

sonnax®

BorgWarner

FRICTION RING CATALOG vol 3



High Thermal Engaging (HTE)

High Thermal Lockup (HTL)

High Thermal Slipping (HTS)

Extreme Torque Lockup (XTL)

BorgWarner torque converter friction rings are made from original equipment materials which rarely before have been available to the aftermarket. BorgWarner is well known and widely respected as the leading supplier of OE friction products. Four friction ring material options are available in a wide range of popular sizes, giving you the opportunity to rebuild converters using what we believe to be the most advanced material available anywhere.



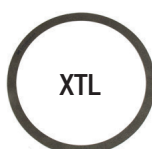
High Thermal Engaging (HTE) Now found in many OE applications, HTE material has the thermal capacity of Kevlar®, with improved consistency and shudder resistance well suited to today's demanding applications. It is dark gray in color and available in .045" and .066" thicknesses as a replacement for Tan or Kevlar materials.



High Thermal Slipping (HTS) One of the latest OE materials and the benchmark for consistency, durability and shudder resistance. HTS material is designed for slipping applications which require high thermal capacity. It is gray/green in color and available in .045" and .066" thicknesses as a replacement for spun-wound, woven or other carbon-based materials.



High Thermal Lockup (HTL) A recent friction material development from BorgWarner, HTL is designed for the most demanding torque-holding applications. Offered in .066" thickness, its high thermal and exceptional torque capacity have already made it the new standard for torque capacity and durability in demanding "Lockup" applications.



Extreme Torque Lockup (XTL) The latest friction material developed by BorgWarner, XTL material provides 30% more torque holding capacity than HTL and is only for extreme duty lockup applications. Offered in .050" thickness, it is available in a few sizes for severe applications.

Dimensions O.D. x I.D.	Thickness & Material	Sonnax Part No.
6.815" x 6.438"	.045" HTE	B45170HTE
	.066" HTE	B66170HTE
7.500" x 6.685"	.045" HTE	B45420HTE
	.045" HTS	B45420HTS
7.838" x 6.674"	.045" HTE	B45660HTE
7.930" x 7.100"	.045" HTS	B45620HTS
8.000" x 7.280"	.045" HTE	B45640HTE
8.080" x 6.930" <i>With cutouts</i>	.045" HTS	B45606HTS
	.066" HTS	B66606HTS
8.250" x 7.125"	.045" HTE	B45160HTE
	.066" HTE	B66160HTE
	.066" HTL	B66160HTL
8.500" x 7.250"	.045" HTE	B45360HTE
	.066" HTE	B66360HTE
	.066" HTL	B66360HTL
8.750" x 7.750"	.045" HTE	B45150HTE
	.045" HTS	B45150HTS
	.066" HTE	B66150HTE
	.066" HTL	B66150HTL

Dimensions O.D. x I.D.	Thickness & Material	Sonnax Part No.
8.843" x 8.062"	.045" HTE	B45140HTE
	.066" HTE	B66140HTE
8.854" x 6.685"	.066" HTL	B66140HTL
	.045" HTS	B45650HTS
8.875" x 8.000"	.045" HTE	B45130HTE
	.066" HTE	B66130HTE
	.066" HTL	B66130HTL
9.000" x 7.500"	.066" HTL	B66570HTL
	.045" HTE	B45320HTE
9.000" x 7.750"	.045" HTS	B45320HTS
	.066" HTE	B66320HTE
	.066" HTL	B66320HTL
	.066" HTS	B66320HTS
	.066" HTS	B66320HTS
9.000" x 8.000"	.045" HTE	B45390HTE
	.066" HTE	B66390HTE
	.066" HTL	B66390HTL
9.000" x 8.250"	.045" HTE	B45310HTE
	.066" HTE	B66310HTE
	.066" HTL	B66310HTL

Dimensions O.D. x I.D.	Thickness & Material	Sonnax Part No.
9.125" x 7.745"	.045" HTE	B45220HTE
	.066" HTE	B66220HTE
	.066" HTL	B66220HTL
9.125" x 7.945"	.045" HTE	B45225HTE
	.066" HTE	B66225HTE
9.125" x 8.125"	.045" HTE	B45540HTE
	.045" HTS	B45540HTS
9.134" x 7.874"	.045" HTS	B45740HTS
9.250" x 8.125"	.045" HTE	B45120HTE
	.045" HTS	B45120HTS
	.066" HTE	B66120HTE
	.066" HTL	B66120HTL
	.066" HTS	B66120HTS
9.250" x 8.312"	.045" HTE	B45110HTE
	.066" HTE	B66110HTE
	.066" HTL	B66110HTL
9.312" x 7.875"	.045" HTE	B45520HTE
	.045" HTS	B45520HTS
	.066" HTE	B66520HTE
	.066" HTS	B66520HTS
9.375" x 8.125"	.045" HTE	B45100HTE
9.440" x 8.380 "	.045" HTS	B45690HTS
9.500" x 8.250"	.045" HTE	B45300HTE
	.045" HTS	B45300HTS
	.066" HTE	B66300HTE
	.066" HTL	B66300HTL
	.066" HTS	B66300HTS
9.500" x 8.500"	.045" HTE	B45090HTE
	.066" HTE	B66090HTE
	.066" HTL	B66090HTL
9.563" x 8.500"	.045" HTS	B45044HTS
9.625" x 7.625"	.045" HTE	B45210HTE
	.066" HTE	B66210HTE
	.066" HTL	B66210HTL
9.625" x 8.375"	.045" HTE	B45290HTE
	.045" HTS	B45290HTS
	.066" HTE	B66290HTE
	.066" HTL	B66290HTL
9.688" x 8.250"	.045" HTE	B45380HTE
9.725" x 8.250"	.045" HTE	B45070HTE
	.045" HTS	B45070HTS
	.066" HTE	B66070HTE
	.066" HTL	B66070HTL

Dimensions O.D. x I.D.	Thickness & Material	Sonnax Part No.
9.750" x 8.125"	.045" HTE	B45080HTE
	.066" HTE	B66080HTE
	.066" HTL	B66080HTL
9.750" x 9.000"	.045" HTE	B45060HTE
	.066" HTE	B66060HTE
	.066" HTL	B66060HTL
9.813" x 8.562"	.045" HTS	B45680HTS
	.066" HTS	B66680HTS
9.813" x 9.060"	.045" HTE	B45340HTE
9.875" x 8.750"	.045" HTE	B45050HTE
	.045" HTS	B45050HTS
	.066" HTE	B66050HTE
	.066" HTL	B66050HTL
	.066" HTS	B66050HTS
9.921" x 7.921"	.045" HTE	B45205HTE
	.066" HTE	B66205HTE
	.066" HTL	B66205HTL
9.938" x 8.938"	.045" HTS	B45064HTS
9.938" x 8.875"	.045" HTE	B45450HTE
	.045" HTS	B45450HTS
	.066" HTE	B66450HTE
	.066" HTL	B66450HTL
10.000" x 8.250"	.045" HTE	B45040HTE
	.066" HTE	B66040HTE
	.066" HTL	B66040HTL
10.000" x 8.750"	.045" HTE	B45200HTE
	.045" HTS	B45200HTS
	.066" HTE	B66200HTE
	.066" HTL	B66200HTL
	.066" HTS	B66200HTS
	.050" XTL	B50200XTL
10.000" x 9.000"	.045" HTE	B45370HTE
	.066" HTE	B66370HTE
	.066" HTL	B66370HTL
10.100" x 7.500"	.045" HTS	B45670HTS
10.135" x 9.350"	.045" HTE	B45330HTE
	.066" HTE	B66330HTE
	.066" HTL	B66330HTL

Chart continued on next page

sonnax® BorgWarner

FRICION RINGS

Dimensions O.D. x I.D.	Thickness & Material	Sonnax Part No.
10.200" x 9.200"	.045" HTS	B45930HTS
	.066" HTS	B66930HTS
10.250" x 8.625"	.045" HTE	B45280HTE
	.045" HTS	B45280HTS
	.066" HTE	B66280HTE
	.066" HTL	B66280HTL
	.066" HTS	B66280HTS
10.375" x 9.375"	.045" HTE	B45270HTE
	.045" HTS	B45270HTS
	.066" HTE	B66270HTE
	.066" HTL	B66270HTL
	.066" HTS	B66270HTS
10.500" x 8.625"	.045" HTE	B45030HTE
	.066" HTL	B66030HTL
10.500" x 9.000"	.045" HTE	B45260HTE
	.066" HTE	B66260HTE
10.500" x 9.188"	.066" HTL	B66260HTL
	.066" HTS	B66500HTS
10.563" x 9.250"	.045" HTE	B45190HTE
	.066" HTE	B66190HTE
	.066" HTL	B66190HTL
10.750" x 9.125"	.045" HTE	B45180HTE
	.066" HTE	B66180HTE
	.066" HTL	B66180HTL
10.750" x 9.500"	.045" HTE	B45020HTE
	.066" HTE	B66020HTE
	.066" HTL	B66020HTL
11.000" x 9.560"	.045" HTE	B45440HTE
	.066" HTL	B66440HTL
11.120" x 9.840"	.045" HTS	B45750HTS
	.066" HTS	B66750HTS
11.125" x 10.000"	.045" HTE	B45250HTE
	.045" HTS	B45250HTS
	.066" HTE	B66250HTE
	.066" HTL	B66250HTL
11.250" x 10.000"	.066" HTS	B66250HTS
	.045" HTE	B45551HTE
	.066" HTE	B66551HTE
11.250" x 9.700"	.066" HTL	B66551HTL
	.045" HTE	B45410HTE

Dimensions O.D. x I.D.	Thickness & Material	Sonnax Part No.
11.500" x 10.000"	.045" HTE	B45010HTE
	.045" HTS	B45010HTS
	.066" HTE	B66010HTE
	.066" HTL	B66010HTL
	.066" HTS	B66010HTS
11.500" x 10.250"	.045" HTE	B45240HTE
	.045" HTS	B45240HTS
	.066" HTE	B66240HTE
	.066" HTL	B66240HTL
11.570" x 10.000" <i>With holes</i>	.066" HTS	B66240HTS
	.045" HTE	B45001HTE
	.045" HTS	B45084HTS
11.625" x 10.375"	.066" HTE	B66084HTE
	.066" HTL	B66084HTL
	.066" HTS	B66084HTS
	.050" XTL	B50084XTL
11.650" x 10.160"	.050" XTL	B50068XTL
11.650" x 10.470"	.045" HTS	B45710HTS
11.800" x 10.200"	.045" HTE	B45510HTE
	.066" HTE	B66510HTE
12.340" x 10.250"	.045" HTE	B45350HTE
	.045" HTS	B45350HTS
	.066" HTE	B66350HTE
	.066" HTL	B66350HTL
	.066" HTS	B66350HTS
12.500" x 10.750"	.045" HTE	B45230HTE
	.045" HTS	B45230HTS
	.066" HTE	B66230HTE
	.066" HTL	B66230HTL
	.066" HTS	B66230HTS
	.050" XTL	B50230XTL
13.625" x 11.500" <i>With holes</i>	.045" HTE	B45002HTE
	.045" HTE	B45000HTE
Master sheets 14" x 14"	.045" HTS	B45000HTS
	.066" HTE	B66000HTE
	.066" HTL	B66000HTL
	.066" HTS	B66000HTS
	.066" HTS	B66000HTS



Know the Terms

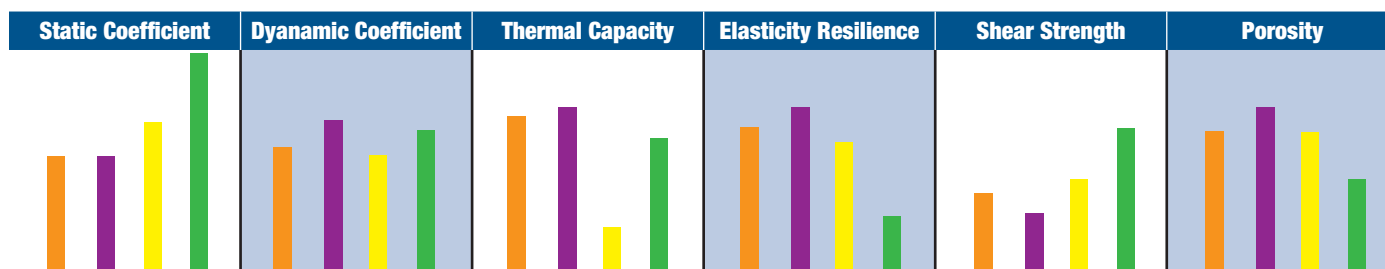
Friction material properties and quality are often discussed and debated, but how often are they really understood? A good grasp on some important terms makes all the difference:

- **Static/Breakaway Coefficient** - Quantifies the ability of a material to avoid slipping. The higher the coefficient, the more force (torque) it takes to begin slipping.
- **Dynamic/Midpoint Coefficient** - Quantifies the relative force required to maintain a constant slip. The higher the coefficient, the less force (apply pressure) and time it takes to modulate or control slipping.
- **Thermal Capacity/Durability** - The amount of thermal distress a material can tolerate before it can no longer function as intended. In short, can it take the heat?
- **Elasticity (Shudder Resistance)** - The ability to conform to variations in running surfaces. The elasticity of the material impacts surface contact (area) and loading (force). It is sometimes referred to as Shudder or NVH Resistance
- **Shear Strength** - The amount of force the friction material can handle before it fails or fractures.
- **Porosity/Density** - The amount of oil the friction material can hold.

Know the Facts

How do you select the right friction material? Based on a comparative analysis of BorgWarner friction material, the charts below demonstrate which material rates the highest for each property.

■ HTE ■ HTS ■ HTL ■ XTL



Know What Matters

The terms above have one thing in common: they are all well-established physical properties by which any piece of friction material can be analyzed and evaluated.

What matters? Which is of greatest importance? That depends on how you intend to use the friction material. For example, in a straight on or off lockup system, static coefficient and shear strength would surely top the list, and thermal capacity and porosity may be on the lower end of importance. As you move further toward a system designed to slip continuously, static coefficient and shear strength become less important considerations compared to thermal capacity and porosity.

In general, these are the levels of importance within the three general lockup categories:

	On-Off Lockup	Limited Slip Lockup	Continuous Slip Lockup
Static Coefficient	High	Medium	Medium
Dynamic Coefficient	Medium	Medium	High
Thermal Capacity	Low	Medium	High
Elasticity Resilience	Low	Medium	High
Shear Strength	High	Medium	Medium
Porosity	Low	Medium	High

Want to learn more about friction material selection?

Read an analysis of a variety of BorgWarner friction material offerings and materials offered by a major competitive brand in "*Selecting Friction Material*," available online in the Sonnax Technical Library.

Scan code with your smartphone



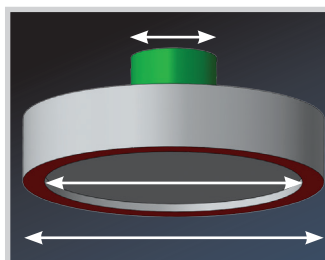
Bonding Guidelines

BorgWarner friction rings should replace other rings with the same parameters and bond as well as or better than other products on the market. Verify the BorgWarner friction ring bond by first conducting a “control test” using your existing process and procedure. Once a satisfactory bond has been established, you can work on trying to decrease bond times and simplify the process. An organized approach is highly recommended; keep careful records and make changes gradually. Each progressive trial should result in faster bond times.

Applying 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



Sonnax Online Bonding Pressure Calculator

Enter the details of the friction ring you are bonding into the calculator on www.sonnax.com to find out the piston pressure required to create the desired pressure at the ring.

Scan code with your smartphone



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

Recommended bond pressures (unit loading) range from a minimum of 200 PSI to a maximum of 400 PSI measured at the friction ring face area. Friction material facings will compress, so it is not recommended to compress the friction material more than 15% of the initial facing thickness (.066" to .056" and .045" to .038"). Compressing material more than 15% decreases porosity and may cause blistering during the bond process. Over-compression also can impact friction characteristics. 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.

The following table shows typical finished facing thickness at different bonding pressures (unit loading).

Facing Bond Pressure (PSI)

	PSI Too Low				Recommended Bonding Pressure Range					PSI Too High	
	0	50	100	150	200	250	300	350	400	450	500
.066" HTL	.0660	.0649	.0637	.0625	.0612	.0600	.0588	.0576	.0563	.0551	.0550
.066" HTE	.0660	.0648	.0635	.0621	.0608	.0595	.0581	.0568	.0555	.0541	.0540
.066" HTS	.0660	.060	.0639	.0628	.0617	.0606	.0594	.0583	.0572	.0561	.0560
.045" HTE	.0450	.0443	.0435	.0427	.0420	.0412	.0404	.0396	.0389	.0381	.0380
.045" HTS	.0450	.0444	.0437	.0431	.0424	.0417	.0411	.0404	.0397	.0391	.0390

Adjusting Temperature & Time

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

The critical surface where you need to read the temperature is the bond line surface, which is NOT the same as the temperature at of the top or bottom heating platens. Once you have the bond line surface up to the temperature, an optimal bond can be achieved in as quickly as two minutes.

Bond time can be further reduced by increasing temperature, but this requires making small adjustments, keeping careful records and trial testing with each change.

Any of the following conditions should yield an acceptable adhesive cure:

- Bond line reaches 400°F for 1 minute and 30 seconds
- Bond line reaches 425°F for 1 minute
- Bond line reaches 450°F for 30 seconds

NOTE: Be sure your process heats the entire bond line surface and never let bond line temperature go beyond 500°F.

Bonding to Typical Dampers and Piston Plates

The following trials have been shown to work for most rebuilders.

NOTE: Remove the insulator if one is used.

	Bottom/Steel Side Temp	Top/Friction Side Temp	Bond Line Temp	Bond Time
Trial 1	425°F	400°F	400°F	1 Minute & 30 seconds
Trial 2	450°F	400°F	425°F	1 Minute
Trial 3	475°F	400°F	450°F	30 Seconds
Trial 4	500°F	400°F	450°F	30 Seconds

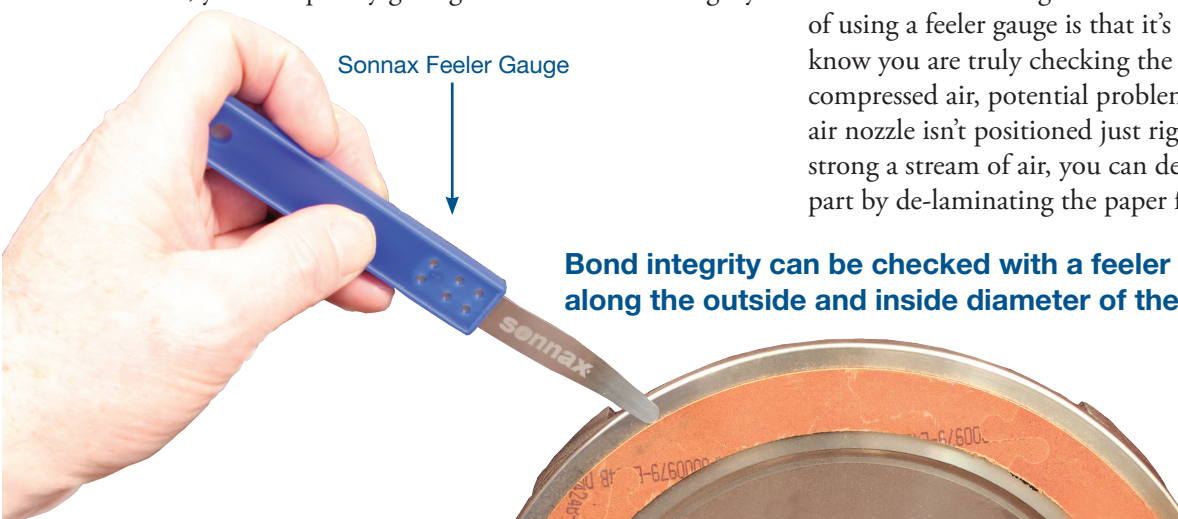
NOTES:

- Be sure the bonder has the energy capacity to maintain temperature between cycles.
- The leading cause of bond failures with a consistent bond process is cleanliness and contamination of the bond surface.
- Significant reductions in heat from the friction side may be required for heavy mass applications.

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. By scraping or chiseling away the surface of the friction material, you can quickly get a good idea of bond integrity.

The obvious problem with the chisel test (and others like it) is that it’s a destructive test, rendering the part useless. A safer way to check bond integrity is a technique used by OE-bonding facilities, which involves a feeler gauge run along the outside and inside diameter of the bonded ring. 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.



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



Sonnax is an Employee-Owned Company

Sonnax is a diversified supplier of specialized drivetrain products to the automotive and commercial vehicle industries, and to industrial sectors utilizing drivetrain technology. We design, manufacture, test and distribute a wide variety of components used to remanufacture torque converters, to rebuild automatic transmissions, and to protect driveshafts and associated components from over-torque damage.

Warranty Policy

Sonnax warrants to the purchaser that each part manufactured or supplied by Sonnax will be free from defects in material or in factory workmanship. The warranty period shall extend for six (6) months from the date of sale. Sonnax must receive all warranty claims before the end of the warranty period.

If Sonnax determines that the part is defective in material or in factory workmanship, Sonnax will, at its option, repair or replace the defective part, or issue an account credit for the purchase price. This remedy is Sonnax's sole liability and the sole remedy provided by Sonnax for any breach of warranty.

All warranty returns must be pre-approved. Please contact Sonnax if you have a part to be returned under this warranty.

This Warranty will not cover: Removal and replacement labor costs; Loss of time, inconvenience or other consequential damage; Any Sonnax part that has been:

Subject to misuse, negligence; alteration or improper maintenance; Improperly installed in the judgment of Sonnax, so as to adversely affect its performance and reliability.

This warranty is the only warranty applicable to parts manufactured or supplied by Sonnax, and is expressly in lieu of any other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular purpose. Any representations or descriptions in brochures, ads or catalogs are approximate only and will not create any warranty or other obligation by Sonnax. There are no warranties which extend beyond the description on the face hereof.

Sonnax does not authorize any person to create for it any other obligation or liability in connection with these parts. Sonnax shall not be liable for any incidental or consequential damage, lost profits, lost savings or punitive damages resulting from any breach of warranty.

BorgWarner Friction Ring Catalog Vol. 3

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