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10 – CARTRIDGE-BEARING BOTTOM BRACKETS

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ABOUT THIS CHAPTER

Cartridge-bearing bottom brackets differ from adjustable-cup bottom brackets in the design of the bearings. The adjustable-cup bottom bracket design has cones, ball bearings, and cups that can all be separated from each other and may potentially be individually replaced. In the case of cartridge bearings, there are ball bearings, but they are encased in a permanent assembly consisting of an inner and an outer bearing race. It is possible that this cartridge bearing assembly can be separated from the rest of the bottom bracket, or that the cartridge bearings are also permanently integrated with the bottom-bracket spindle and a cylinder that encloses the entire structure.

A universal result of the cartridge-bearing design is that there is no adjustment of bearings. Additionally, the most common designs do not permit any service of the bearings, including cleaning, greasing, or replacing the parts. Therefore, when the bottom bracket develops symptoms of tight or loose bearings, the only repair is to replace the complete assembly. The cartridge-bearing bottom brackets that have cartridge bearings that can be separated from the spindle can sometimes be cleaned and greased, or the cartridge-bearing assemblies can be individually replaced.

There are two ways that cartridge-bearing bottom brackets are installed into the bottom-bracket shell. There are cartridge-bearing bottom brackets that thread into conventional threaded bottom-bracket shells, and there are cartridge-bearing bottom brackets that must be pressed into unique bottom-bracket shells that have no threads. The threaded type is most common, but there are a variety of threaded styles that require different service techniques and tools. The less-common types that press into the bottom-bracket shell, also vary in design. Additionally, these press-in varieties are becoming outdated, and there are limitations to parts and tool availability.

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Cartridge-bearing bottom brackets are available with a variety of spindle types. Some cartridge-bearing bottom brackets have a classic square-taper spindle, and can be used as a replacement for an adjustable-cup bottom bracket with the same spindle design. There are also cartridge-bearing bottom brackets that have cylindrical spindle ends with a splined engagement to the crank arms. These splined-spindle bottom brackets are made in three common configurations at the time of this writing, but there are also other spline configurations that are less common.

Sections

After the ***GENERAL INFORMATION*** section, the sections in this chapter are organized by the method of attachment of the bottom bracket to the bottom-bracket shell.

The second section in this chapter, ***THREAD-IN BOTTOM BRACKETS***, covers the cartridge-bearing bottom brackets that thread into the frame. This section is further divided by the degree to which the bottom-bracket spindle is integrated into the assembly. The thread-in bottom brackets that have a spindle that is integrated with any other part of the assembly are covered in one procedure (see **figure 10.1**), and then the thread-in bottom brackets that have a separate spindle (can be completely separated from the bearing) are covered in another procedure.

Within each group of thread-in cartridge bottom brackets, variations in procedure for different brands and models are noted by specific comments, rather than by creating a unique procedure for each brand and model.

The last section in this chapter, ***PRESS-IN BOTTOM BRACKETS***, covers those cartridge-bearing bottom brackets that are pressed into unthreaded bottom-bracket shells. These are all covered by one procedure that is predominantly generic in nature, but it has specific comments for some variations in design that may be encountered.

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TERMINOLOGY

Bottom bracket: The bearing assembly that allows the crankset to rotate in the bottom-bracket shell.

Bottom-bracket shell: The 1.5" diameter, 3" long horizontal frame tube at the bottom of the frame that contains the bottom bracket.

Cartridge bearing: A self-contained bearing assembly consisting of an outer race, bearings, and an inner race. Typically, the inner and outer races are metal cylinders, and the bearings are concealed behind a rubber seal that covers the gap between the inner and outer races.

Cup: A threaded cup or sleeve that threads into a bottom-bracket shell to retain a cartridge-bearing bottom-bracket assembly. The cup can be a separate piece from the main bottom-bracket assembly, or it may be integral to the main bottom-bracket assembly. Depending on the variety of bottom bracket, the cup might resemble the bearing cup found in a conventional adjustable-cup bottom bracket (without the cup race on the inside), or it may be a simple cylinder with threads on the outside and an internal spline configuration in one face.

E-type front derailleur: There are two types of front derailleurs. The traditional type mounts by means of a clamp to the seat tube and has no effect on bottom-bracket selection and setup. An E-type front derailleur is attached to a bracket that mounts between a flange on the bottom bracket and the right end of the bottom-bracket shell. Certain cartridge-bearing bottom brackets are made specifically for use with E-type front derailleurs.

Race: The circular track on which a ball bearing rolls. A misuse of this term is to use it to describe a set of ball bearings held together in a holder, which is more properly called a *retainer.*

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Seal: Usually a rubber disc, or rubber-coated metal disc, that covers the bearings to reduce the introduction of contaminants into a bearing assembly, such as a cartridge bearing.

Spindle: The axle that rotates inside the bottom-bracket shell. The word *axle* is sometimes used in the vernacular in regards to the bottom-bracket spindle.

PREREQUISITES

For all types of bottom brackets, the only prerequisite is crank-arm removal and installation.

If changes in the effective spindle length create changes in the chainring position, then front derailleur adjustment would also be required.

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INDICATIONS

SYMPTOMS INDICATING WORN BEARINGS

If a looseness (radial play or side play) develops between the spindle and the bearings, the bearings may be worn out, or cups may be loose. If securing the cups does not eliminate this symptom, the entire bottom bracket must be replaced, unless it is a type that has cartridge bearings that can be separated from the spindle and cups.

If a spindle feels tight or difficult to rotate, particularly if there is a grinding sensation as it is rotated, then this can also indicate the bearings are worn out. Some cartridge-bearing systems can have their seals removed, in which case the bearings can be cleaned and regreased. If this does not solve the tight feeling, then the entire bottom bracket must be replaced, unless it is a type that has cartridge bearings that can be separated from the spindle and cups.

SYMPTOMS INDICATING BAD GREASE

Grease can dry out or be washed out of any bearing, whether it is described as sealed or not. The symptom of a lack of grease is that the spindle feels tight when rotated. This symptom can also be caused by worn or rusted bearings. Some cartridge-bearing systems can have their seals removed, in which case the bearings can be cleaned and regreased. If this does not solve the tight feeling, then the entire bottom bracket must be replaced, unless it is a type that has cartridge bearings that can be separated from the spindle and cups.

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Symptoms indicating loose parts

A creaking or clicking noise that occurs as the crank arms are rotated under load can indicate loose parts in the bottom bracket. The cups may be loose in the bottom-bracket shell, there may be a looseness between the bearing assembly and the cups, or there may be a looseness between the cartridge bearings and the spindle. Removal and examination of the assembly can reveal the source of the noise, but it may not be possible to detect the cause by visual inspection. Installing the assembly with proper torque and the application of Loctite between parts that may be moving inappropriately may eliminate the symptom, and only by doing so does it become certain that loose parts were the source of the noise.

Symptoms indicating need of facing

Most cartridge-bearing bottom brackets are designed in such a way that performance is not compromised by poor facing of the shell. Some, however, may exhibit a symptom of the spindle rotating smoothly before the cups are secured, but once the cups are fully secured, a tightness or binding develops. If this occurs, facing the bottom-bracket shell should solve the problem.

TOOL CHOICES

The design or brand of bottom bracket determines which tools are needed. **Table 10-1** covers tools for thread-in cartridge bottom brackets only. Tools for press-in cartridge-bearing bottom brackets are described in the section for that bottom-bracket type. The preferred choices in **table 10-1** are in **bold**. A tool is preferred because of a balance among ease of use, quality, versatility, and economy. When more than one tool for one function is **bold**, it means that several tools are required for different configurations of parts.

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COMPLICATIONS

Damaged splines in cups

Many of the cartridge-bearing bottom brackets that thread into the bottom-bracket shell have an internal spline that is engaged by a splined tool, for the purpose of removing and installing the cups. Due to corrosion of the threads, or improper use of the splined tool, the splines in the cups may become stripped. Since there is no other way to hold and turn the cups, in the worse case it may become impossible to remove the bottom-bracket assembly.

In some cases, if the splines in the cup on one side are damaged, the other side may still be removable. Sometimes the main assembly will come out along with the still-removable cup, or it may remain in the bottom-bracket shell, still attached to the cup with the damaged splines. If this occurs, it is possible that the main assembly and the damaged cup are two separate pieces, and by applying impact to the end of the bottom-bracket spindle on the same side as the damaged cup, it may be possible to drive the main assembly out the side where the other cup has already been removed. If this works, it will leave a threaded cup in one end of the bottom-bracket shell. It may be possible to collapse the empty cup in on itself, or to use a cutting implement to carefully cut the cup into several sections, which can then be easily removed. Minor thread damage in the bottom-bracket shell that is the result of sectioning the cup can be repaired with a bottom-bracket tap.

If the damaged splines are in a cup that is integrated into the main bottom-bracket assembly, then there is no recommended method for removal of the damaged parts.

Damaged cup threads

Cups are often made of softer materials, such as aluminum or plastic. When cups made of these softer materials are threaded into a bottom-bracket shell with poor condition threads, it is likely that the cup threads will end up deformed or stripped. Particularly when the cups are made of these softer materials, the need for cleaning the existing bottom-bracket-shell threads with a tap before installing the cups is critical.

Creaking from the bottom bracket

With a thread-in cartridge-bearing bottom bracket, the fit between cups and the bottom-bracket assembly is generally a press fit. If the fit is loose, then motion between the parts can create a creaking noise that is difficult to isolate. The creaking noise can also be the result of insufficient torque on the cups.

Similarly, pressed-in cartridge-bearing bottom brackets can develop creaking due to a loose fit between the cartridge bearings and the bottom-bracket shell or between the cartridge bearings and the spindle.

In each case, the use of Loctite eliminates the creaking noises by eliminating the motion. The use of grease to eliminate the creaking noises is not recommended because it only eliminates the noise and does not eliminate the undesirable motion.

THREADS

All thread-in cartridge-bearing bottom brackets fit the same bottom-bracket-shell threads as adjustable-cup bottom brackets. For thread information, see table 9-2.

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THREAD-IN BOTTOM BRACKETS: INTEGRATED-SPINDLE TYPES

These bottom brackets typically consist of two parts: a main assembly including an outer shell, bearings, and a spindle; and a separate cup. This two-part variety also has a threaded cup that is integrated with the outer shell for engagement to one end of the bottom-bracket shell (see figure 10.1). A common variation of this class of bottom bracket has three basic parts, consisting of two separate cups and a main assembly (including a shell, the bearings, and the spindle).

Common brands with this design are American Classic bottom brackets, Campagnolo bottom brackets, FSA bottom brackets, Race Face bottom brackets, Phil Wood bottom brackets, all Shimano cartridge-bearing bottom brackets (square-taper and splined varieties), and TruVativ bottom brackets. Other less-seen brands might be similar to the specific brands and models covered in this section, but for brands not listed here, any model-specific information must be obtained from the manufacturer.

REMOVAL

1. Use appropriate procedure for removal of both crank arms (see square-fit crank-arm removal or spline-fit crank-arm removal).
2. Measure protrusion of right end of spindle beyond face of right cup and record measurement here: mm

Most bottom brackets of this type have a flange on the right-side cup that fixes the position of the bottom bracket, but some models have no flange (so the chainring position can be adjusted). When removing and reinstalling a bottom bracket with no flange (or replacing it with an identical one), it is useful to measure the position of the right cup so the chainrings can be returned to their original position.

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3. ***Flangeless right cup only:*** Measure amount face of cup protrudes beyond shell, then record measurement here: mm

In the next step, if the cup is fit by a splined tool, special care is needed to prevent the cup tool from slipping out of alignment and damaging the cup splines. If the cup is difficult to turn, the chance of a failure is greatly increased. A secondary device can be used to positively retain the tool, if it seems that damage may occur. When the spindle is the type with a square taper, a long bolt can be inserted through the cup tool and threaded into the spindle for this purpose (see **table 10-1** for brand and model of this device). When the spindle is the type with splines, then it is usually hollow. In this case, depending on the diameter of the hole through the spindle, a quick-release skewer or a long axle with nuts can be inserted through the spindle and the tool to provide for the security of the tool.

4. Engage tool to left-side cup, then turn counterclockwise to remove cup. ***NOTE: If removal is difficult, use secondary device to stabilize tool until cup breaks loose.***
5. Note thickness of spacers (if any) found between left-side cup and bottom-bracket shell (see **table 10-2**) and record here: mm
6. Inspect left-side cup for thread identification information, if unsure of thread type. If unmarked, measure thread pitch and diameter, then use **table 9-2** to identify thread type.
7. Look up thread direction for right side of bottom bracket in **table 9-2** then check correct direction here: *left* *right*
8. Engage tool to right-side cup, then turn clockwise if *left* was marked in step 7, or counterclockwise if *right* was marked in step 7. ***NOTE: If removal is difficult, use secondary device to stabilize tool until cup breaks loose.***

9. Note thickness of spacers (if any) found between right-side cup and bottom-bracket shell (see table 10-2) and record here: mm

INSTALLATION

The cups may be steel, aluminum, or plastic. The bottom-bracket shell may be steel, aluminum, or titanium. Whenever the cups and the bottom-bracket shell are different metals, galvanic corrosion can potentially fuse the cups permanently into the shell. This can be prevented by using an appropriate type and quantity of either anti-seize compound or Loctite. Although both these materials can be effective in preventing corrosion, each of these thread preparations has different advantages and disadvantages.

Anti-seize compound is a thick, grease-like compound with special chemical properties that counteract galvanic corrosion. For aluminum and steel material combinations, a general anti-seize compound is sufficient. For titanium mated with aluminum or steel, an anti-seize compound made specifically for titanium gives the best results. In either case, the disadvantages of working with anti-seize compounds are that they are messy and difficult to clean up, they may still wash out in the worst cases of exposure to moisture, and they do not enhance the security of the cups. The advantage of anti-seize compound is that it retains most of its benefit if the parts are taken apart and then reassembled without additional application of anti-seize.

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Loctite is a compound that is applied to the threads and then cures after the installation of threaded item to a hard material. It seals the threaded area from exposure to the atmosphere and moisture. Once cured, the effectiveness remains complete until the part is unthreaded. In addition to sealing the threaded area, Loctite increases the level of security that is achieved through the torque setting on the threaded part. Loctite is less messy to work with than anti-seize compounds and cannot dry out, evaporate, or wash out. Because Loctite on the threads adds security, it reduces the amount of torque needed to secure the part. The disadvantage of Loctite is that it breaks down if the threaded part is turned after the curing starts. Therefore, each time the part is adjusted, or removed and reinstalled, additional Loctite needs to be applied.

When installing new parts, consider any factory-applied dry coating on the threads to be a form of Loctite. If the threads are not completely coated, additional Loctite is needed to prevent corrosion.

1. ***New installation only:*** Measure width of bottom-bracket shell, then check specifications to confirm new assembly is suitable for shell width.
2. Thoroughly treat metal cup threads with Loctite 242 or appropriate anti-seize compound.
3. Inspect assembly and cups for indications of thread direction and for right-side or left-side designations for whole assembly. In absence of either, inspect whether threads slope up to right or left when cups are held vertically (up to left is left-hand thread).

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4. ***Reinstallation only:*** Install any spacer(s) noted during removal onto right-side cup. mm
   New installation only: Refer to table 10-2 or manufacturer's instructions for right-side spacer requirements, then install recommended spacers onto right-side cup.
5. ***If installing E-type front derailleur:*** Place derailleur mount over right-side cup.

In the next step, if the right-side cup has a flange, the cup is simply threaded in until the flange meets the bottom-bracket shell. However, some models have no flange, and the final location of the right-side cup is adjustable for the purpose of changing the chainring position. If a flangeless variety is being reinstalled, or replaced with a matching one, then the position of the right-side cup should have been noted during disassembly. If a flangeless variety is being installed without this information, then the final right-side cup position needs to be determined by trial and error. Install the bottom bracket and right crank arm, then check for clearance and **chainline problems**. Once correct chainring position has been established, measure the right-side cup position, then complete the final installation of the bottom bracket.

6. ***Flanged right cup only:*** Carefully hand-thread right-side cup into right side of bottom-bracket shell until threads have started cleanly, then thread cup in completely with tool.
   Flangeless right cup only: Carefully hand thread right-side cup into right side of bottom-bracket shell until threads have started cleanly, then use tool to thread cup in until original position is restored.
7. ***Three-part assembly only:*** Insert right end of main assembly into left side of bottom-bracket shell, then seat assembly against right-side cup.

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8. ***Reinstallation only:*** Install any spacer(s) noted during removal onto left-side cup. mm
   New installation only: Refer to table 10-2 or manufacturer's instructions for left-side spacer requirements, then install recommended spacers onto left-side cup.
9. Hand-thread in left-side cup until threads have started cleanly, then snug left-side cup with tool.
10. ***Reinstallation of three-part assembly only:*** Confirm right end of axle protrudes same amount from face of right-side cup as recorded during removal.
11. ***If installing E-type front derailleur (mounts to bottom bracket):*** Align front derailleur to mounting hole on frame, then install and secure mounting bolt.
12. ***If Loctite is used:*** Secure left cup to minimum torque (see manufacturer's instructions or table 10-3) or to 360in-lbs if no specification is available. Repeat for right cup.
    If Loctite is not used: Secure left cup to maximum torque (see manufacturer's instructions or table 10-3) or to 420in-lbs if no specification is available. Repeat for right cup.
13. Use appropriate procedure for installation of both crank arms (see square-fit crank arm installation or spline-fit crank-arm installation).

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SHIMANO SQUARE-TAPER-SPINDLE BOTTOM-BRACKET INTERCHANGEABILITY

Shimano is the dominant variety of square-taper-spindle cartridge-bearing bottom brackets. Table 10-4 shows the variety of square-taper bottom brackets made by Shimano. There are variations in what shell width the bottom bracket fits and whether it can used with an E-type derailleur. To use an E-type derailleur, usually a bottom bracket must be an E-type bottom bracket. The letter code "E" is added to the model name for this purpose. For example, a UN52 is not E-type compatible, but a UN52-E is E-type compatible. When replacing one cartridge with another, the shell-width designation of the replacement (found on the cartridge body) must match the original, except that a 73mm-shell model can be used in a 68mm shell with the addition of a 2.5mm spacer on *each* side. The E-type bottom brackets can be used for non-E-type derailleurs if a 2.5mm spacer is installed on the drive side in place of the derailleur-mounting bracket.

Shimano cartridge-bearing bottom-bracket spindles are marked with letter codes that correspond to different length spindles. These codes and the corresponding spindle lengths are:

Code	Length
MM	107mm and 110.5mm
LL	113mm
D-H	115mm
YL	116mm
XL	118mm
ZL	121mm
NL	122.5mm
EL	127.5mm

Most Shimano cartridges install from the right side of the bottom-bracket shell (see **figure 10.2**). This includes all the XTR, Dura-Ace, 105, UN, ES, and TY models, plus the CT91, CT92, CS15, and LP28 models. The remaining CT, CS, and LP models install from the left side of the bottom-bracket shell.

By adding spacers between the main assembly flange and the shell, the chainline can be changed. Some bottom brackets will accept a 2mm spacer, but bottom brackets with a plastic cup on one side can only have a 1mm spacer added. In **table 10-4**, when spacers are needed to achieve a specific chainline value, the spacer thickness indicated following the Shimano letter code needs to be added between the bottom-bracket shell and the main assembly flange. *Note: Bottom brackets with plastic cups will not accept more than 1mm of spacer thickness under the main assembly flange!*

Because different models of cranksets used on the same length of spindle could have different chainline values, the **Relative chainline** column does not show the actual chainline, but the amount of increase in chainline that each spindle length creates over the shortest available length. For example, if the bike is currently equipped with a crankset that has a 47.5mm chainline when used with the existing bottom bracket with an LL spindle (relative chainline +3) , then installing a bottom bracket with an XL spindle (relative chainline +5) increases the chainline by 2mm to 49.5mm.

CAMPAGNOLO SQUARE-TAPER-SPINDLE BOTTOM-BRACKET INTERCHANGEABILITY

Campagnolo square-taper-spindle bottom brackets are not interchangeable with the Shimano type due to unique spindle and taper lengths. Within the Campagnolo brand, there are three varieties. The first variety is distinguished by the presence of splined holes in the face of each cup (for the engagement of the installation tool) and the fact that the drive-side (right) cup has a flange. All Record and Chorus cartridge-bearing bottom brackets are of this variety. For simplicity, this variety is called "single flange" from here on. The second variety also has splined holes in the cup faces, but it is distinguished by the lack of any flanges on the cups. This variety is only seen as part of the Athena model group (now discontinued). For simplicity, this variety is called "flangeless" from here on. The third variety is distinguished by the presence of six semi-circular notches in both cup flanges (for the engagement of the installation tool). This variety has been part of the Centaur, Mirage, Veloce, and Xenon model groups. For simplicity, this variety is called "double flange" from here on. Only the Record and Chorus cranksets can be used with the single-flange bottom brackets. The flangeless and the notched-flange bottom brackets are interchangeable (see **table 10-5**) and are used with the Athena, Centaur, Mirage, Veloce, and Xenon cranksets.

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SHIMANO OCTALINK BOTTOM-BRACKET INTERCHANGEABILITY

The Shimano-designed Octalink splined spindle is made in two varieties, one with a 5mm spline length and the other with a 9mm spline length (see **figure 10.3**). Both configurations have eight splines and are the same diameter, but due to differences in spline thickness and length, they are not interchangeable.

9MM-SPLINE BOTTOM-BRACKET INTERCHANGEABILITY

The 9mm-spline version is available in several models, including BB-ES70, BB-ES71, and BB-ES50 bottom brackets. When "-E" is added to the end of these model names, or the shell width is shown as 68E or 73E, the bottom bracket is officially made specifically for use with E-type derailleurs. Shimano specifications further indicate that those without the "-E" in the model name can only be used with non-E-type derailleurs. However, **table 10-6** shows how exceptions can be made to these specifications.

All of these models are made in configurations specific to 68mm or 73mm bottom-bracket shell widths. The E-type bottom brackets can be used for non-E-type derailleurs if a 2.5mm spacer is installed on the drive side in place of the derailleur-mounting bracket. The 73mm-shell models can be used in 68mm shells with the addition of a 2.5mm spacer on *each* side. **Table 10-6** shows some additional exceptions for the purpose of modifying the stock chainline values.

In each of these variations (shell width and derailleur type), there is a choice between 113mm spindle length and 118mm spindle length. In all cases, the 113mm spindle length produces a 47.5mm chainline, and the 118mm spindle length produces a 50.0mm chainline. The 47.5mm chainline is generally preferable, unless there are problems with adequate inward travel of the front derailleur (most likely when the derailleur is mounted to a seat tube larger than 28.6mm diameter) or if the chainring-to-frame clearance is less than 2mm.

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As shown in **table 10-6**, chainline can be adjusted incrementally by using a bottom bracket intended for a different shell and derailleur setup than the one being used, in combinations with spacers added between the drive-side cup and the bottom-bracket shell. For those bottom brackets that utilize spacers for chainline adjustment, there are spacers available in 1mm, 1.5mm, 2.0mm, and 2.5mm dimensions. By using these singly or in combinations, any spacing can be achieved from 1.0mm through 2.5mm (the largest recommended amount).

In combinations using an E-type derailleur and a non-E-type bottom bracket, the spacer should go between the derailleur bracket and the drive-side cup. In combinations using an E-type derailleur and an E-type bottom bracket for a 73mm shell, the spacer should go between the derailleur bracket and the bottom-bracket shell.

5MM-SPLINE BOTTOM-BRACKET INTERCHANGEABILITY

The Shimano-designed Octalink splined spindle is made in two varieties, one with a 5mm spline length and the other with a 9mm spline length (see **figure 10.3**). Both configurations have eight splines and are the same diameter, but due to differences in spline thickness and length, they are not interchangeable.

The 5mm spline length is found on XTR, Dura-Ace, Ultegra, and 105 model bottom brackets. Some of these models are available both as cartridge-bearing bottom brackets and as adjustable-cup bottom brackets. See **5MM-SPLINE BOTTOM-BRACKET INTERCHANGEABILITY** for interchangeability of all bottom bracket types with a 5mm spline length.

ISIS BOTTOM-BRACKET INTERCHANGEABILITY

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The ISIS configuration bottom bracket is a ten-spline system utilized primarily by American Classic, FSA, Race Face, and TruVativ. At the time of this writing, any spindle/crank-arm interface with ten splines is the ISIS configuration. The ISIS standard insures that bottom brackets of equal spindle length position a specific crankset in a constant position regardless of brand or model. However, different models have varying capacities to be modified or adjusted. **Table 10-7** shows these variations.

Table 10-7 is a list of all possible ISIS bottom-bracket setups for 68mm, 70mm, and 73mm shells and the consequential chainline values. This table is limited to spindle lengths up to 118mm. Some varieties with a flange on the right-side cup can be adjusted for chainline by use of spacers behind the flange, but not all flanged models have this capacity. In certain cases, models with no flanges on the cups can be positioned in a range of position in the bottom-bracket shell for the purpose of adjusting chainline. In **table 10-7**, when the **Minimum Chainline** and **Maximum Chainline** columns are the same, there is no means of adjustment. These chainline values are relative, not absolute. The difference between the numbers indicates the amount of change that occurs when switching one choice for another. For example, a crankset is installed, and the current chainline is 45mm. The existing bottom bracket is a Race Face flanged model in a 68mm shell (with no spacer). It has a spindle length of 113mm. This bottom-bracket, shell, and spindle combination has a potential relative chainline range of 1.5–5.0, but since the current setup has no spacer, the relative chainline is the minimum 1.5. An FSA (68 type) bottom bracket with a 113mm spindle is being considered as a replacement. Since it has a minimum relative chainline of 4.0, the chainrings would end up 2.5mm further out (4.0-1.5=2.5), resulting in a chainline of 47.5mm (45+2.5=47.5).

For those bottom brackets that utilize spacers for chainline adjustment, there are spacers available in 1mm, 1.5mm, 2.0mm, and 2.5mm dimensions. By using these singly or in combinations, any spacing can be achieved from 1.0mm through 3.5mm (the largest recommended amount).

Table 10-7 is divided into sections for each combination of shell width and derailleur type (E-type or standard clamp). Many models work with E-type derailleurs without being specifically designated as such, but certain models must be specified as E-type to be used with the E-type derailleur. If this is the case, some part of the model-designation code will include the letter E. Additionally, some models work with a variety of shell widths, and some are made for specific shell widths. When either of these conditions are the case, the entry in the **Models** column specifies E type, 68 type, 70 type, or 73 type. In these cases, the manufacturer's model code should include the corresponding letter or number. When the entry in the **Models** column contains no such reference, then that model works for all conditions.

ISIS bottom brackets exist for shell widths greater than 73mm, and for spindle lengths in excess of 118mm. These configurations are used for downhill-specific mountain bikes that utilize single chainrings. The options are limited enough that there is little value in including them in table 10-7. Fortunately, chainline is far less critical in bikes made for this purpose.

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THREAD-IN BOTTOM BRACKETS: SEPARATE-SPINDLE TYPES

This variety of bottom bracket is distinguished by the fact that the cartridge bearings can be separated from the spindle. When a bottom bracket of this type is installed, it may not appear unique, but when it is out, if it is of this type, then the center section of the spindle (between the bearings) will be visible.

The spindle typically has shoulders that support the bearings, and the bearings are either a slip fit or a press fit onto the spindle. In some instances, the spindle has no shoulders, and the position of the spindle relative to the cups and bearings is set by means of locking collars on the spindle, found just outward from the cups. These locking collars are easily identified by the presence of small hex-key set screws in their perimeters. If locking collars are present, they must be removed before disassembling the bottom bracket.

The most common variety of the separate-spindle style of cartridge-bearing bottom brackets has notched lockrings threaded onto both cups. This characteristic generally identifies the bottom bracket as one covered by this section. However, a few on the less common cartridge-bearing bottom brackets with integrated spindles also have two lockrings.

Some varieties of this bottom bracket appear very similar to an adjustable-cup non-cartridge-bearing bottom bracket when installed. There is a notched lockring threaded onto the left cup and two wrench flats on the right-side cup. With this variety, you may not realize you are working on a cartridge-bearing bottom bracket until the left-side cup has been removed.

REMOVAL

1. Use appropriate procedure to remove both crank arms (see square-fit crank-arm removal or spline-fit crank-arm removal).

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2. ***Locking-collar types only:*** Measure amount axle protrudes from right-side cup face, then loosen all set screws and remove locking collars from spindle: mm
   All except locking-collar types: Measure amount axle protrudes from right-side cup face: mm
3. ***Lockring types only:*** Use lockring spanner to loosen left-side lockring (counterclockwise).
4. Turn adjustable cup counterclockwise to remove it.
5. Remove spindle or spindle/bearing assembly from left side of bottom-bracket shell. Check if spindle is symmetrical, and if not, which end was on the drive side.
6. Inspect left-side cup for thread identification information if unsure of thread type. If unmarked, measure thread pitch and diameter, then use **table 9-2** to identify thread type.
7. Look up thread direction for right side of bottom bracket in **table 9-2** then check correct direction here: *left* [ ] *right* [ ]
8. ***Lockring types only:*** Use lockring spanner to remove right-side lockring (clockwise if *left* was marked in step 7, or counterclockwise if *right* was marked in step 7), then measure amount cup protrudes from right end of shell: mm
9. Engage tool to right-side cup, then turn clockwise if *left* was marked in step 7, or counterclockwise if *right* was marked in step 7. ***NOTE: If removal is difficult, use secondary device to stabilize tool until cup breaks loose.***
10. If cartridge bearings on spindle are being replaced, support inside face of bearing on top of vise jaws (spindle between jaws, but not clamped), then tap on end of spindle with mallet to drive spindle out of bearing. Repeat for other side.

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In some cases, the cartridge bearings are a press fit in each cup. To remove a bearing from a cup, the cup should be reinstalled in the bottom bracket, and a bearing removal tool is needed. The most universal tool for this purpose is the Bicycle Research Sealed Bearing Removal Kit (#SBR-K). Alternatively, a spindle with shoulders can be used to drive the bearing out, and then step #10 can be used to remove the bearing from the spindle.

11. If cartridge bearings in cups are being replaced, install cup back in shell to use bearing removal tool, then remove cup. Repeat for other side.

INSTALLATION

The cups may be steel or aluminum. The bottom-bracket shell may be steel, aluminum, or titanium. Whenever the cups and the bottom-bracket shell are different metals, galvanic corrosion can potentially fuse the cups permanently into the shell. This can be prevented by using an appropriate type and quantity of either anti-seize compound or Loctite. Although both these materials can be effective in preventing corrosion, each of these thread preparations has different advantages and disadvantages.

Anti-seize compound is a thick, grease-like compound with special chemical properties that counteract galvanic corrosion. For aluminum and steel material combinations, a general anti-seize compound is sufficient. For titanium mated with aluminum or steel, an anti-seize compound made specifically for titanium gives the best results. In either case, the disadvantages of working with anti-seize compounds are that they are messy and difficult to clean up, they may still wash out in the worst cases of exposure to moisture, and they do not enhance the security of the cups. The advantage of anti-seize compound is that it retains most of its benefit if the parts are taken apart and then reassembled without additional application of anti-seize.

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Loctite is a compound that is applied to the threads and then cures after the installation of threaded item to a hard material. It seals the threaded area from exposure to the atmosphere and moisture. Once cured, the effectiveness remains complete until the part is unthreaded. In addition to sealing the threaded area, Loctite increases the level of security that is achieved through the torque setting on the threaded part. Loctite is less messy to work with than anti-seize compounds and cannot dry out, evaporate, or wash out. Because Loctite on the threads adds security, it reduces the amount of torque needed to secure the part. The disadvantage of Loctite is that it breaks down if the threaded part is turned after the curing starts. Therefore, each time the part is adjusted, or removed and reinstalled, additional Loctite needs to be applied.

When installing new parts, consider any factory-applied dry coating on the threads to be a form of Loctite. If the threads are not completely coated, additional Loctite is needed to prevent corrosion.

1. Inspect cups for thread direction or side-of-bike information. In absence of either, inspect whether threads slope up to right or left when cups are held vertically (up to left is left-hand thread).
2. Treat cup threads with appropriate Loctite or anti-seize compound.
3. ***Flanged right cup only:*** Carefully hand-thread right-side cup into right side of bottom-bracket shell until threads have started cleanly, then thread cup in completely with tool.
   Lockring type only: Carefully hand-thread right-side cup into right side of bottom-bracket shell until threads have started cleanly, then use tool to thread cup in until original position is restored.
4. ***Only if bearings are not in cups:*** Place bearings over each end of spindle, then press on as far as possible by hand.

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5. Insert right end of spindle or spindle/bearing assembly into left side of bottom-bracket shell, then seat assembly against right-side cup.
6. Hand-thread in left-side cup until threads are started cleanly, then snug left-side cup with tool.
7. ***All except locking-collar types:*** Confirm right end of axle protrudes same amount from face of right-side cup as recorded during removal.
   Locking-collar types only: Move spindle as necessary to set desired right-side axle protrusion from cup face, then install locking collars and secure set screws.
8. ***Flanged cup only, if Loctite is used:*** Secure cup to minimum torque (see manufacturer's instructions) or to 360in-lbs if no specification is available.
   Flanged cup only, if Loctite is not used: Secure cup to maximum torque (see manufacturer's instructions) or to 420in-lbs if no specification is available.
9. ***Lockring type only:*** Secure lockring(s) to equivalent of 300in-lbs.
10. Use appropriate procedure for installation of both crank arms (see square-fit crank arm installation or spline-fit crank-arm installation).
11. ***Double-lockring types:*** Check chainring position to determine if cups need to be repositioned to improve chainring position.
    Locking-collar types: Check chainring position to determine if collars need to be repositioned to improve chainring position.

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PRESS-IN BOTTOM BRACKETS

Some press-in cartridge-bearing bottom brackets have cartridge bearings held in by a mild press fit and retained by snap rings in a groove in the bottom-bracket shell. Others rely more on a strong press fit or Loctite to keep the bearings secure, and there are no snap rings.

Other variations exists in the design of the spindle. The spindle may have two shoulders that position it in the bearings and shell (shouldered type). Instead of integrated shoulders, there may be locking collars that are adjustable and are secured by set screws (locking-collar type). The least common variety has neither shoulders or set screws and is fixed in position strictly by the press fit between the spindle and the bearings (shoulderless type).

REMOVAL

1. Use appropriate procedure to remove crank arms (see **square-fit crank-arm removal** or **spline-fit crank-arm removal**).
2. Record right-end spindle protrusion (from shell face) here: mm
3. ***Snap-ring type only:*** Remove snap rings with snap-ring pliers.
4. Use plastic mallet to drive spindle out of shell (one bearing should also come out).
5. Support inner face of bearing on top of vise (with spindle inside jaws, but not clamped), then tap on spindle end with mallet to drive spindle out of bearing.

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The remaining bearing needs to be removed from the shell. The most universal tool for this purpose is the Bicycle Research Sealed Bearing Removal Kit (#SBR-K). A CalVan #28 bearing extractor is an effective, but crude, alternative tool. A third alternative is that a spindle with shoulders can be used to drive the bearing out, and then step #10 can be used to remove the bearing from the spindle. If the spindle has locking collars instead of shoulders, it may not be effective for driving out the bearing.

6. Use bearing-extractor tool (or spindle) to drive out other bearing.

INSTALLATION

1. ***Locking-collar type only:*** Reposition locking collars if desired, then secure set screws.
2. ***Locking-collar and shouldered types only:*** Place bearing on top of vise, with jaws open just enough to clear spindle, then insert spindle into bearing and use mallet to tap spindle in until collar or shoulder is against bearing (check that right-side protrusion is correct).
   Shoulderless type only: Place bearing on top of vise, with jaws open just enough to clear spindle, then insert spindle into bearing and use mallet to tap spindle in until right end matches original protrusion.
3. Treat outer surface of both bearings with Loctite RC680 (or equivalent).
4. Place left end of spindle/bearing assembly fully into right end of bottom-bracket shell, then place remaining bearing over spindle and against shell.

In the next step, the bearings need to be pressed into the shell. There is not a tool made specifically for this purpose, but there is a bicycle tool made for another purpose that can be useful. The Stein #FCC1 is a tool made to help retain a fixed-cup wrench to the fixed cup of a bottom bracket shell. The tool consists of a large cylinder and a threaded shaft. For the purpose of pressing the bearings in, remove the threaded shaft and place the large-hole end of the cylinder against the face of the bearing.

5. Alternating between sides frequently, use mallet on Stein FCC1 tool to tap each bearing completely into shell.

In the next step, a drift punch is suggested, but a standard adjustable cup can be placed against the bearing (flat-face first) for a similar purpose.

6. ***Snap-ring type only:*** Carefully use drift against outer perimeter of bearing to drive each bearing in just enough to clear snap-ring grooves in shell, then install snap rings.
7. Use appropriate procedure for installation of both crank arms (see square-fit crank arm installation or spline-fit crank-arm installation).

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THREAD-IN CARTRIDGE-BEARING BOTTOM-BRACKET TOOLS (table 10-1)

Tool	Fits and considerations
SHIMANO-STYLE AND ISIS-STYLE SPLINED CUPS	
Park BBT-2	Use with 3/8" drive or 32mm headset wrench (older versions not ISIS compatible)
Lifu 11B0	Shimano only, use with 1/2" drive wrench
Lifu 11B1	Use with 1/2" drive wrench
Lifu 11B3	Use with 32mm headset wrench
Shimano TL-UN65	Shimano only, use with 1/2" drive or 32mm headset wrench
Shimano TL-UN74-S	Use with 32mm headset wrench
VAR 996/PRO2	Shimano only, use with 32mm headset wrench (includes 8mm and 15mm retaining bolt)
VAR 996/PRO2	Shimano only, has built-in handles (includes 8mm and 15mm retaining bolt)
Race Face Installation Tool	Use with 1/2" drive or 8mm bit socket
FSA Installation Tool	Use with 1/2" drive or 8mm bit socket
Pedro's 6460200	Use with 1/2" drive or 24mm wrench
Lifu D8D4	Adapts 1/2" drive versions of above tools to be driven by 8mm bit socket
Stein BBT/Bolt	Long bolt used to retain above tools when used with square-taper spindles
CAMPAGNOLO-STYLE SPLINED CUPS	
Park BBT-5	Fits Campagnolo splined cups (also fits Campagnolo cassette lockring)
Campagnolo 7130036	Fits Campagnolo splined cups (also fits Campagnolo cassette lockring)
VAR 414B	Fits Campagnolo splined cups (also fits Campagnolo cassette lockring)
PHIL WOOD-STYLE SPLINED CUPS	
Phil Wood Tool	Fits Phil Wood splined cups
NOTCHED-FLANGE MOUNTING RINGS (all varieties)	
TruVativ BB-02-SPL-TOOL	Fits notched-flange TruVativ ISIS bottom brackets, use with 1/2" drive or 32mm headset wrench (Park BBT-8 or Shimano TL-UN96 that fits certain XTR and Dura-Ace non-cartridge bottom brackets are poor substitutes)
Park BBT-3	Fits notched-flange cups on KSS bottom brackets
Campagnolo 1130050	Fits notched-flange cups on Campagnolo, Sachs (works with torque wrench)
Park BBT-4	Fits notched-flange cups on Campagnolo, Sachs (won‘t work w/ torque wrench)

STOCK SPACING FOR CARTRIDGE-BEARING BOTTOM-BRACKETS (table 10-2)

Model	Shell width	E-type derailleur	Left-side spacer	Right-side spacer
American Classic ISIS 113mm	68mm	no	2.5mm	2.5mm
American Classic ISIS 113mm	68mm	yes	2.5mm	none
American Classic ISIS 113mm	73mm	no	none	none
Race Face SRX & Evolve (all lengths[1])	68mm	no	none	2.5mm
Race Face SRX & Evolve (all lengths[1])	68mm	yes	none	none
Race Face SRX & Evolve (all lengths[1])	73mm	no	none	none
Shimano XTR BB-M952 (all lengths[2])	68mm	no	2.5mm	2.5mm
Shimano XTR BB-M952 (all lengths[2])	68mm	yes	2.5mm	none
Shimano XTR BB-M952 (all lengths[2])	73mm	no	none	none
Shimano XTR BB-M952 (all lengths[2])	73mm	yes	none	none
TruVativ 108mm spindle[1]	68mm	no	none	none
TruVativ 113mm spindle[1]	68mm	no	none	2.5mm
TruVativ 113mm spindle[1] (E & H models only)	68mm	yes	none	none
TruVativ 113mm spindle[1]	73mm	no	none	none
TruVativ 118mm spindle[1]	68mm	no	none	2.5mm
TruVativ 118mm spindle[1] (E & H models only)	68mm	yes	none	none
TruVativ 118mm spindle[1]	73mm	no	none	none
TruVativ 118mm spindle[1] (E & H models only)	73mm	yes	none	none

[1] Chainline varies with length. See table 10-7 for other chainline options.

[2] Achieves 47.5mm chainline with stock spacers. See table 9-5 for other chainline options.

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CUP TORQUES (table 10-3)

Bottom-bracket brand	Torque Range
American Classic	300–360in-lb
Campagnolo	300–620in-lb
Full Speed Ahead (FSA)	347–434in-lb
Phil Wood	300in-lb
Race Face	420in-lb
Shimano (metal splines only)	435–608in-lb
Shimano (plastic splines only)	350in-lb
TruVativ	300–360in-lb

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SHIMANO SQUARE-TAPER-SPINDLE BOTTOM BRACKETS

(table 10-4)

Relative chainline	Right-installing cartridge	Left-installing cartridge
0	MM	MM
+1	MM + 1mm spacer	LL & D-H + 2mm spacer
+2	MM + 2mm spacer	LL & D-H + 1mm spacer
+3	LL & D-H	LL & D-H
+4	YL, LL & D-H + 1mm spacer	YL, & XL + 1mm spacer
+5	XL	XL
+6	XL + 1mm spacer	ZL & NL + 2mm spacer
+7	XL + 2mm spacer	NL + 1mm spacer
+8	NL	NL
+9	NL + 1mm spacer	EL + 2mm spacer
+10	NL + 2mm spacer	EL + 1mm spacer
+11	EL	EL

Note: Shimano makes different versions of most cartridge models that fit 68mm, 70mm, and 73mm bottom-bracket shells. Always use a cartridge with a designation that matches the shell size.

Note: If using an E-type front derailleur, the model designation must include an "E."

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CAMPAGNOLO SQUARE-TAPER-SPINDLE BOTTOM BRACKETS

(table 10-5)

Length (all available for 68mm & 70mm shells)	Cups	Use with seat tube diameter	Chainline
Double flange and flangeless (all models except Record and Chorus)			
111mm symmetrical	Double	all	43.5mm
111mm symmetrical	Triple	28.6mm	45.0mm
115.5mm asymmetrical	Triple	32.0–35.0mm	47.5mm
Single flange (Record and Chorus only)			
102mm symmetrical	Double	all	43.5mm
111mm asymmetrical	Triple	all	46.5mm
111mm symmetrical	Single	n/a	n/a

9MM-SPLINE BOTTOM BRACKETS (table 10-6)

Models ES50, ES70, & ES71: Shell-width & derailleur/spindle (mm)	Spacer on right	Chainline
Installed in 68mm shell width with standard derailleur		
68E/113	none	45.0mm
68E/113	1.0mm	46.0mm
68E/113	1.5mm	46.5mm
68E/113	2.0mm	47.0mm
68E/113, 73/113	2.5mm	47.5mm
68/113	none	47.5mm
68E/118	2.5mm	47.5mm
68/113, 68E/118	1.0mm	48.5mm
68/113, 68E/118	1.5mm	49.0mm
68/113, 68E/118, 73/118	2.0mm	49.5mm
68E/118, 73/118	2.5mm	50.0mm
68/118	none	50.0mm
Installed in 68mm shell width with E-type derailleur		
73E/113	1.0mm[1]	46.0mm
73E/113	1.5mm[1]	46.5mm
73E/113	2.0mm[1]	47.0mm
73E/113	2.5mm[1]	47.5mm
68E/113, 73/113, 73E/118	none	47.5mm
68E/113, 73/113, 73E/118	1.0mm[2]	48.5mm
68E/113, 73/113, 73E/118	1.5mm[2]	49.0mm
73/113, 73E/118	2.0mm[2]	49.5mm
73/113, 73E/118	2.5mm[2]	50.0mm
68E/118, 73/118	none	50.0mm

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Table 10-6 (continued)

Models ES50, ES70, & ES71: Shell-width & derailleur/spindle (mm)	Spacer on right	Chainline
Installed in 73mm shell width with standard derailleur		
73E/113	none	45.0mm
73E/113	1.0mm	46.0mm
73E/113	1.5mm	46.5mm
73E/113	2.0mm	47.0mm
73E/113	2.5mm	47.5mm
73/113, 73E/118	none	47.5mm
73/113, 73E/118	1.0mm	48.5mm
73/113, 73E/118	1.5mm	49.0mm
73/113, 73E/118	2.0mm	49.5mm
73/113, 73E/118	2.5mm	50.0mm
73/118	none	50.0mm
Installed in 73mm shell width with E-type derailleur		
73E/113	none	47.5mm
73E/113	1.0mm[1]	48.5mm
73E/118	none	50.0mm

[1] With 68E and 73E, spacer(s) install between derailleur bracket and shell.

[2] With 73/113, spacer(s) install between derailleur bracket and cup flange.

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ISIS-SPLINE BOTTOM BRACKETS (table 10-7)

Brand: model types	Shell width	Spindle length	Left-side spacer	Right-side spacer	Minimum chainline	Maximum chainline
Installed in 68mm shell with standard derailleur (clamp type)						
Race Face: flangeless	68	108			0.0[1]	4.0[1]
American Classic: all	68	108			1.5	1.5
FSA: 68 type	68	108		0–1.5	1.5	3.0
Race Face: flanged	68	113		0–3.5	1.5	5.0
TruVativ: all	68	108			1.5	1.5
TruVativ: all	68	113		0–2.5	1.5	4.0
Race Face: flangeless	68	113			2.0[1]	6.0[1]
American Classic: all	68	113	3.5–1.5[2]	1.5–3.5[2]	3.0	5.0
FSA: 68 type	68	113		0–1.5	4.0	5.5
TruVativ: all	68	118		0–2.5	4.5	7.0
FSA: 68 type	68	118		0–1.5	7.0	8.5
Race Face: flanged	68	118		0–1.5	7.0	8.5
Installed in 68mm shell with E-type derailleur						
American Classic: all	68	113	2.5–1.5[2]	0-1.0[2]	4.0	5.0
FSA: 68E type	68	113		0-1.5	4.0	5.5
Race Face: flanged	68	113		0-1.0	4.0	5.0
TruVativ: all	68	113			4.0	4.0
Race Face: flanged	68	118		0-1.0	7.0	8.0
TruVativ: all	68	118			7.0	7.0

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Table 10-7 (continued)

Brand: model types	Shell width	Spindle length	Left-side spacer	Right-side spacer	Minimum chainline	Maximum chainline
Installed in 70mm shell with standard derailleur (clamp type)						
FSA: 70 type	70	108		0-1.5	1.5	3.0
FSA: 70 type	70	118		0-1.5	7.0	8.5
Installed in 73mm shell with standard derailleur (clamp type)						
Race Face: flangeless	73	108			2.5	2.5
American Classic: all	73	113			4.0	4.0
FSA: 73 type	73	113		0-1.5	4.0	5.5
Race Face: flanged	73	113		0-1.0	4.0	5.0
TruVativ: all	73	113			4.0	4.0
Race Face: flangeless	73	113			4.5	4.5
FSA: 73 type	73	118		0-1.5	7.0	8.5
Race Face: flanged	73	118			7.0	7.0
TruVativ: all	73	118			7.0	7.0
Installed in 73mm shell with E-type derailleur						
FSA: 73E-type	73	113		0-1.5	4.0	5.5
TruVativ: E-type	73	118			7.0	7.0

[1] Because the cups have no flanges and have extra thread, the bottom bracket can be moved left/right up to 4mm.

[2] Right-side and left-side spacers (including derailleur bracket, if any) must total 5.0mm.

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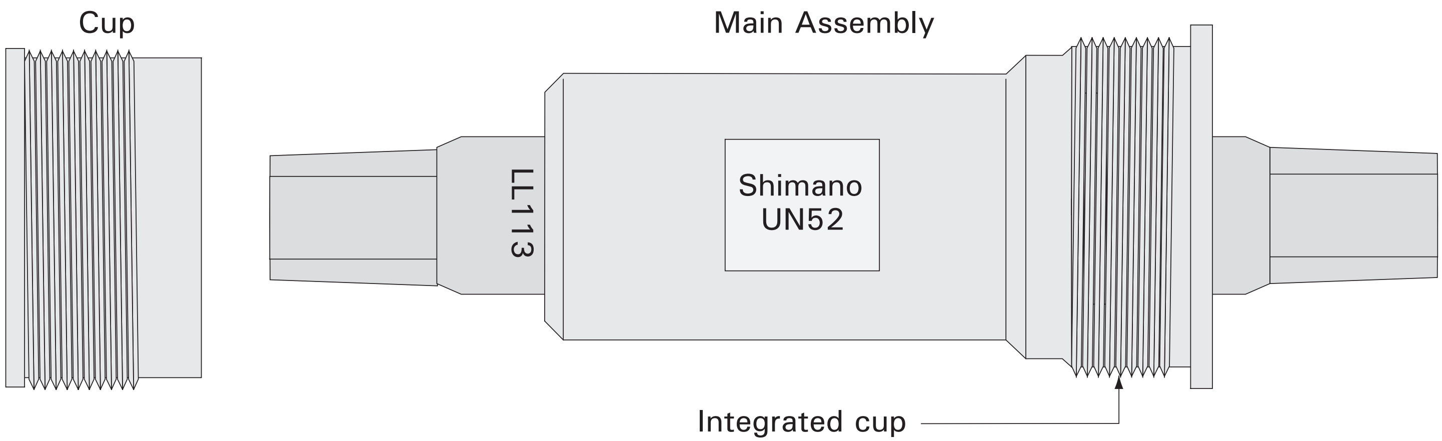
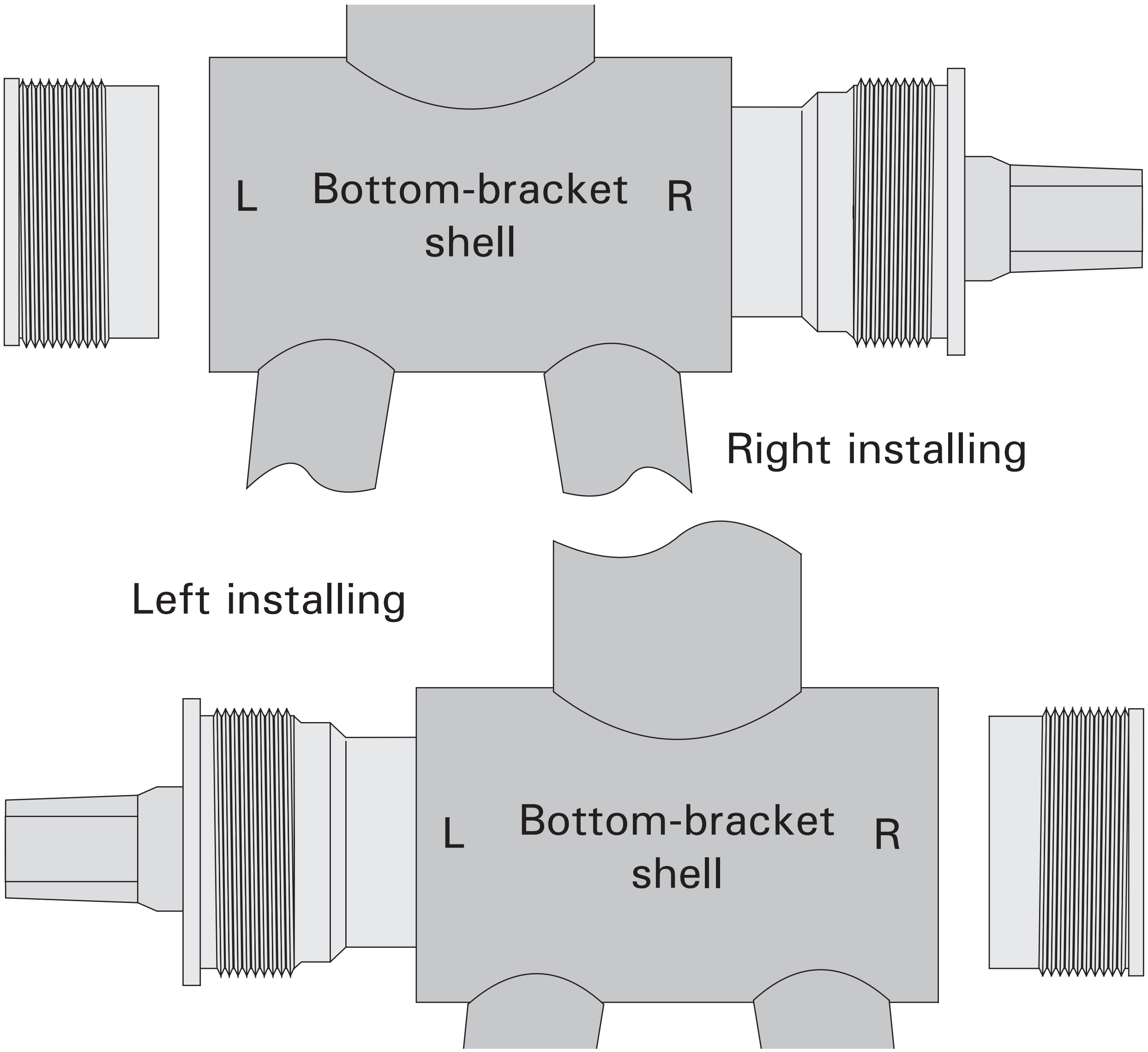
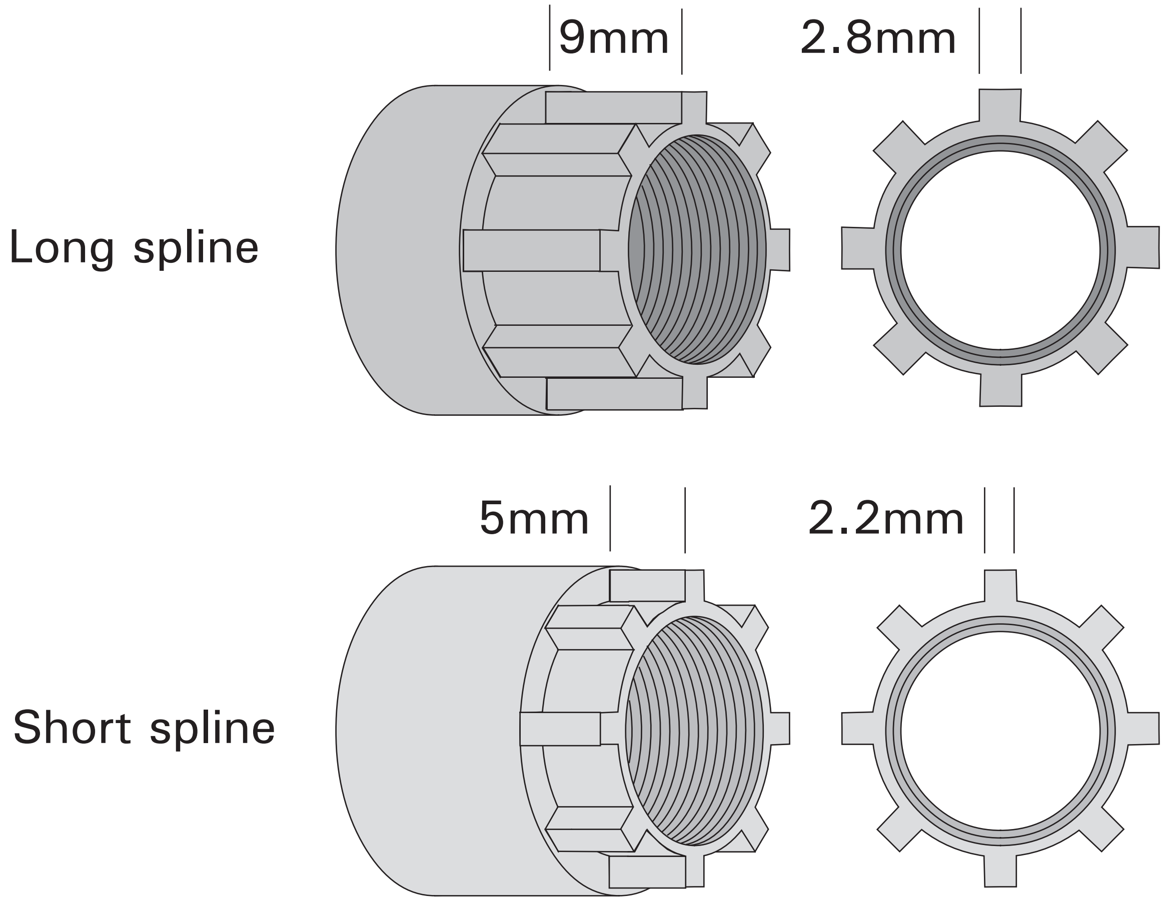


10.1 A typical two-part cartridge-bearing bottom bracket, consisting of a cup and a main assembly. There is a three-part variety which has a main assembly and two separate cups.

«««« Manual Navigator
«« Chapter Navigator
« Model Navigator



10.2 With some Shimano bottom brackets, the main assembly is installed from the right, and with others it is installed from the left.



10.3 Shimano Octalink splines.