine Housing Containment** – A compressor/turbine wheel is weakened 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 rotordynamic stability beyond the maximum turbocharger operating speed. This means no bearing problems and a long turbo life.
- ▶ **Thrust Bearing Capacity** - A test that stresses the thrust bearing at extreme conditions. This test makes sure your Garrett turbocharger can tolerate the load you put it through.
- ▶ **Compressor & Turbine Seal** - Multiple turbochargers are run on-engine under conditions designed to cause seal leakage. No significant leakage is allowed during these tests.
- ▶ **Heat Soakback** - A turbocharger instrumented with thermocouples is taken beyond maximum operating temperature and shut down hard! Repeat the test four more times and make sure maximum temperatures stay within our strict limits to avoid oil "coking" or build up inside the center housing. This is particularly critical for high temperature gasoline applications.

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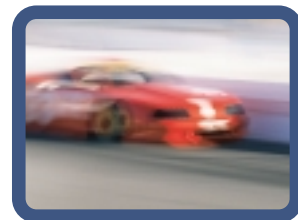
- ▶ **Compressor & Turbine Performance** - The entire operating range of both the compressor and turbine are mapped on one of Garrett's "Performance Gas Stands." These test cells are calibrated to strict standards to assure accuracy and consistency.
- ▶ **Compressor & Turbine Blade Frequencies** - Garrett has strict requirements for compressor and turbine blade natural frequency. This is critical on large trims where the blade must be stiff enough to withstand potentially damaging vibrations.
- ▶ **Thermal Cycle** - A 200-hour endurance test that cycles the turbocharger from low temperature to "glowing red" every 10 minutes. To ensure a long turbo life, no cracking of the turbine housing or distortion of the heat shroud are allowed.
- ▶ **Rotor Inertia** - A measurement made to document the rotational inertia of Garrett's compressor and turbine wheels. Garrett's products are known for their high flow / low inertia characteristics.
- ▶ **Shaft Critical Speed** - An analytical "test" that ensures that destructive shaft "critical speeds" are well out of the turbocharger operating range. For example, large wheels may require a large shaft diameter to avoid the "shaft bending" critical speed.
- ▶ **Compressor Fatigue** - Garrett will not sell compressor or turbine wheel castings that have not passed a strict "test to failure" cyclic fatigue test. Garrett runs tests on a regular basis to ensure quality and to constantly improve our products.
- ▶ **Turbo Vibration** - The entire turbocharger is vibrated on Garrett's large shaker table. Vibration levels are monitored to ensure product durability.

Statement of Warranty

YOU, THE BUYER, MAY CHOSE IN YOUR SOLE DISCRETION TO RESELL OR USE GARRETT ENGINE BOOSTING SYSTEMS PERFORMANCE PRODUCTS FOR RACING VEHICLES, WHICH ARE INHERENTLY DANGEROUS AND MAY NEVER BE DRIVEN ON A PUBLIC ROADWAY. GARRETT, THE SELLER, DISCLAIMS ANY AND ALL LIABILITY ASSOCIATED WITH RACING VEHICLES AND COMPONENTS. ACCORDINGLY, NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED IN BUYER'S PURCHASE ORDER TERMS AND CONDITIONS OR SELLER'S SALES ORDER TERMS AND CONDITIONS OR OTHER PUBLICATIONS (INCLUDING THIS CATALOGUE), OR CONTAINED IN ANY OTHER AGREEMENTS BETWEEN THE PARTIES, SELLER MAKES NO REPRESENTATION OR WARRANTY WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR REPRESENTATION AS TO CONDITION, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR SUITABILITY AS TO ANY OF THE ITEMS LISTED IN THIS CATALOGUE. ALL ITEMS ARE BEING SOLD ON AN "AS IS" BASIS. IN NO EVENT SHALL SELLER OR ANY OF ITS AFFILIATES BE LIABLE IN CONNECTION WITH PRODUCTS LISTED IN THIS CATALOGUE FOR SPECIAL, PUNITIVE, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING LOST PROFITS, TO THE FULL EXTENT THESE DAMAGES MAY BE DISCLAIMED BY LAW. YOU MAY HAVE OTHER RIGHTS THAT DIFFER FROM STATE TO STATE.

Use of compressor maps and turbine maps

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APPENDIX

Appendix A

TURBO TERMS

A/R- A/R describes a geometric property of all compressor and turbine housings. Increasing compressor A/R optimizes the performance for low boost applications. Changing turbine A/R has many effects. By going to a larger turbine A/R, the turbo comes up on boost at a higher engine speed, the flow capacity of the turbine is increased and less flow is wastegated, there is less engine backpressure, and engine volumetric efficiency is increased resulting in more overall power.

CHRA- center housing rotating assembly – The CHRA includes a complete turbocharger minus the compressor, turbine housing, and actuator.

Clipped Turbine Wheels- When an angle is machined on the turbine wheel exducer (outlet side), the wheel is said to be ‘clipped’. Clipping causes a minor increase in the wheel’s flow capability, however, it dramatically lowers the turbo efficiency. This reduction causes the turbo to come up on boost at a later engine speed (increased turbo lag). High performance applications should never use a clipped turbine wheel. All Garrett GT turbos use modern unclipped turbine wheels.

Free-Float- A free floating turbocharger has no wastegate device. This turbocharger can’t control its own boost levels. For performance applications, the user must install an external wastegate.

GT- The GT designation refers to Garrett’s state-of-the-art turbocharger line. All GT turbos use modern compressor and turbine aerodynamics which represent huge efficiency improvements over the old T2, T3, T3/T4, T04 products. The net result is increased durability, higher boost, and more engine power over the older product line.

On-Center Turbine Housings- On-center turbine housings refer to an outdated style of turbine housing with a centered turbine inlet pad. The inlet pad is centered on the turbo’s axis of rotation instead of being tangentially located. Using an on-center housing will significantly lower the turbine’s efficiency. This results in increased turbo lag, more backpressure, lower engine volumetric efficiency, and less overall engine power. No Garrett OEM’s use on-center housings.

Trim- Trim is an area ratio used to describe both turbine and compressor wheels. Trim is calculated using the inducer and exducer diameters. As trim is increased, the wheel can support more air/gas flow. Use these formulas when calculating trim:

$$Trim_{Compressor} = \frac{(Inducer\ Diameter)^2}{(Exducer\ Diameter)^2} \times 100$$

$$Trim_{Turbine} = \frac{(Exducer\ Diameter)^2}{(Inducer\ Diameter)^2} \times 100$$

Wastegate- A wastegated turbocharger includes an integral device to limit turbo boost. This consists of a pneumatic actuator connected to a valve assembly mounted inside the turbine housing. By connecting the pneumatic actuator to boost pressure, the turbo is able to limit its maximum boost output. The net result is increased durability, quicker time to boost, and adjustability of boost.