BorgWarner Turbo Speed Sensor (Blade-Pass Type)

Turbo speed sensors are not new or exotic technology, but the installation procedure has been difficult for the end user. Competing products have required the customer to remove their compressor cover and take it to a machinist. This machinist then has to set up the cover at a compound angle to precisely drill the speed sensor bore while carefully hitting the contour area of the wheel bore and at the right angle.

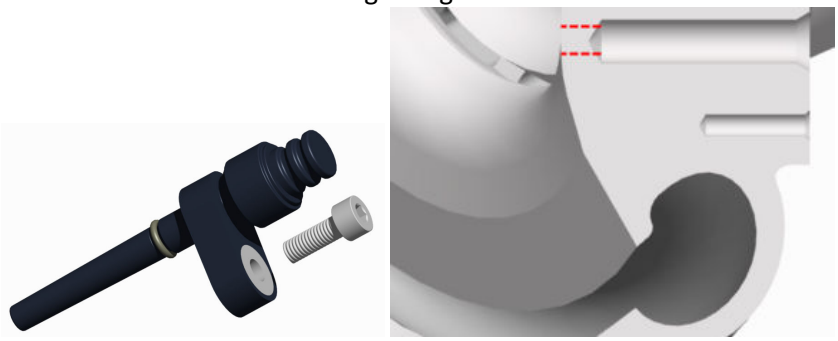


Figure 1: Speed Sensor Kit (Left) and Hole Drilling Schematic (Right)

The BorgWarner solution provides this precision machining already done to the compressor cover. The hole stops short of protruding into the compressor wheel bore. If a user decides to buy a speed sensor as an upgrade accessory, they can remove the compressor cover and extend the hole the rest of the way through to the wheel bore using a hand drill. A 1/4" drill bit is used and the length required to be drilled is quite short. This hole allows the tip of the sensor to come flush with the contour surface. The hole does not have to be precise, as no sealing takes place in the small hole that the user just created. The hole should be de-burred where it pierces into the wheel bore. The goal is to make sure that there are no sharp edges remaining in the wheel bore that the compressor wheel can become snagged on.

Installation steps:

1. Remove compressor cover from turbo (CAREFULLY)
2. Place cover on a table, with some kind of backing so that it won't slide while being drilled
3. Equip a hand drill with a 1/4" drill bit
4. Drill out the bottom of the speed sensor bore while being careful not to nick the side-walls of the bore where the speed sensor o-ring will seal.
5. De-burr the hole where it protruded into the compressor wheel region.
6. Lubricate the speed sensor o-ring
7. Install the speed sensor into the bore and check for a good fit.
8. Use a file on the mounting surface if the sensor needs to protrude further into the bore. The sensor tip should be nearly flush (within 0.5mm) with the edge of the hole.
9. Tighten speed sensor hold-down bolt.
10. Re-install compressor cover on turbo and verify that the compressor wheel spins freely.

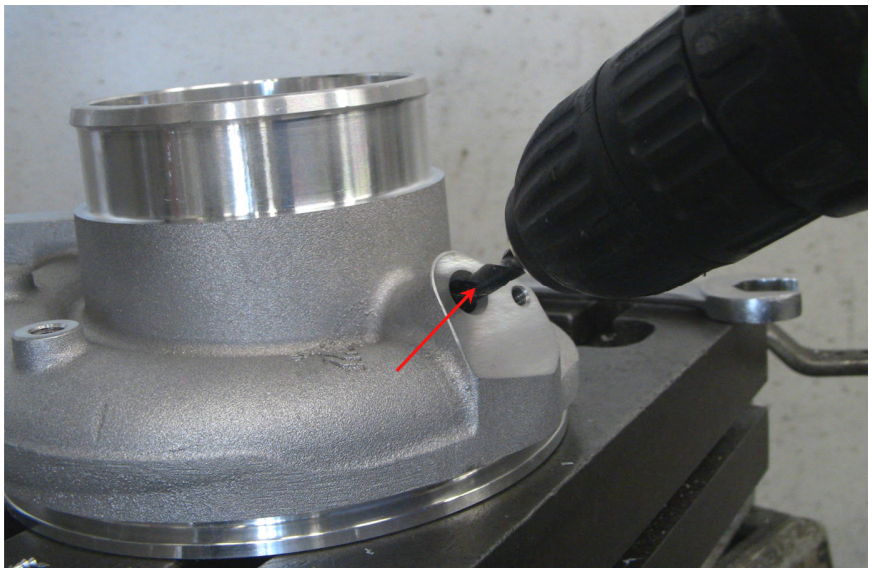


Figure 2: Drilling the 1/4" Hole

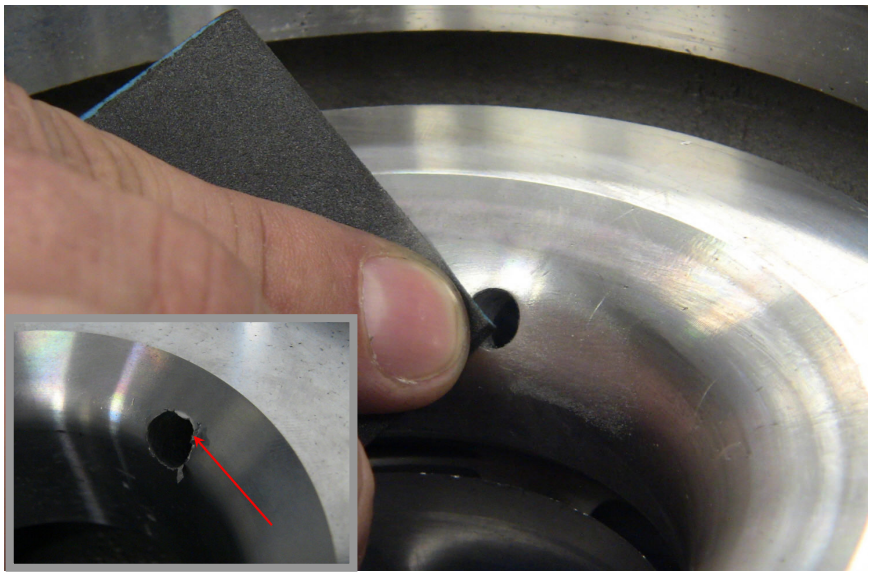


Figure 3: De-burring the Edge of Hole with Sandpaper

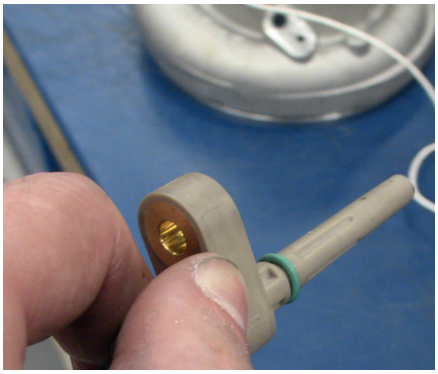


Figure 4: Lubricate O-Ring, Install, Check Depth, and Tighten Bolt

Figure 5: Example of Sensor Tip that is Not Sufficiently Deep

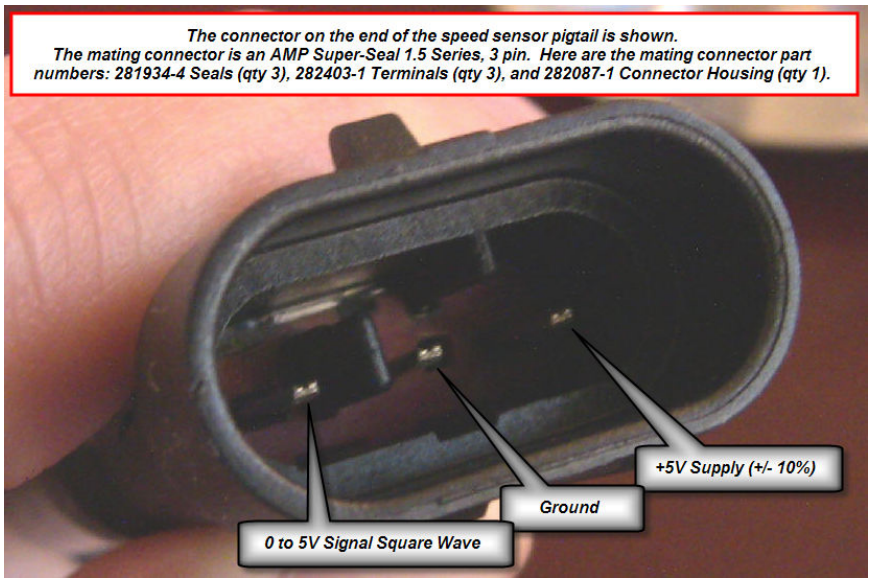
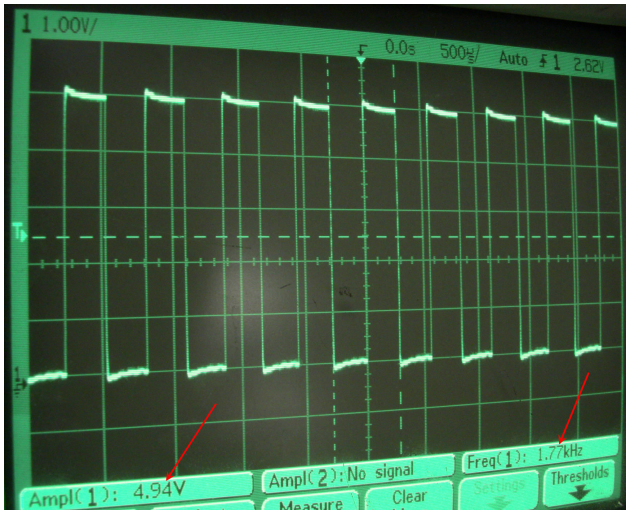


Figure 6: For Those Who May Want to Connect to the Speed Sensor Frequency Output Directly

The speed sensor is powered by a +5V supply, and the return signal is a variable frequency square wave that has maximum amplitude of 5V and has a 50% duty cycle. The frequency of this signal depends on the speed of the wheel. Each passing blade creates a pulse, and all the EFR wheels have 14 blades except for the 67mm (which has 12 blades). The sensor embedded electronics divides the blade-pass frequency by 8, and then the resulting count forms the output waveform. Here is an example:

*100,000 rpm * 14 blades/rev = 1,400,000 blade pass counts per minute*
1,400,000 / 60 sec/min = 23,333 blade pass counts per second (Hz)
23,333 / 8 count divisor = 2,917 Hz output frequency



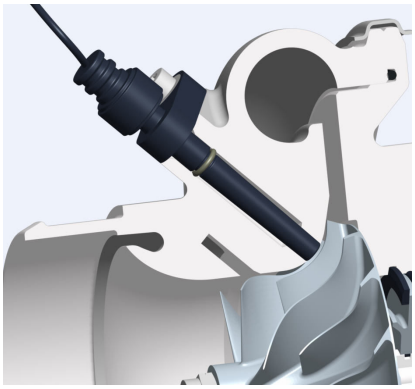


Figure 7: 0-5V Frequency Output Waveform (this example is 1770Hz, which is 60,686 rpm on a 14-blade wheel)

Some users will not have a convenient way to log or display the native frequency signal that is output from the speed sensor. In response to this problem, we have worked with an electronics manufacturer to make a "converter box" that will convert this frequency output into a variable voltage output. By generating a 0-5V signal that is proportional to compressor wheel speed, we offer the end user the ability to easily log or display turbo speed. Also planned is a LCD screen dashboard display from this same supplier.

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Here is the output from the RRG "Turbo Speed Scaler" device (14-blade example shown):