

Torque converter rebuilders have been routinely replacing friction elements in torque converters since the late 1970's, when early on/off lockup systems became widespread. The early lockup materials were hard, paper-based materials which were bonded with a primitive adhesive. The bond process was very forgiving with that combination. Fast forward to today and the friction materials available in the aftermarket are much more sophisticated. Materials are now engineered to be more compliant and are intended to slip and/or fully lock in very exacting ways. Because of this, you need to pay close attention to your bonding practices when bonding these newer, highly engineered materials.

## General Guidelines for a Good Bond

BorgWarner friction rings use a solvent-based adhesive that is activated by heat and requires a specific regimen of temperature, time and pressure to achieve the best bond possible. This applies whether you use old-school clamping fixtures in a pizza oven or have the latest purpose-built bonder with programmable digital controls. Temperature, time and pressure all work in concert together, and not having the correct parameters for just one of these variables can result in bond failures. The following general guidelines will help ensure that you are optimizing your bonding process.

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## Temperature

The critical surface where you need to read the temperature is the bond line surface (the metal surface that the friction ring will adhere to). The bond line temperature is NOT the same as the temperature of the top or bottom heating platens. To measure temperature, you can use special crayons to mark near the bond line; the mark will change colors when it reaches a specified temperature (Fig. 1). There also are very precise pyrometers with wired probes which you can use to get real-time temperature measurements (Fig. 2). "Point and shoot" wireless thermometer guns are available, but rebuilders have reported that these can be inconsistent. Some temperature-related tips for getting a proper bond:

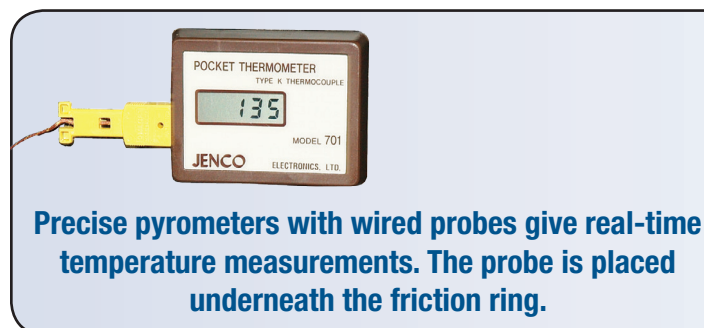
- Keeping an even bond line temperature between 400° and 450° is optimal for a proper bond of BorgWarner materials. Do not let the bond line temperature go beyond 500°.



- It is critical to get the cover/mass to temperature prior to the adhesive curing to the friction material. Should the heat from the friction material side cure the adhesive prior to the steel cover getting to temperature (typically 350°F min.), a "cold" bond may occur.
- Be sure your process heats the entire bond line surface; there must not be any cold spots anywhere on the bond surface.

## Time

Once you have the bond line surface up to the proper temperature, an optimal bond can be achieved in as quickly as two minutes. That's NOT two minutes total, but two minutes after you get the bond line *up to and within* the proper temperature and pressure range. Bond time can be further reduced by increasing temperature, but this requires making small adjustments, keeping careful records and trial testing with each change.



# Bonding BorgWarner Friction Rings

## Pressure

The pressure described here is the pounds per square inch (psi) that your fixture or bonder applies against the face of the friction ring. If you are using one of the commercially available bonders which utilize hydraulic or pneumatic systems to apply pressure, you will need to do some simple calculations or use the Sonnax friction ring bonding calculator found on our website. The variables you need to consider in calculating the force applied to the face of the ring are:

- Surface area of the ram/piston
- The surface area of the friction ring
- The amount of air or oil pressure acting on the ram

Like temperature, pressure must be applied evenly. If your fixture process applies inconsistent force to the face of the friction ring, you will have bond problems. You also must be certain that there is no interference between the bonder die and TCC piston. There are pressure tapes, contact papers and other

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methods which you can employ to verify that your process distributes pressure evenly over the complete friction face.

The acceptable range for applying pressure to BorgWarner friction rings is 200–400 psi, measured at the friction ring face area. You can expect BorgWarner friction rings to compress slightly when subjected to pressure. Depending on the type and thickness of the BorgWarner material that you are bonding, the material will compress a specified amount relative to the pressure it's bonded with. Too little pressure and the friction ring bond will be inadequate; too much pressure and the friction material itself will be compromised. It is not recommended to compress the friction material more than 15% of the initial thickness.

## Sonnax Online Bonding Pressure Calculator



Enter the details of the friction ring you are bonding into the calculator on [www.sonnax.com](http://www.sonnax.com) to find out the piston pressure required to create the desired pressure at the ring.



Scan with your smartphone

## Don't Forget About Cleanliness & Surface Finish

Beyond the three main variables of time, temperature and pressure, there are some other basics to consider. Absolutely critical to a good bond are *cleanliness* and *surface finish* of the bond surface.

In terms of cleanliness, all oils, dirt and contaminants must be totally removed from the surface. Things like rust inhibitors or soap residue from parts washing machines (or even just a dirty parts washer that needs servicing) can cause bad bonds. Once you have the surface clean, make sure it stays clean. Oil from your hands or even oily/smoky/dusty shop air can leave a residue and quickly contaminate bond surfaces.

Surface finish also is a critical feature that can't be ignored. If the bond surface is too rough or too smooth, you will have bond problems. Surface roughness as measured on the Ra scale should be kept between 90 and 125. Converter rebuilders may think that a good profilometer (a tool that

measures surface finish) is too expensive and not needed, but if it saves you from bonding problems it is well worth the investment (**Fig. 3**).

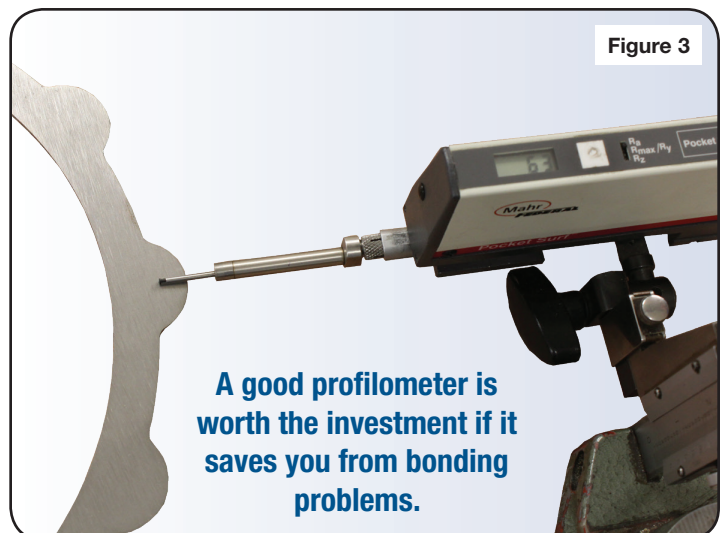


Figure 3

**A good profilometer is worth the investment if it saves you from bonding problems.**

### Surface roughness as measured on the Ra scale should be kept between 90 and 125.

Scraping a bond surface with your fingernail to feel surface roughness is not a valid measurement! Some rebuilders use a lathe to prep surface finish, while others use a grit-blasting process to prep the bond surface. 100 Ra on a lathe cut finish feels much different on your fingernail than 100 Ra on a grit-blasted surface. Some surfaces, such as those originally carburized by the factory, must be turned. Chemical or water jet removal of friction material on these surfaces will not produce a proper bonding surface.

Depending how you prepare the surface roughness, be sure that you don't create a problem by impregnating the surface with foreign substances which will inhibit the bond. Beyond the mentioned situation where you can contaminate the surface through problems with your wash process, you can add contaminants in other ways as well. If you are using a grinding wheel, a time saver belt, an emery cloth or similar abrasives to prepare the surface, you could be unknowingly contaminating the bond surface with the binders which are in those types of abrasives. If you are grit blasting the surface, you also might be contaminating the surface with residue from the blast media. Check with the provider of the media to see if it leaves any residue.

Rebuilders often ask if there is a specific chemical that can be used to clean the bond surface. Acetone is an acceptable solvent that can be used to clean the bond surface. If the bond surface is contaminated with rust inhibitors or other residues, however, acetone may not be effective in removing the foreign substances. In some cases, it may be necessary to pre-wash with a hot-water solution. Acetone also can be used as an activator if you want to "pre-tack" friction material to

the bond surface. Use a clean acid brush or an eye dropper to apply a small amount (a single drop or two will do) of acetone onto three evenly spaced locations around the adhesive. Mix the acetone into the adhesive so that the three spots become tacky and you can place the ring on the bond surface.

**A note about SonnaPrep:** Sonnax used to offer a chemical product called SonnaPrep. The benefit was that it essentially made the parameters for bonding (time, temperature and pressure) a little more forgiving. The same formula is still available today, but is sold under the name BondPrep and must be purchased directly from the manufacturer. Contact your Sonnax sales rep for more information on BondPrep.

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### A Good Shelf Life Requires Proper Storage - Store Rings Flat

Rebuilders also ask about the shelf life of friction materials. The quick answer is that, if the rings stay clean, dry (keeping them in the bag they are shipped in works great) and at ambient temperatures below 100°F, then the shelf life can exceed five years. Storing rings flat (as opposed to standing them on edge or hanging them on the wall) also helps them to keep their form and promotes better bonds.

### Testing the Bond

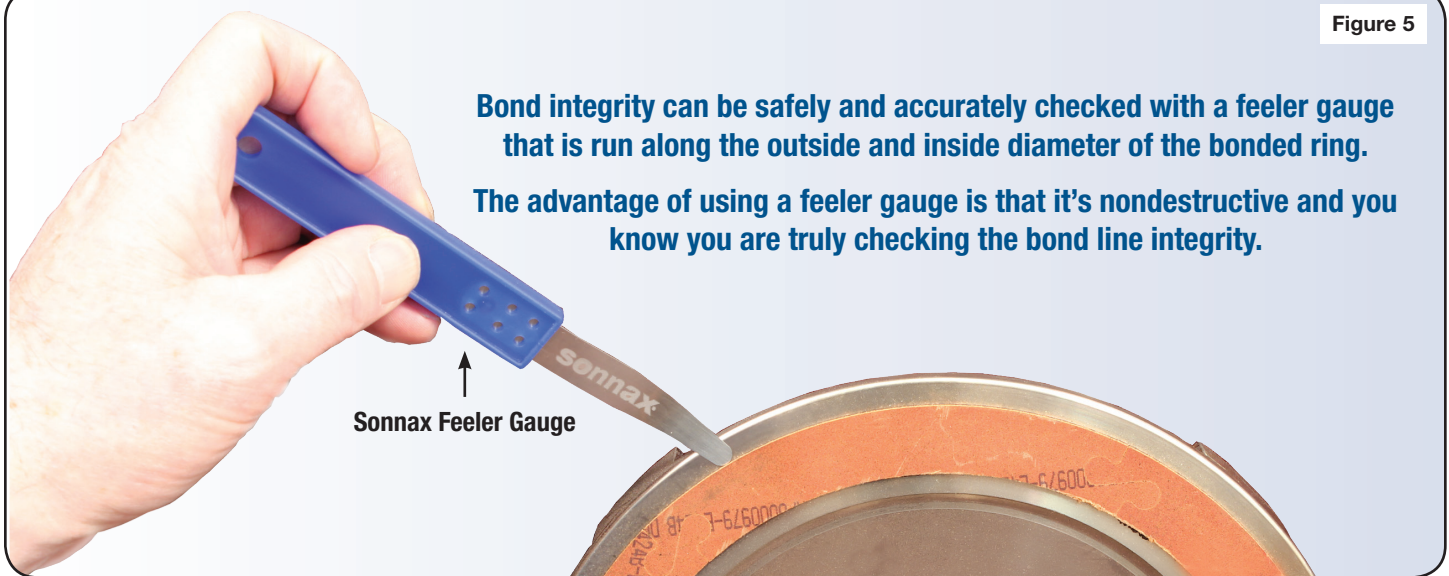
After paying attention to time, temperature, pressure, cleanliness and surface finish, you may want to randomly test your bonds to see if you are getting good results. With newer materials, the old standby "bend test" is not necessarily the best test method, so the definitive test of the BorgWarner bond is what Sonnax refers to as the chisel test (Fig. 4).



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Figure 5



**Bond integrity can be safely and accurately checked with a feeler gauge that is run along the outside and inside diameter of the bonded ring.**

**The advantage of using a feeler gauge is that it's nondestructive and you know you are truly checking the bond line integrity.**

By scraping or chiseling away the surface of the friction material, you can quickly get a good idea of bond integrity. If you can easily scrape adhesive off of the bond surface and quickly see large patches of clean, bare metal, then that's not a good bond. If you have a good bond, you will have to repeatedly scrape the surface (with a really sharp scraper) to get down to bare metal, and even then the adhesive will still be in the crevices of the surface of the steel. The obvious problem with the chisel test (and others like it) is that it's a destructive test, rendering the part useless.

Visiting many different OE bonding operations, Sonnax has noted bond integrity being safely and accurately checked with a feeler gauge that is run along the outside and inside diameter of the bonded ring (Fig. 5).

This method replaces the air check method of blowing compressed air at the ring to see if you can get any separation

between the ring and the steel surface. The advantage of using a feeler gauge is that it's nondestructive and you know you are truly checking the bond line integrity. With compressed air, potential problems can be missed if the air nozzle isn't positioned just right. Plus, if you have too strong a stream of air, you can destroy a bond and ruin the part by de-laminating the paper from the adhesive.

**There is a lot that goes into proper bonding, but once you understand all of the variables, bonding BorgWarner friction rings is a quick and relatively easy step in the torque converter remanufacturing process. A little planning, effort and process control up front will prevent the headaches down the line that come with bonding failures.**

**Contact your Sonnax sales representative today for more information about BorgWarner friction rings.**

**Call (800) 843-2600 or visit [www.sonnax.com](http://www.sonnax.com)**

## **Bonding BorgWarner Friction Rings**

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