

Turbo Speed Sensor Kit

Bill of Materials & Precautions

Application:
All Catalog Garrett GT, GTX
and G-Series Turbos

Part Numbers: 781328-0001: GT, GTX *Street Kit*
781328-0002: GT, GTX *Pro Kit*
781328-0003: G-SERIES *Street Kit*
781328-0004: G-SERIES *Pro Kit*

Parts List			Tools Needed
Item	Description	Qty.	• 10mm open-end wrench • Wire cutters / crimpers • Threadlocking compound • Heat-shrink or electrical tape • 20-gauge connectors for 12V power and ground • Zip-ties to secure wiring harness • 6mm and 7mm wrench or socket • Wrench(es) to remove compressor housing and turbo if necessary
1	Speed sensor 769366-1 or 873148-0010	1	• NOTE: Bolt and fastener sizes may be different from one model year to the next depending on OE specifications. Different tools than those listed above may be required.
2	Spacer block	1	
3	Layout (machining drawing) 776243	1	
4	Installation Instructions	1	
5	M4 x 0.70 x 18mm screw	1	
6	M4 x 0.70 x 20mm screw	1	
7	M4 x 0.70 x 22mm screw	1	
8	Main Wiring Harness 778178-0001	1	Recommended Other Items • Factory Service Manual (if applicable) • Safety glasses • Anti-seize compound
9	Power / Logger Pigtail 778178-0002	1	
10	Gauge	1	
11	Gauge Extension Harness 778178-0003	1	
Table of Contents			PLEASE INSURE THAT THE PART NUMBER THAT HAS BEEN RECEIVED WAS THE INTENDED PART NUMBER BEFORE BEGINNING INSTALLATION. See Garrett Advancing Motion’ return policy if the incorrect kit has been ordered.
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IMPORTANT INFORMATION - PLEASE READ CAREFULLY



We recommend that this Garrett product be installed by a qualified automotive technician. If you have any doubts as to your ability to install this product, consult with a local automotive repair company. Please be sure to carefully read all of the attached instructions prior to starting the installation process. If you have any questions about the enclosed parts or the instructions, call the distributor that you purchased the kit from for clarification.

Prior to the Garrett product installation, be sure that the vehicle is parked on a level surface and the engine is cool. Engine fluids and components can be extremely hot following normal vehicle operation. Avoid direct contact of engine fluids or components with your skin which may cause personal injury.

IMPORTANT INFORMATION - PLEASE READ CAREFULLY

Return Policy

Only unused and complete merchandise will be accepted for return subject to inspection and acceptance by Garrett Advancing Motion. No goods will be accepted without prior return authorization from Garrett Advancing Motion. No returns are accepted after thirty (30) days from original ship date from Garrett. All accepted returns are subject to a 20% restocking charge - NO EXCEPTIONS.

Damaged Shipments

The customer must file a claim with the shipping company if goods arrive in a damaged condition. The customer must also notify the distributor from which the goods were purchased with pertinent information.

Refused Shipments

Sending a shipment back to The Garrett Garage (or Garrett) does not automatically give rise to a complete refund or credit. Garrett Advancing Motion may, at its sole discretion require different payment means for any shipment refused and then reshipped. It is the customer's responsibility to make all arrangements with Garrett Advancing Motion for disposition of refused shipments.

Shortage or Discrepancy Claim

Shortage or Discrepancy claims must be reported within forty-eight (48) hours of receipt of goods to the distributor from which the goods were purchased. The Garrett distributor will determine the best solution on how to address shortages or discrepancies.

Limited Warranty

Garrett Advancing Motion warrants to the original purchaser of its Turbocharger Products that such Turbocharger Products will, for a period of 1 year from date of shipment and subject to the Limitations on Warranty, be free from defects in materials and workmanship. For approved warranty claims Garrett Advancing Motion will, at its sole discretion, either credit the original purchaser in an amount equal to the original purchase price, or replace the applicable Turbocharger Product free of charge, within 60 days of Garrett Advancing Motion' approval. This is purchaser's sole and exclusive remedy and provides the complete financial responsibility of Garrett Advancing Motion for a warranty claim. To be eligible for reimbursement, Customer must (a) submit all warranty claims to Garrett Advancing Motion within 30 days of the discovery of the alleged Turbocharger Product defect; and (b) complete and return a Returned Material Authorization Form. Consumers are required to work through Garrett distributors in order to process any warranty claims.

When Garrett Advancing Motion requires the examination of a failed part, Garrett Advancing Motion will promptly notify Customer and will await receipt of the failed part before further processing the warranty claim. If Garrett Advancing Motion ultimately determines that the failed part is covered under the Limited Warranty, Garrett Advancing Motion will reimburse Customer for the actual cost of ground shipment for any part found to be defective.

IMPORTANT INFORMATION - PLEASE READ CAREFULLY

Limitations on Warranty

The Limited Warranty does not apply to any parts: (a) not used in accordance with Garrett Advancing Motion' written instructions (b) for which no fault is found; (c) that have been modified in any manner not specifically approved by Garrett Advancing Motion; (d) for which an inspection indicates that reasonable and proper installation and/or preventative care and maintenance has not occurred; (e) that have been subject to damage attributable to or caused by misuse, abuse or vandalism; mishandling, improper shipping or other transit related damage; acts of god or insurrection; foreign object entry; any part not supplied by Garrett Advancing Motion; any repair, maintenance or service by anyone other than Garrett Advancing Motion; or any other acts that are beyond Garrett Advancing Motion' reasonable control; or (f) attributable to parts not supplied by Garrett Advancing Motion expressly disclaims any and all warranties relative to the foregoing circumstances.

Garrett Advancing Motion shall not be liable to Customer under any circumstances for any special, incidental or consequential damages, including without limitation, damage to or loss of property other than for Turbocharger Products; damages incurred in installation, repair or replacement; lost profits, revenue or opportunity; loss of use; losses resulting from or related to downtime of Turbocharger Products; the cost of replacement transportation, power, or compression; the cost of substitute products; or claims of third parties for such damages, howsoever caused, and whether based on warranty, contract, and/or tort (including negligence, strict liability or otherwise).

The Limited Warranty is the only warranty made by Garrett Advancing Motion for any of its turbochargers and related parts and/or services, and is in lieu of and excludes all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. Garrett Advancing Motion hereby disclaims all other warranties not expressly set forth. Some jurisdictions do not allow for the exclusion of implied warranties, so the above exclusions may not apply to you, however if implied warranties do apply they are limited to the original purchaser and for a period of one (1) year from the date of shipment.

Diagnosing Your Vehicle

Do not rely on diagnostic software without seeking the advice of an ASE certified mechanic. Diagnostic software should only be used as a general guideline to help you facilitate the repair of your car. If you experience or suspect any malfunction of vital safety equipment, such as your brakes, exhaust, motor, transmission, fuel delivery system, your car's structural integrity or any other potentially life threatening malfunction, cease driving your vehicle immediately and seek professional help. Always consult your owner's manual.

Vehicle Modification Notice

Any modifications to your car are AT YOUR OWN RISK. You should consult the owner's manual and service manual. You should also contact your car's manufacturer to determine what effects modifications may have on your safety, warranty, performance, etc. Please also contact your local authorities to determine whether your intended modifications will make your car illegal to drive on public roads. A vehicle modified by the use of competition parts may not meet the legal requirement for use on public roads. It is your responsibility to comply with federal, state, and local laws prior to driving your vehicle on public roads.

IMPORTANT INFORMATION - PLEASE READ CAREFULLY

OTHER PRECAUTIONS

Observe all safety precautions and warnings contained in the installation instructions. Wear eye and ear protection and appropriate protective clothing. When working under or around the vehicle support it securely with jack stands. Use only the proper tools. Exercise extreme caution when working with flammable, corrosive, and hazardous liquids and materials.

LEGAL INFORMATION

This product is an aftermarket part that is not legal for street use in California and New York. Use on public roads may also be prohibited in other states adopting California emissions standards under Section 177 of the Clean Air Act. If you do not live in California or New York, you should check with your state authorities to find out whether this product is legal for street use in your state. Federal and state laws also prohibit the tampering with parts or vehicle design elements affecting emissions on vehicles intended for use on public roads. You are responsible for ensuring that the use of this product complies with all applicable federal, state or local laws, regulations and ordinances. This product may be used on racing vehicles that will never be driven on public roads or highways.

Contact Information for Questions

Please contact the Garrett distributor from which the equipment was purchased for any questions regarding this Shipping/Returns/Cancellation Policy, for notifications to Garrett Advancing Motion, and for instructions on processing damaged shipments and authorized returns.

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Garrett
ADVANCING MOTION

Installation Instructions

1. Remove the compressor housing from your turbocharger. This may necessitate removing the turbo from the vehicle, if it is already installed. Typically the compressor housing is attached to the turbo using a v-band clamp or bolted clamps. Remove all bolts, clamps, and the wastegate actuator – whatever is necessary to separate the compressor housing from the turbo (see fig. 1). Do not loosen the wastegate rod end or lock nut, and do not adjust the actuator; simply unbolt its bracket from the compressor housing.

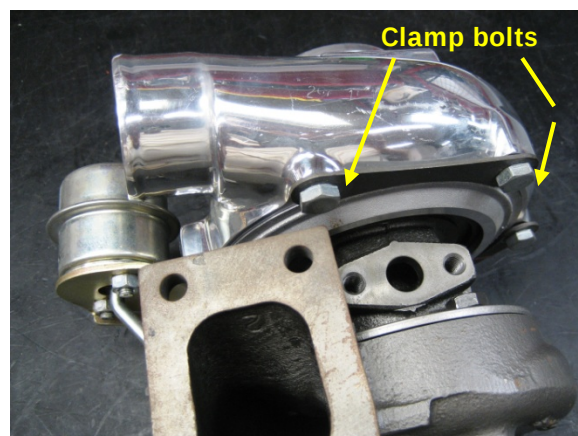


Fig. 1

2. If the compressor housing has a pre-drilled speed sensor port and plug installed from factory(see fig. 2), skip to step 6 for removal instructions.



Fig. 2

3. Refer to the enclosed layout drawing 776243 and find your particular Garrett turbo on sheet 2. Check the turbo nameplate for part number. Otherwise, cross-reference www.GarrettMotion.com or your Garrett catalog to confirm your turbo part number, or call a distributor if you are unsure. Once you have identified the part number, highlight the correct row in the table for future reference. The dimensions in this table refer to the views on sheet 1 of this drawing; these are instructions for the machinist to modify your housing. For example, if you have a Disco Potato turbo (GT2860RS) part number 739548-1, or -5 or -11, highlight row 18. You will only need the dimensions listed in this row (see figure 3).

GT2860R	707160-0005	446237-0025	0.60	21
GT2860R	707160-0007	446237-0039	0.42	21
GT2860RS	739548-0001 739548-0005 739548-0011	446296-0015	0.60	21
GT2860RS	739548-0009	467937-0015	0.60	21
GT2871R	472560-0015 771847-0001	467937-0013	0.60	11
GT2871R	743347-0001	446296-0015	0.60	21

Fig. 3

4. Take your compressor housing and the highlighted layout 776243 (all sheets) to a qualified machine shop. Make sure the machinist is capable of meeting the tolerances on the drawing and knows which row of dimensions to use before agreeing to pay for the work. You may want to supply the machine shop with the spacer, screw and speed sensor so they can test-fit the parts in the housing (see figure 4).

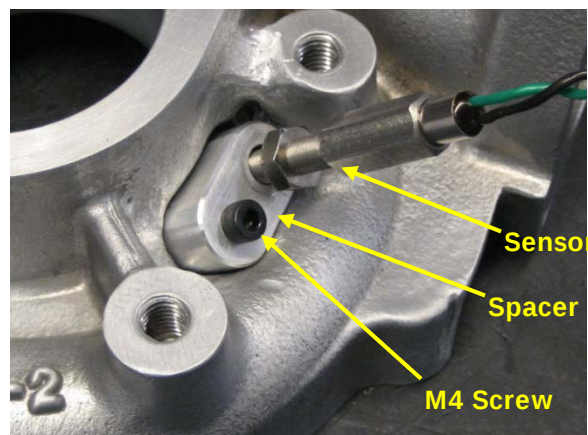


Fig. 4

Installation Instructions

NOTE: On the machining Layout (776243 sheet 1), datum A is always the main compressor housing mating surface, which is a machined surface around the perimeter of the housing, and is usually inset by several millimeters.

5. Once the housing is machined, install the spacer with the supplied M4 screw. There are different lengths of screws supplied in the kit; the layout drawing shows which screw to use on each turbo. Do not torque the screw at this point. If your housing has a ported shroud and the machined spacer pocket has broken through to the inside, coat the outside of the spacer with RTV or similar sealant to prevent an air leak past the spacer (see figure 5).

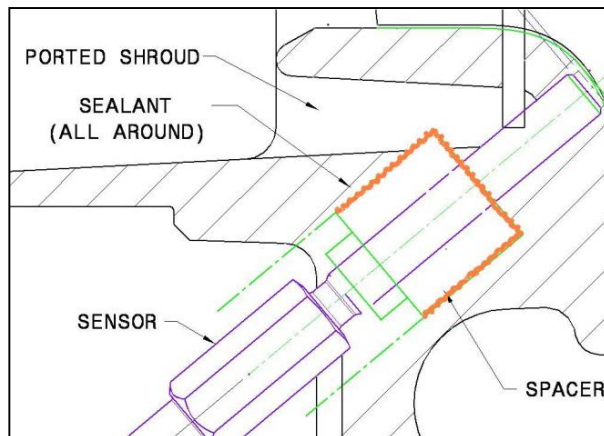


Fig. 5

6. If the compressor housing has a pre-drilled speed sensor port and plug installed from factory, follow these instructions (Fig. 6). Using a 5mm Allen wrench (Hex key), remove plug completely from the compressor housing (Fig 7). Keep plug in safe place just in case it is needed in the future. Thread is a unique M6x0.5mm and cannot be purchased from stores. Follow the instructions in the next steps to install speed sensor but do not use M4 screws or spacer block for installation.



Fig. 6



Fig. 7

Installation Instructions

7. Test fit the speed sensor. If the lock nut is not accessible by wrench once installed, apply a threadlocking compound that will cure slowly enough to allow adjustment and final tightening. Install the speed sensor loosely in the housing – do not tighten the lock nut yet.

IMPORTANT: Make sure the **tip** of the sensor is approximately flush with the inside contour of the housing. (see figure 8). Tighten the M4 spacer screw once the sensor has been installed in the housing.

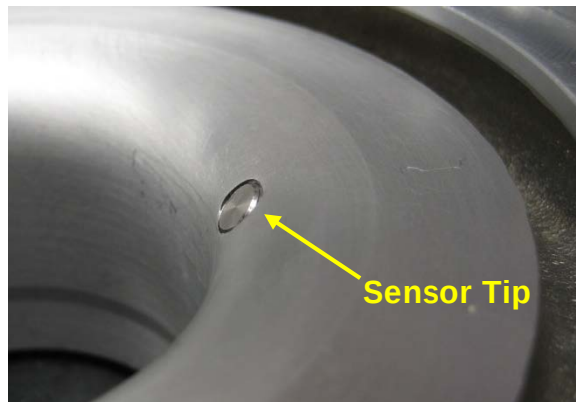


Fig. 8

8. Count the number of blades on your compressor wheel, including small (splitter) blades. Record this number below; you will need it later (see figure 9).

Number of Compressor Wheel Blades: _____

9. Install the housing on the turbocharger with its bolts and clamps. Make sure housing orientation is correct. Reinstall the wastegate actuator with bracket. Tighten and torque the clamping bolts, according to the tabulated columns “Comp. Housing Clamp Bolt Torque” and “Clamp Bolt Thread Type” on the layout (776243) for your turbocharger.

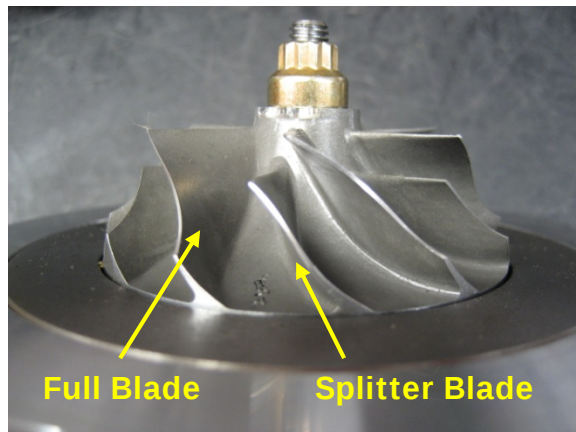


Fig. 9

Installation Instructions

10. Setting the sensor depth: if the turbocharger is still in the vehicle, ensure that there is enough space to adjust the sensor by turning it in and out. Also ensure there is sufficient space to turn the compressor wheel by hand. If not, remove the turbocharger from the vehicle. Slowly turn the sensor clockwise, while simultaneously spinning the wheel very slowly. Turn the sensor inwards, just until the tip contacts the edge of a compressor wheel blade (see figure 10). Be extremely careful not to jam the wheel into the sensor – the blades or sensor could be damaged. You should be able to feel a SLIGHT resistance and noise while gently turning the wheel as it contacts the sensor. Then turn the sensor back counterclockwise, approximately **1.6** full turns. This sets the sensor depth correctly. The nominal distance from the blade edge is 0.8mm. The sensor thread pitch is 0.5mm/thread ($0.5\text{mm/thread} \times 1.6 \text{ threads} = 0.8\text{mm}$).

NOTE: If the Garrett Turbo Speed Sensor Kit is being used with an older Garrett (T-Series) turbo, or with a non-Garrett unit, refer to figure 10 below for general placement of the sensor. It should always be installed at 0.8mm clearance from the wheel. The sensor hole should be drilled at an angle, placing the sensor near the base of the wheel below the level of the splitter blades, in order to accurately measure the speed. On custom applications the sensor can be used with or without the spacer block.

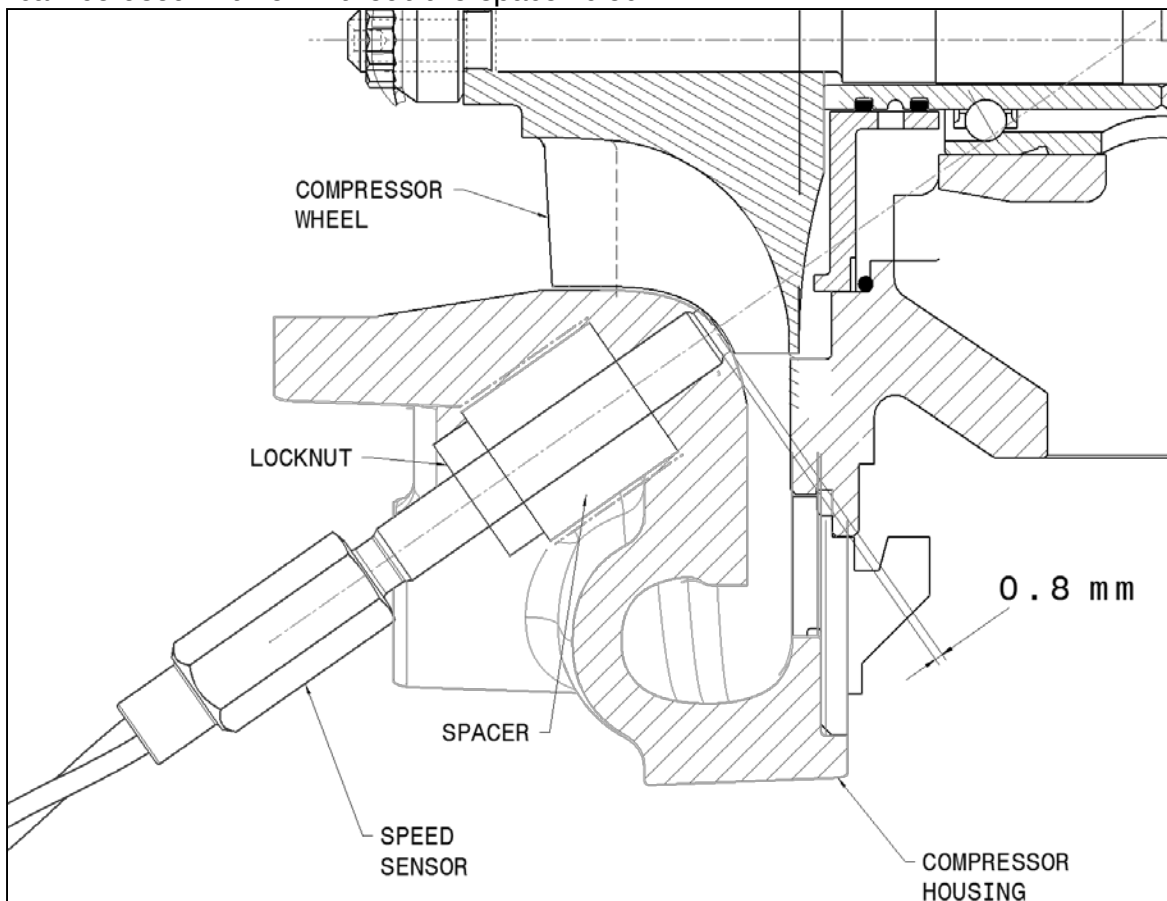


Fig. 10

Installation Instructions

11. Tighten the speed sensor lock nut firmly with a 10mm wrench. If there is not enough clearance to use a wrench, use needle-nose or similar pliers in conjunction with threadlocking compound to tighten the nut as securely as possible. (see figures 11 and 12).

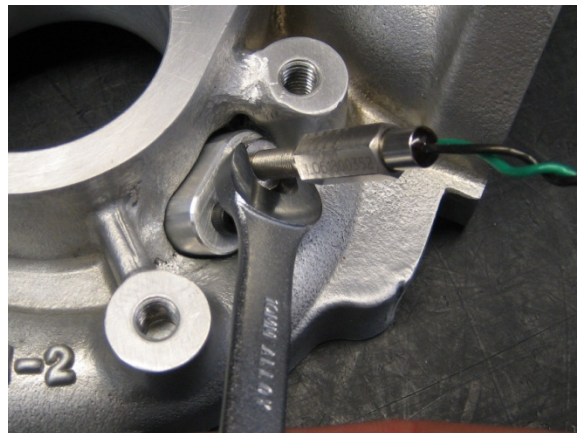


Fig. 11

12. Reinstall your turbocharger if it is not already in the vehicle.

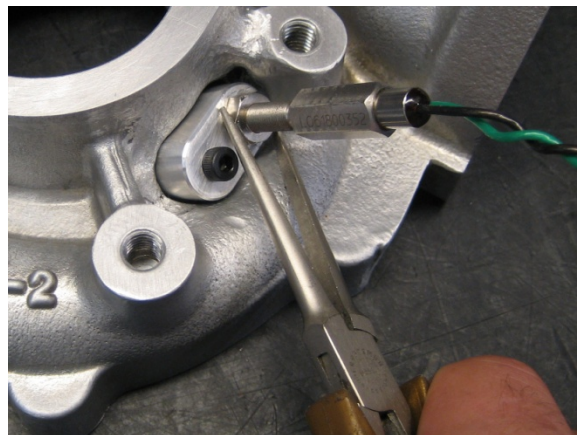


Fig. 12

13. Unpack the 3-way wiring harness and find the longest end (3 pins, approx. 35.5 in / 900mm long). This end connects to the speed sensor. Connect the harness to the sensor and lay the harness out in the engine bay to begin determining wiring harness routing. See figure 13 below.

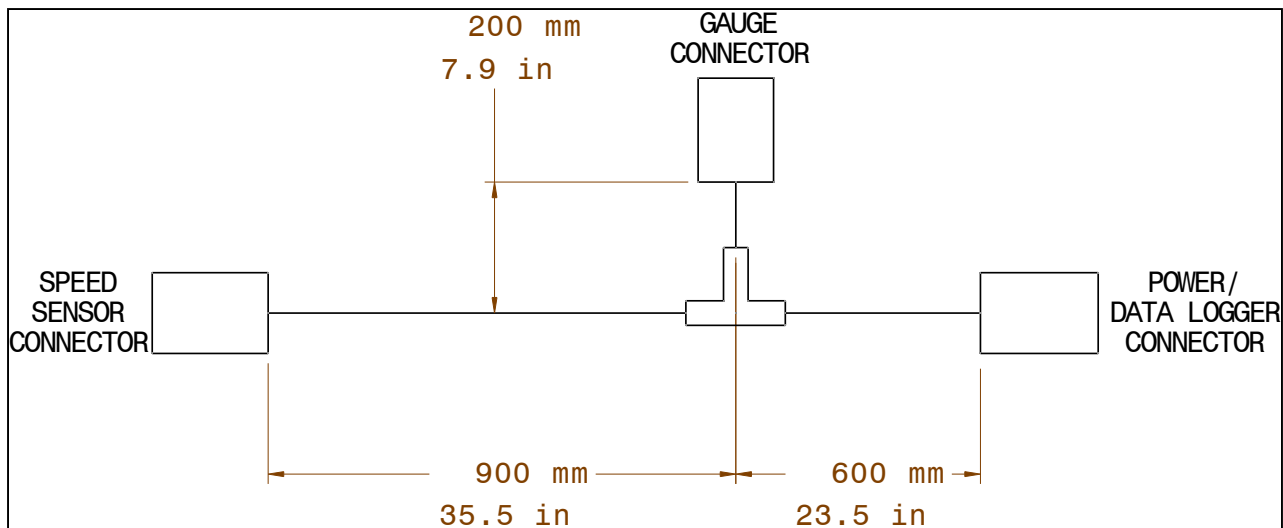


Fig. 13: Wiring Harness Diagram

Installation Instructions

G-SERIES TURBOCHARGERS ONLY

Speed Sensor Kit 781328-3 or 781328-4

14. Remove bolt from speed sensor port plug located on inlet side of compressor housing using a 7mm socket or wrench(Fig. 14). Remove speed sensor port plug from compressor housing by pulling on it gently and rotating if necessary. Put bolt aside to be used when installing speed sensor. Note: Compressor Housing does not need to be removed from Turbocharger and Turbocharger does not need to be removed from engine if there is adequate space to access the speed sensor plug.

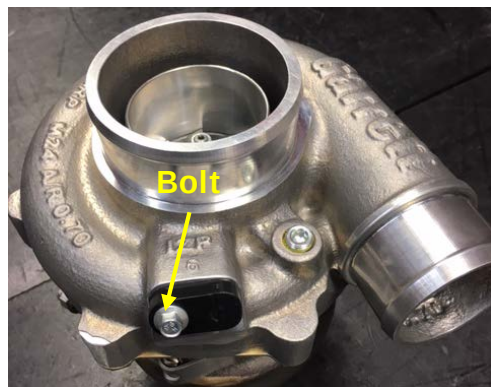


Fig. 14

15. Locate your new G-series speed sensor 873148-0010 from G-Series Speed Sensor Kit. Apply a light coat of oil on O-ring located on the speed sensor body. (Fig. 15)

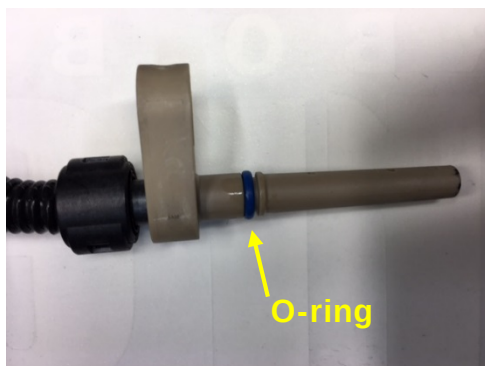


Fig. 15

16. Push speed sensor into speed sensor port on the compressor housing until firmly seated. Re-use bolt from speed sensor plug from step 14 and torque to 5-6Nm(44-53inlbs) Using 7mm socket and torque wrench. (Fig. 16)



Fig. 16

Installation Instructions

Section A: STREET KIT WITH GAUGE ONLY

1. Locate the second-to-longest end of the harness (approx. 23.5 in / 600mm) Connect the power/data logger pigtail, which has 4 loose wires extending from the connector. Connect the red wire to a fused 12V DC power source. Connect the black wire to a chassis ground point. Crimp-on or soldered connectors are recommended.
2. Set the gauge for your particular compressor wheel. Long press the button on the dial face for 3 seconds to enter the calibration mode to define the number of compressor blades based on **figure 17** below. (If you desire to use the sensor to pick up a single magnet or machined flat on a shaft, choose 1 blade, or 2 blades if there are 2 magnets or flats, etc.)
3. The orange and green wires on the pigtail are not needed unless you plan on data-logging the speed signal (see Section C below). Cover the ends with electrical tape or heat-shrink tubing and secure the wires. To install the gauge, connect the gauge extension harness to the shortest end of the main wiring harness (7.9 in / 200mm). Run the extension into the vehicle interior and connect the gauge after determining a suitable mounting location. The gauge itself is a standard 2 1/16" diameter and should mount in any properly-sized gauge pod using the included bracket and nuts. The gauge extension harness can be left out if the main harness is long enough without it.

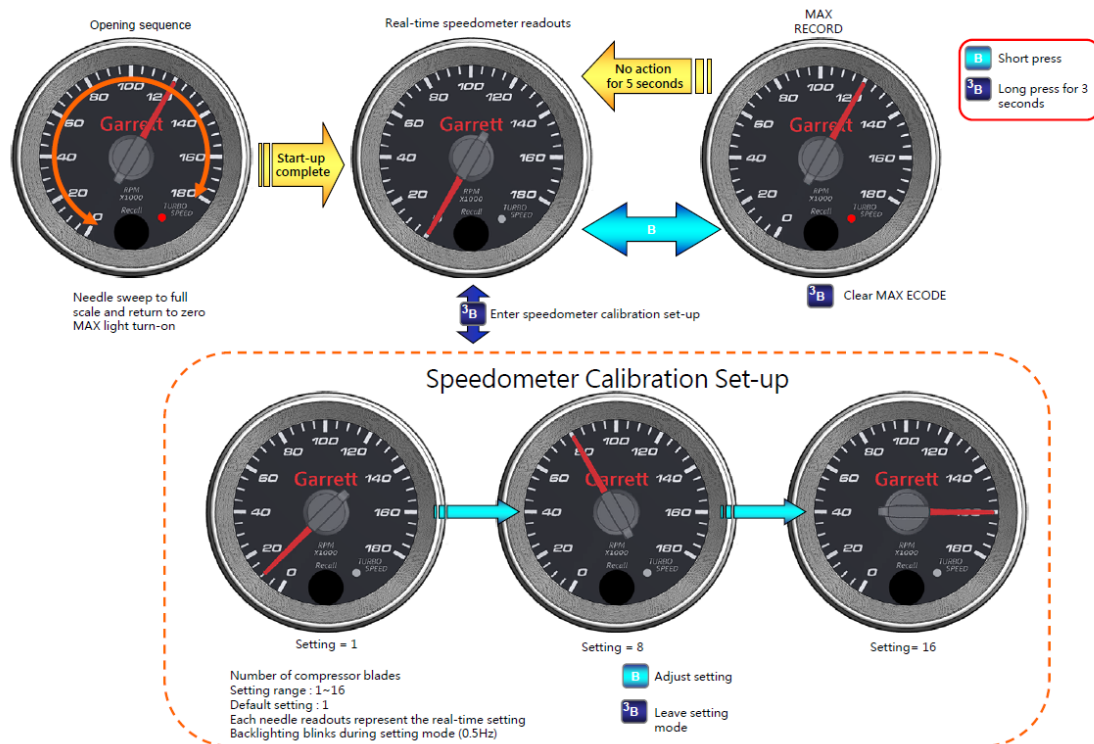


Fig. 17

Installation Instructions

4. Gauge lighting: refer to a wiring diagram for your vehicle and connect the white gauge wire to the output of the dash light dimmer knob, or directly to the headlight switch if desired (see **figure 18**).

5. Key on wiring: Connect the brown gauge wire (see **figure 18**) to a permanent 12 V power. This power line drives the pointer return to zero once the power shuts off to avoid pointer stopping in the middle of the dial weep when the power shuts off unexpectedly.

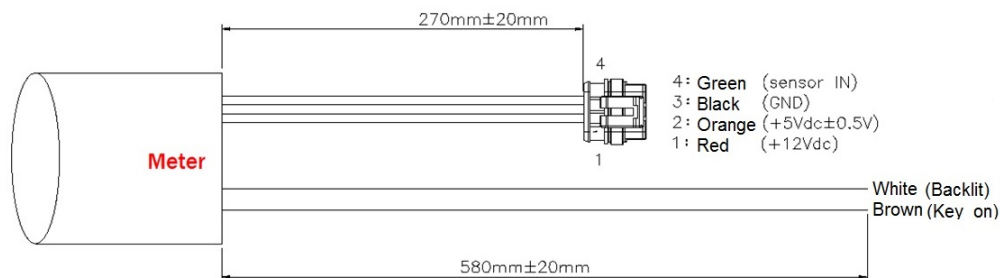


Fig. 18

Section B: PRO KIT WITH DATA LOGGING, **NO GAUGE**

(data logger not included)

1. For data logging, connect the orange wire on the pigtail to a +5V DC ($\pm 0.5V$) source. This supplies sensor power. Your data logging device may have a 5V DC source available. The sensor output signal is carried by the green wire. Connect the green wire to the data logging device on a channel selected for turbo speed signal. Connect the black wire to data logger ground. The red wire is not used; cover the end with electrical tape or heat-shrink.

CAUTION: DO NOT CONNECT THE ORANGE WIRE IF SENSOR IS USED WITH A DATA LOGGER IN ADDITION TO THE SPEED GAUGE (see section C below).

(continued on next page)

Installation Instructions

Sensor Signal: the speed sensor will output a square-wave signal at 1/8 the input frequency (originally intended for 8-blade wheel). The input frequency is simply one pulse per blade, as the blades pass by the sensor. The sensor therefore measures the following input frequency (in rpm):

$$RPM = (60 * 8) * (f_{out} / N)$$

Equation 1

where N is the number of blades, and RPM is the turbo speed.

Therefore, your data logger needs to convert the speed sensor signal based on equation 1.

For example, with a 12-bladed wheel,

$$RPM = 480 * (f_{out} / 12) = f_{out} * 40$$

Example

Therefore the logger would need to multiply the sensor signal by 40 in order to record true turbo RPM (for a 12-bladed wheel).

IF your ECU already converts the signal to RPM then you will need a conversion factor to adjust the input to the correct number of blades.

$$Conversion_Factor = (8 / N)$$

Equation 2

For example, with a 12-bladed wheel,

$$Conversion_Factor = (8 / 12) = 0.75$$

Example

Therefore the signal to the ECU will need to be multiplied by 0.75 for correct turbo speed.

Section C: STREET KIT WITH GAUGE AND DATA LOGGER (data logger not included)

For data logging with the Street Kit (gauge installed), follow all instructions in sections A and B above, EXCEPT: DO NOT connect the orange wire to 5V DC. The orange wire will *not* be used. Vehicle 12V DC power is connected to the red wire as in section A, and the green wire is connected to the data logger as in section B. The black wire is connected to ground. Cover the end of the orange wire with electrical tape or heat-shrink and secure it out of the way.

Installation Instructions (cont'd)

Section D: MAXIMUM SPEED RECALL FUNCTION

1. Push the recall button once to display the last maximum speed.
2. Push the recall button again and release it immediately to go back to normal operation mode. The speed gauge will return to normal operation mode after 5 seconds if the button is not pressed again.

TO RESET:

1. Push and hold the recall button for at least 2 seconds to reset the recorded maximum speed.
2. Push the recall button again to verify that the previous max speed has been cleared.

Section E: Mapping

If you are familiar with turbocharger operational theory (as explained in the Turbo Tech sections on www.GarrettMotion.com), you can use the turbo speed data to plot operating points on your compressor map, which can enable you to make a close estimate of airflow through the engine. For example, during a full-throttle acceleration test up to redline, you can observe maximum boost and maximum turbo speed (which will be near redline), and use this information to estimate flow at redline.

From the boost gauge pressure you can estimate Pressure Ratio across the compressor by accounting for atmospheric pressure and losses in the intake plumbing, as in Turbo 103 on the Garrett website. Draw a horizontal line on the map at this estimated PR value. The compressor's operating point is where it intersects the estimated speed line, based on turbo speed observed from the test. From this point, draw a vertical line down to the airflow axis, and you will have your flow estimate.

(continued on next page)

Installation Instructions (cont'd)

For a more accurate estimate of airflow, you will need to “correct” the turbo speed for the compressor inlet temperature, since flow on a compressor map is corrected for standard atmospheric conditions. Using a thermocouple or equivalent temperature sensor installed as close as possible to the compressor inlet, use the following equation to correct the turbo speed:

$$RPM_{corrected} = \frac{RPM_{measured}}{\sqrt{(T_{1c} + 460) / 545}}$$

Where T_{1c} is the measured compressor inlet air temperature in degrees Fahrenheit. After calculating the corrected speed for each point, plot corrected speed vs. pressure ratio on the map, and find the corrected airflow on the horizontal axis. In this way, a boost gauge and the Garrett Turbo Speed Sensor Kit can be used to gauge the effectiveness of performance upgrades (such as free-flowing air filters or head porting) by comparing airflow before and after the upgrade. This method will also help to validate your turbo selection and guide decisions to upgrade your turbo, by showing “where you are” on the compressor map more accurately than otherwise possible.

If you are interested in the *actual* airflow (in lb/min) through the compressor, you will need to “uncorrect” the flow estimate with the following equation:

$$W_{act} = \frac{W_c (P_{1c} / 13.95)}{\sqrt{(T_{1c} + 460) / 545}}$$

Where P_{1c} is the measured compressor inlet pressure (in psi) and W_c is the corrected airflow estimate from the map (lb/min). You can use corrected airflow to make before-and-after comparisons, but calculating the actual airflow will give a more accurate measurement of the true flow through the engine.

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