33 – FRONT DERAILLEURS

ABOUT THIS CHAPTER

This chapter is about installing, adjusting, and servicing front derailleurs. The procedures for installation and adjustment make references to installing the chain, shifter, and cable. These items are covered in the **CHAINS**, **SHIFT-CONTROL MECHANISMS**, and **DERAILLEUR-CABLE SYSTEMS** chapters.

The front derailleur procedure assumes that the rear derailleur is already installed. The rear derailleur need not be precisely adjusted, but must be able to move the chain to the innermost and outermost cogs. It may seem like a good idea to install and adjust the rear derailleur first, because of this. However, the rear-derailleur procedure requires that the front derailleur be able to shift the chain to the innermost and outermost positions, as well. Whichever is done first, to complete one derailleur adjustment it is necessary to do at least some preliminary work on the other derailleur.

There is some confusing and contradictory terminology used regarding derailleurs, so be sure to review the terminology section to become clear on the terms used by *this* book.

GENERAL INFORMATION

TERMINOLOGY

High gear: On front derailleurs, high gear refers to the chainring furthest from the frame. It is called high gear because using it results in the highest number when calculating gear ratios, not because the top of this chainring is higher than the other chainrings (as is commonly assumed). These two explanations of the term are consistent with each other, but if this same system is used with rear gears it can be confusing. For this reason, this book will always use the more wordy alternative, *outermost chainring*, or a letter code that is described in **NAMING COGS AND GEAR COMBINATIONS** (page 33-2).

Outermost chainring: The one that has the most teeth and is furthest from the frame.

Top gear: Same as *high gear*.

Low gear: On front derailleurs, low gear refers to the chainring closest to the frame. It is called low gear because using it results in the lowest number when calculating gear ratios, not because the top of this chainring is lower than the other chainrings (as is commonly assumed). These two explanations of the term are consistent with each other, but if this same system is used with rear gears it can be confusing. For this reason this book will always use the more wordy alternative, *innermost chainring*, or a letter code that is described in **NAMING COGS AND GEAR COMBINATIONS** (page 33-2).

Bottom gear: Same as *low gear*.

Innermost chainring: The one that has the least teeth and is closest to the frame.

Limit screws: Adjustable stops that are used to stop the inward and outward motion of the derailleur at points that enable the chain to shift to the innermost and outermost chainrings without going too far.

H-screw: A limit screw for stopping the derailleur from shifting the chain out past the outermost chainring.

L-Screw: A limit screw for stopping the derailleur from shifting the chain in past the innermost chainring.

Derailleur cage: The assembly that surrounds and moves the chain.

Outer plate: The plate in the derailleur cage that is on the outward side of the chain.

Inner plate: The plate in the derailleur cage that is on the inward side of the chain.

Cage or plate tail: The rear end of the derailleur cage or of one of the cage plates.

Cage or plate nose: The front end of the derailleur cage or of one of the cage plates.

Parallelogram: In regard to the front derailleur, this is the part of the body (consisting of two arms on four pivots, between the mounting clamp and the cage) that moves the derailleur cage inward and outward.

Adjusting barrel: A hollow screw in the shift-control mechanism (and rarely, in the derailleur) that the inner wire passes through and the housing stops against. As it is screwed in and out, the relative length or tension of the cable system is changed.

Pinch mechanism: This is the mechanism that attaches the inner wire to the derailleur. The inner wire is usually routed through a groove in a plate on the derailleur, and a bolt or nut presses a washer or plate on top of the inner wire to trap and compress it in the groove. The groove in the plate is often hidden by the pressure washer/plate.

Indexing: The type of shifting in which the shift mechanism moves in distinct increments. These increments are designed to precisely move the chain from one chainring to the next. Indexing has virtually replaced friction shifting. In friction shifting, the lever moves smoothly over its full range of motion without any incremented stops. It is up to the operator to decide what the correct amount of lever motion is to get from one chainring to the next.

Mounting bolt: This is the bolt through the derailleur clamp that attaches the derailleur to the seat tube.

Return spring: A spring inside the parallelogram that causes the derailleur to move in as far as the inner-limit screw will allow, when the tension on the inner wire is released.

Over-shift: When the chain moves too far to shift to, and align with, the intended chainring.

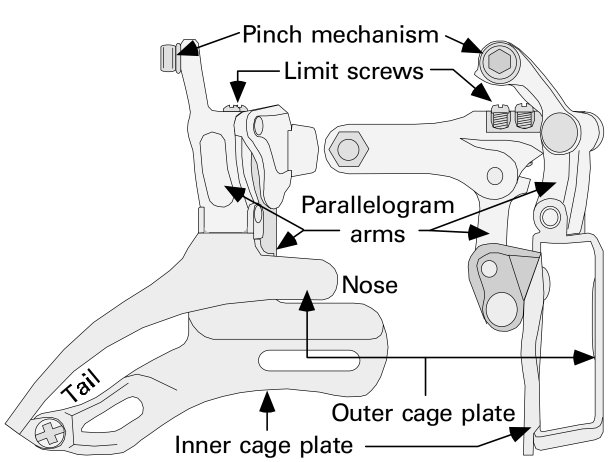
Under-shift: When the chain does not move far enough to shift to, and align with, the intended chainring.

In-shift: A shift to a chainring that is further inward than the one that the chain is currently on.

Out-shift: A shift to a chainring that is further outward than the one that the chain is currently on.

Up-shift: This is a term that will *not* be used, because it is an imprecise phrase.

Down-shift: This is a term that will *not* be used, because it too is imprecise.

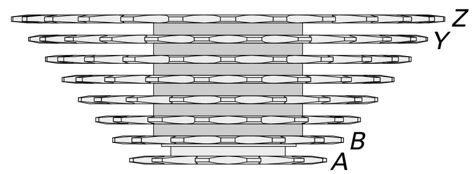


33.1 Back and face views of a front derailleur.

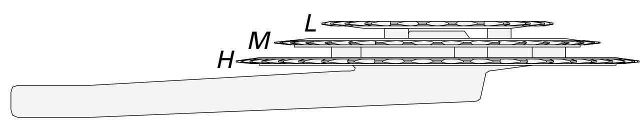
NAMING COGS AND GEAR COMBINATIONS

To perform certain adjustments, the chain needs to be in certain gear combinations. Numbering the gears to identify them does not work, because rear-cog sets have between 5 and 8 gears (so the innermost could be called 5, 6, 7, or 8), and cranksets have between 1 and 3 chainrings (so the innermost might be called 1, 2, or 3).

To avoid confusion, gears will be assigned codes as shown in figures 33.2 and 33.3 (below).



33.2 "A" is always the outermost cog. "B" is always the next-to-outermost cog. "Y" is always the next-to-innermost cog. "Z" is always the innermost cog.



33.3 "H" is always the outermost chainring. "M" is always the middle chainring of a triple. "L" is always the innermost chainring.

Using the above diagrams, it should be easy to conclude that putting the chain in a gear combination of *A/M* would place the chain in the outermost position in the rear, and the middle position of a triple crank. *Y/L* would mean the chain was in the next-to-innermost position in the rear and the innermost in the front.

PREREQUISITES

Shifter and cable installation

In order too adjust the front derailleur, the shift-control mechanism and cable system must be installed.

INDICATIONS

Maintenance

Dirt and wear both affect derailleur performance.

Dirt in the parallelogram can affect shifts. This can be cleaned by immersing the fully-assembled derailleur in solvent, which can quickly remove the dirt.

Wear can adversely affect the parallelogram pivots. When the pivots are worn out, the derailleur must be replaced.

Changing chainrings, right crank arm, or bottom bracket

Any time a chainring, the right crank arm, or a bottom bracket is changed, it is necessary to check the front derailleur adjustment.

Changing chain

Whenever a chain is replaced, shift performance is affected. Fresh chains have less lateral flexibility than worn chains. Different chains have different performance characteristics. After replacing a chain, the derailleur should be checked and readjusted if necessary.

Symptoms indicating adjustment is needed

There are a number of symptoms indicating a probable need for derailleur adjustment.

If the derailleur under- or over-shifts when shifting to the *H* chainring, or the cage rubs the chain while on the *H* chainring, the front-derailleur H-screw may need adjustment, or the derailleur height and rotation may be wrong.

If the derailleur under- or over-shifts when shifting to the *L* chainring, or the cage rubs the chain while on the *L* chainring, the front-derailleur L-screw may need adjustment, or the derailleur height and rotation may be wrong.

If any shift feels hesitant or results in the cage rubbing the chain after the shift is completed, the indexing needs adjustment.

Symptoms indicating derailleur service is needed

If the derailleur is dirty and the inward action is sluggish, the derailleur should be removed and cleaned, then installed and adjusted.

Symptoms indicating derailleur replacement is needed

The inner plate of the cage can get gouged and worn out from trying to shift when the derailleur is not properly adjusted. If the inner cage plate is gouged or scarred in any way, the derailleur should be replaced.

The derailleur cage can get bent from abusive shifting, crashes, or failure to secure the derailleur. Minor bends can be realigned, but sometimes the derailleur needs to be replaced.

Parallelogram pivots wear out, resulting in excess play in the derailleur. This excess play would show up by wiggling the tail of the cage in and out.

TOOL CHOICES

Table 33-1 (below) shows most of the tools available for front-derailleur adjustment. Most of them are the same tools used for rear derailleurs. Preferred choices are shown in **bold** type. These highlighted tools are recommended because of a balance among: ease of use, versatility, durability, and economy.

TIME AND DIFFICULTY

Front-derailleur adjustment, including hanger alignment and cable-system setup, is a 12–16 minute job of moderately-high difficulty. Front-derailleur removal, cleaning, installation, and adjustment is a 25–30 minute job of moderately-high difficulty.

COMPLICATIONS

Wobbling chainrings

Wobbling chainrings make it difficult to find a limit-screw setting that enables the shift, without ending up with the chain rubbing on the derailleur cage.

FRONT-DERAILLEUR TOOLS (table 33-1)

Tool	Fits and considerations
CAGE ALIGNMENT	
Park BT-3	Actually a brake tool for aligning caliper arms, this tool works well for bending the front-derailleur cage.
FOURTH-HAND (CABLE TENSION) TOOLS (These tools are same as those used for rear derailleurs and brakes.)	
Dia-Compe 556	Tends to let inner wire jam in tool
Hozan C356	Tends to let inner wire jam in tool
Lifu 0100	Consumer tool
Park BT-2	Least tendency for inner wire to jam in tool
VAR 233	Tends to let inner wire jam in tool

Chainring wobble can be caused by a number of things. It could be a loose bottom bracket, mis-mounted crankarm, mis-aligned chainring-mounting arms, or bent chainrings. Before adjusting the limit screws, the chainring wobble must be checked and whatever the problem (if any) must be fixed.

Component compatibility problems

See **COMPONENT COMPATIBILITY** (below), for the numerous complications you might encounter.

Damaged derailleur

Bent derailleur cages are fairly common, but not always obvious. It is not unusual to spend time adjusting the derailleur, only to find that it will never work well due to cage damage.

Worn components other than derailleur

Worn chains, chainrings, cables, and shift controls can all affect derailleur adjustment. It is usually not until the attempt to adjust the derailleur fails, that these other factors will get considered, resulting in duplication of effort to adjust the derailleur. If out-shifts are the problem, chainring-tooth wear should be checked.

Derailleur wear

Derailleur wear can be difficult to detect. The parallelogram pivots develop wear. This wear cannot be quantified or seen, except by comparing free play at the tail of the derailleur to a new one of the same model.

Dirty drive train

Dirt in the chain, cable system, shift-control mechanism, and chainrings can affect shift performance. Adjusting a derailleur (particularly an indexing one), without cleaning the related components, is a waste of time.

COMPONENT COMPATIBILITY

It is always best to follow manufacturer's recommendations when selecting components. When non-compatible components are used together, it is likely to show up as a shifting problem. Not all such problems are immediately obvious. If using unmatched components, do not assume that there are no compatibility problems until the indexing has been checked. There is a section in this chapter that explains how to test indexing performance.

Derailleur and shifter

With indexing systems, compatibility between the shifter and derailleur is critical. This is because an indexing shifter will pull a very specific amount of cable for each click. The derailleur must move a very specific distance in order to line up with the next chainring. If the amount of cable moved is wrong, the derailleur will move the wrong distance.

The shifter and derailleur should be brand-matched, whenever possible. There are, however, a few after-market shifter controls that are made specifically for a different brand of derailleur. Grip Shift controls made for Shimano derailleurs are the most common example.

Even within the same brand, there may be problems. For example, Shimano Dura-Ace shift controls and derailleurs are not compatible with other models of Shimano equipment.

Inner wire and shifter

The inner wire must be compatible with the shifter because it is the combination of the shifter-drum diameter *and* the inner-wire thickness that determines how much cable is moved for a given amount of lever motion. See ***SHIFT-CONTROL MECHANISMS*** (page 30-2) for more information on shifter and inner-wire compatibility.

Derailleur and seat-tube size

Derailleurs come with a variety of clamp sizes to fit a variety of seat-tube sizes. Some seat tubes have a fitting built into the side of the seat tube that the derailleur attaches to. This "braze-on" fitting is virtually universal, but requires a specially-designed derailleur.

The common seat-tube sizes are 1" (25.4mm), 1.125" (28.6mm), 1.25" (31.8mm), and 1.375" (34.9mm). The two middle sizes are most common. The 1.125" size is found on most steel frame bikes, except MTBs with oversize tubing. The 1.25" size is found on most MTB's and frames made of materials other than steel. The rarer 1" size is found on inexpensive bikes sold in department stores and on old Schwinns. The 1.375" size is found on just a few bikes with extremely oversized tubing.

Maximum chainring-size difference

Every derailleur is rated for the largest size difference between chainrings that can be tolerated. This is called the derailleur's *maximum capacity*. The maximum capacity represents the greatest differential that can exist between the number of teeth on the smallest chainring and the largest chainring being used. When this capacity is exceeded, the chain will drag on the bottom of the derailleur cage, when the chain is in the *A/L* position. The rated capacity can sometimes be exceeded, and there are times when the full rated capacity cannot be used. The rating is based on an assumption of the angle between the seat tube and the line from the center of the bottom bracket to the center of the rear wheel. If this angle is less than the assumption (shallow seat-tube angle or low bottom bracket), then the capacity can be exceeded. If this angle is more than the assumption (steep seat-tube angle or high bottom bracket), then the full rated capacity might not be available to use.

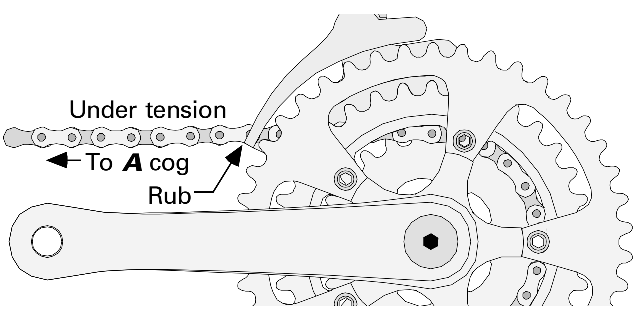
Ratings for derailleurs can be determined in several ways.

Manufacturer's literature: There is often an instruction sheet that comes with a new derailleur. This instruction sheet normally includes the ratings for the derailleur. Some manufacturers will supply literature on request.

Sutherland's Handbook for Bicycle Mechanics: This book includes ratings for a wide variety of derailleur models, but is up-to-date for only a brief time after publication. It is particularly useful if trying to figure out the capacity of an older-model derailleur.

Bike'alog: This computerized source reference for bicycle parts has capacity information for many currently-available models of derailleurs.

Test method: To test if a derailleur's maximum capacity is being exceeded, follow this procedure. Install the derailleur at the correct height, and put a chain through the cage from the top of the innermost chainring to the top of the outermost rear cog. Pull the chain tight. If the chain drags on the cross-piece at the tail of the derailleur cage, then the maximum capacity has been exceeded. It is not meaningful if a slack chain dangles and touches the cross-piece that connects the cage plates together at the tail of the derailleur cage.



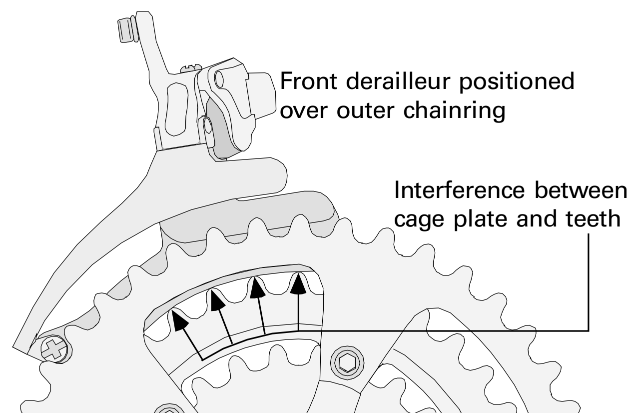
33.4 The chain drags on the cross-piece of the tail of the derailleur cage if the maximum capacity of the derailleur is exceeded.

Minimum chainring-size difference

For every derailleur there is a minimum difference between the size of the outermost chainring and the next chainring inward. This is a rare problem, but it is important to be aware of it. On most bikes, the differences between chainrings are usually ten teeth or more. Since most derailleurs have a minimum capacity of eight or ten teeth, minimum capacity is rarely an issue.

It *does* show up as an issue when a bike is equipped with a "half-step" gear selection. Half-step gearing gets its name from the fact that changing from one chainring to another results in about half the change in gear ratio that results from changing from one rear cog to an adjacent rear cog. When the chainrings are a half-step configuration, they will have a difference only of 4–6 teeth between the outermost chainring and the next one in. If the chainrings are set up like this, it is important to check the front derailleur's minimum capacity. Derailleurs that are described as "alpine" or "cross-over" are never suitable for use with half-step chainrings.

Some compact drive chainring sets that have an 8-tooth difference between a large chainring with 42 teeth have and a middle chainring with 34 teeth. Many MTB derailleurs are not suitable for this 8-tooth difference.



33.5 The bottom edge of the inner cage plate interferes with the teeth of the middle chainring on a triple crankset when the minimum capacity has been violated.

Ratings for derailleurs can be determined in several ways.

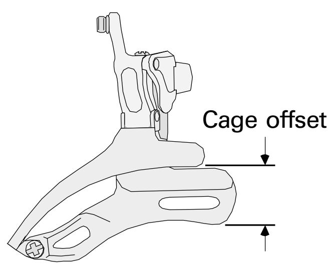
Manufacturer's literature: There is often an instruction sheet that comes with a new derailleur. This instruction sheet normally includes the ratings for the derailleur. Some manufacturers will supply literature on request.

Sutherland's Handbook for Bicycle Mechanics: This book includes ratings for a wide variety of derailleur models, but is up-to-date for only a brief time after publication. It is particularly useful if trying to figure out the capacity of an older-model derailleur.

Bike'alog: This computerized source reference for bicycle parts has capacity information for currently-available models of derailleurs. Instead of numerical ratings, there may simply be a reference to "alpine," "cross-over," or "half-step."

Test method: To test if a derailleur's minimum capacity is being exceeded, follow this procedure. Install the derailleur to the correct height on the seat tube. Swing the derailleur out far enough that the inner plate swings over the top of the next-to-outermost chainring. If the inner plate clears, then the minimum capacity has not been exceeded.

Measurement method: If the bottom edge of the inner cage plate is never more than 10mm below the bottom edge of the outer cage plate, then the derailleur is half-step compatible. If the offset is greater than 10mm at any point, then the derailleur cannot be used with half-step chainrings.



33.6 Measure cage-plate offset here.

Derailleur and chainring-set position

It is possible for the chainring set to end up too close to the frame for the front derailleur to work. This can happen even though chainline is acceptable and chainring-to-frame clearance is adequate. When the chainrings are too close to the frame, the moving part of the derailleur may bump into the seat tube or itself before the cage has moved enough to complete the shift. The best solution to this is to change the bottom bracket to move the chainrings as far out as the chainline will allow. At times, it may be necessary to re-space the rear hub *and* move the chainring set, so that the chainrings and rear cog set can both be moved out together to maintain the chainline.

Derailleur and chain

Indexed derailleurs moved in fixed amounts. The chain must respond as expected for the shift to be completed. If the chain has more lateral flexibility than expected, when the derailleur moves its fixed amount, then the chain will not respond enough to complete the shift. Chains vary in lateral flexibility because of brand differences and wear. If the derailleur manufacturer's recommendations are not followed, shift performance may be compromised.

Chain and chainrings

The width of a chain must be suitable to the chainring set or it may rub against adjacent chainrings. See the ***CHAINS*** chapter (page 26-2 and 26-16).

The shaping of the side plates of the chain affects a chain's ability to engage the chainring's teeth. When not using the manufacturer's recommended chain, shift performance may be compromised.

UNDERSTANDING HOW FRONT DERAILLEURS WORK

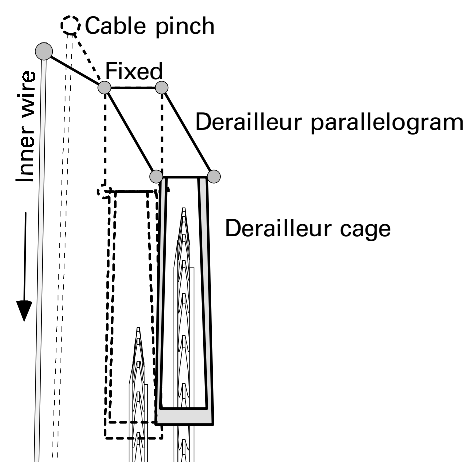
The operation of a front derailleur is relatively complex. By understanding what is happening in a front derailleur, the installation and adjustment procedures outlined here will become clearer.

How a cable moves the derailleur in and out

Most shift-control mechanisms operate by pulling the inner wire through one or more lengths of housing. The mechanism takes up excess inner wire and pulls the derailleur to its outermost position. Figure 33.7 shows this in a simplified form.

The piece of exposed wire closest to the derailleur is attached to an arm that serves as an extension of one of the parallelogram arms. When this lever is rotated about its pivot, the whole parallelogram structure changes shape so that it expands or contracts, moving the derailleur cage out or in.

When the tension on the cable is released, a spring in the parallelogram causes it to return toward its original position.

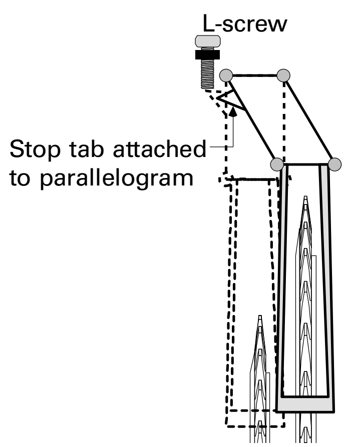


33.7 How a derailleur parallelogram is deformed across its diagonal, to deflect it laterally to a more outward position.

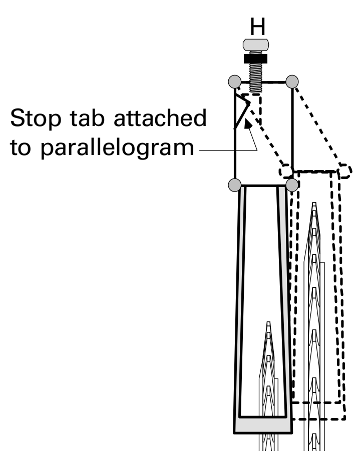
How limit screws work

The two limit screws act like two adjustable barricades. There is usually some projection or surface on a parallelogram arm that the limit screw butts up against. By adjusting one limit screw, the range of travel for the parallelogram in one direction will be changed. In other words, by loosening the H-screw, the barricade that stops the outward motion of the parallelogram is changed so the parallelogram can move further out. By loosening the L-screw, the barricade that stops the inward motion of the parallelogram is changed and the derailleur can move further in.

Changing one limit screw does not affect the other. Changing the H-screw setting only changes the shift to the outermost cog. Changing the L-screw only changes the shift to the innermost cog. Figures 33.8 and 33.9 show a simplified and exaggerated model of how limit screws affect the range of motion of the parallelogram.



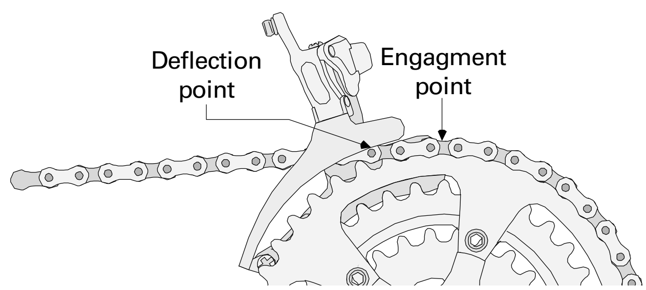
33.8 *A stop tab attached to the parallelogram bumps into the H-screw to stop the derailleur's outward motion.*



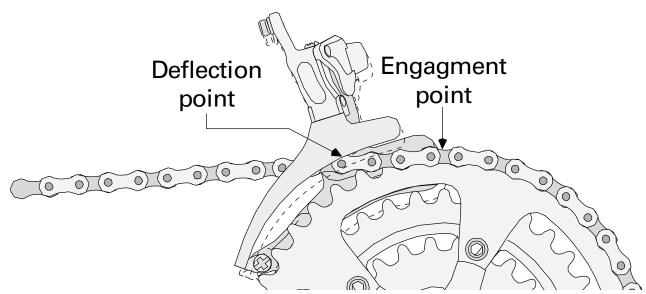
33.9 *A stop tab attached to the parallelogram bumps into the L-screw to stop the derailleur's inward motion.*

The importance of derailleur height

One of the most important factors affecting front shifting performance is the distance from the derailleur cage to the chainrings. Consider the point that the cage pushes on the chain to be the *deflection point* (see figure 33.10). Consider the point that the chain engages the chainring to be the *engagement point* (see figure 33.11). The engagement point is always at the top dead center of the chainring; it never moves. As the derailleur moves up, the deflection point on the chain moves further back in the derailleur cage. Consequently, as the derailleur moves up, the distance between the engagement point and the deflection point increases. The greater this distance is, the more derailleur motion is needed to deflect the chain enough to cause it to disengage one chainring and engage another. Figures 33.10 and 33.11 show in an exaggerated fashion how moving the derailleur up increases the distance from the engagement point to the deflection point.



33.10 *With the derailleur at the recommended height, the deflection point is only two and a half links behind the engagement point.*



33.11 *Note how the deflection point has moved to three and a half links behind the engagment point now that the derailleur height has moved up.*

What happens when the derailleur shifts the chain from the outermost chainring inward to the next chainring

Before reading this, put a bike in the stand and shift the chain off of the outermost chainring. As you shift, turn the crank very slowly and move the derailleur in very slowly. Observe exactly what is happening with the chain and derailleur cage for the duration of the shift.

When the derailleur moves inward, the nose of the outer plate deflects the chain just behind the engagement point. Since the distance between the deflection point and the engagement point is very small, only minimal cage motion is needed to cause the chain to derail to the inside of the outermost chainring.

Once the chain disengages from the outer chainring, it is moving inward. Something has to stop the chain from moving too far. That is accomplished by the inner plate of the cage. The rest position of the inner plate is determined either by the derailleur's L-screw on a double-chainring set, or by the indexing adjustment of the cable on a triple-chainring set. If either the L-screw or the cable-tension adjustment is too loose, then the derailleur cage will move too far inward.

After the nose of the outer plate starts the chain derailment and inward motion, two things can add to this inward motion. One is the angle of the chain coming from the rear cogs, and the other is the motion of the tail of outer plate.

Chains naturally want to run straight, rather than in the S-shaped curve that is required when the chain is on two gears that are not in line with each other. When the chain is on an inward cog in the rear, and the chain gets released from the chainring, it tries to straighten itself out. This straightening tends to move the chain inward. The opposite is true if the chain is on one of the outermost cogs when the shift in from the outermost chainring occurs. Since the chain is fixed to a rear cog that is already further out than to where the chain is being pushed, the tendency of the chain to straighten out actually resists the inward motion of the chain. Consequently, when a chain is on an inward cog in the rear, the inward shift of the chain in front is enhanced; when the chain is on an outward cog in the rear, the inward shift of the chain is restricted. Whenever chainline is off, one of these two tendencies becomes exaggerated. If the chainrings are too far out relative to the rear cogs, then the chain has a tendency to shift too far in the front, when being shifted in. If the chainrings are too far in relative to the rear cogs, then the chain resists inward shifts in the front.

The tail of the outer cage plate also affects the inward motion of the chain. When the in-shift starts, the chain is high on the outermost chainring and is being pushed by the highest, most forward, part of the outer plate. Once the chain derails, the chain begins to drop to the smaller chainring. At this point, it is lower and further back in the derailleur cage. This is when the motion of the tail of the derailleur cage affects the shift inward from the outermost chainring.

Two things determine the range of motion of the tail of the outer plate. One is the L-screw setting (double-chainring sets) or cable tension (triple-chainring sets). The less the whole mechanism is allowed to travel inward, the less the outer plate will move. The primary function of the L-screw or cable tension setting, however, is to position the inner plate so that it will stop the chain from moving too far.

The second factor that influences the inward range of motion of the outer plate is the shape of the derailleur cage. If the tail of the cage is wide, the tail of the outer plate will not end up as far in when the inner plate arrives at its innermost position. If the tail of the cage is narrow, the tail of the outer plate will end up further inward when the inner plate stops at the same point. The width of a derailleur-cage tail can be modified by bending the plates or by changing spacers between the tail ends of the two plates.

What happens when the derailleur shifts the chain from a middle chainring to the innermost chainring

Before reading this, put a bike in the stand and shift the chain from the middle chainring in. As you shift, turn the crank very slowly and shift the derailleur in very slowly. Observe exactly what is happening with the chain and derailleur cage for the duration of the shift.

This is a more difficult shift than the shift from an outer chainring to a middle or inner chainring. The reason is that the top of the middle chainring is much further below the derailleur, so the deflection point is way back on the outer cage plate. This difference is what led Shimano to redesign their chainring teeth to make it easier for the chain to derail inward. This way, the outer plate does not have to move as far to achieve chain derailment.

Other than the fact that this shift naturally demands more of the derailleur, the principles are the same as the shift from the outer chainring.

What happens when the derailleur shifts the chain out to the outer chainring

Before reading this, put a bike in the stand and shift the chain from the next-to-outermost chainring out. As you shift, turn the crank very slowly and move the derailleur cage out slowly. Observe exactly what is happening with the chain and derailleur cage for the duration of the shift.

With this shift, the inner plate moves the chain and the outer plate prevents it from going too far. The shift starts when the tail of the inner plate contacts the chain and pushes it outward. The next thing to happen is that the teeth of the outer chainring (at about the 10:00 position), begin to catch the chain, causing it to rise. As the chain begins to rise, it moves in the derailleur cage and the deflection point moves forward. The nose of the inner plate completes the shift by pressing the chain the rest of the way onto the chainring, close to the engagement point. Because of the short distance between the nose of the inner plate and the engagement point, small changes in the nose position can make big differences in shift performance. Although it is the tail of the inner plate that begins the shift, the final position of the nose of the inner plate is the most critical factor affecting the completion of the shift to the outermost chainring.

Two factors influence the final position of the nose of the inner plate. These are: the H-screw setting and the width of the nose of the cage.

When the H-screw is set, it determines the range of motion of the entire cage. The function of this screw is to position the outer cage plate close enough to the outer chainring so that it is impossible for the chain to move out past the chainring. Consequently, the H-screw cannot be used to adjust the final position of the nose of the inner plate.

Unlike in-shifts, the width of the tail is relatively unimportant to out-shifts. It is the cage width at the nose that is the most important factor. This is controlled by toeing the nose of the inner plate. The final position of the nose of the inner plate is adjusted by bending the nose towards or away from the chain. This is called *toeing* the nose. These days, most derailleurs already come with a good amount of toe, but toeing can be used to speed up the shift to the outer chainring anytime it is sluggish.

Chain angle and load on the chain dramatically affect this shift. As in the case of in-shifting, the position of the chain in the rear affects the tendency of the chain to move one direction or the other. When the chain is in an inward position in the rear, it resists outward motion at the chainrings. When the chain is in an outward position in the rear, it encourages the outward motion of the chain. Load is important because the rising teeth on the chainring being shifted to must help the chain rise by just brushing against the chain. When there is load on the chain, it keeps the chain down.

What happens when the derailleur shifts the chain from an inner chainring to a middle chainring

Before reading this, put a bike in the stand and shift the chain from the innermost chainring to the middle chainring. As you do this, turn the crankset very slowly and move the derailleur cage out slowly, and observe exactly what is happening with the chain and derailleur cage for the duration of the shift.

Like the shift to the outermost chainring, this shift is initiated by the contact of the tail of the inner plate to the chain. This occurs at a considerable distance from the engagement point. Consequently, a great deal of lateral motion is required to move the chain enough to engage the middle chainring. As in the case of a shift to the outermost chainring, the teeth of the middle chainring intersect the chain, and cause it to rise. Unlike the shift to the outermost chainring, the chain never rises enough to engage the nose of the inner plate. This means that the deflection point never gets very close to the engagement point. The only way to keep the chain moving out is to move the inner plate outward more. Consequently, a lot more outward motion is required to shift out to a middle chainring than is required to shift out to an outer chainring. This is perhaps the most demanding shift for a front derailleur to make.

The amount of outward motion of the cage is controlled by the operator on a friction system. It is controlled by the cable-tension adjustment on an indexing system. It is the difficulty of this shift that led Shimano to develop the HyperDrive chainring design, which features an extra set of teeth on the inner face of the middle chainring. These extra teeth help pick up the chain. The HyperDrive chainring's primary teeth are also designed to make it easier for the chain to engage.

The importance of the rotational alignment of the cage

Rotational alignment of the derailleur cage (adjusted by rotating the derailleur mount around the seat tube), controls two important things. It affects the relative angles of the cage plates to the chain, and it affects the relative width of the cage.

Rotational alignment affects the relative angle of the cage plates to the chain. This is most critical when looking at the relationship between the chain and the outer cage plate, when the chain is on the large chainring. If the chain is on an outer rear cog, the outward motion of the chain is enhanced; the chance of the chain shifting out past the outer chainring is at its greatest. Consequently, it is at this time that it is most important to keep the nose of the outer plate as close to the outer chainring as possible. The chain angles out to the outermost cog. The outer plate should remain in a position so that it stays parallel to the chain when the chain is on the outermost chainring and rear cog. Make certain that the outer plate is parallel to the chain, and not the chainrings. Otherwise, there will be large gap between the chain and the nose of the outer plate at the point the chain just clears the tail of the cage. This reduces the effectiveness of the outer plate in preventing an over-shift.

Rotational alignment also affects the effective width of the derailleur cage. Think of the opening in the back of the cage like a window opening in a wall. If you are facing the wall directly and the window is right in front of you, then the full width of the window is apparent, and it would be relatively easy to throw a ball through the window. On the other hand, if the wall is rotated so that you are no longer facing the window squarely, its apparent width is reduced, and it becomes much more challenging to throw the ball through the opening. When a derailleur cage is not rotated correctly, it is effectively narrower, and it is a lot more likely that the chain will end up rubbing the cage in some gear combination.

ABOUT THE REST OF THIS CHAPTER

The rest of this chapter is divided into five parts:

INSTALLATION AND ADJUSTMENT
TESTING INDEX PERFORMANCE
FRONT-DERAILLEUR SERVICE
FRONT-DERAILLEUR TROUBLESHOOTING
EIGHT -AND NINE-SPEED COMPATIBILITY

INSTALLATION AND ADJUSTMENT

INSTALLATION

NOTE: Before proceeding further, be sure to be acquainted with the section, NAMING COGS AND GEAR COMBINATIONS (page 33-2).

Compatibility checks

1. [ ] Check reference information to determine that derailleur and shift-control mechanism are compatible.

2. [ ] Check reference information to determine that inner wire, housing, and shift-control mechanism are compatible.

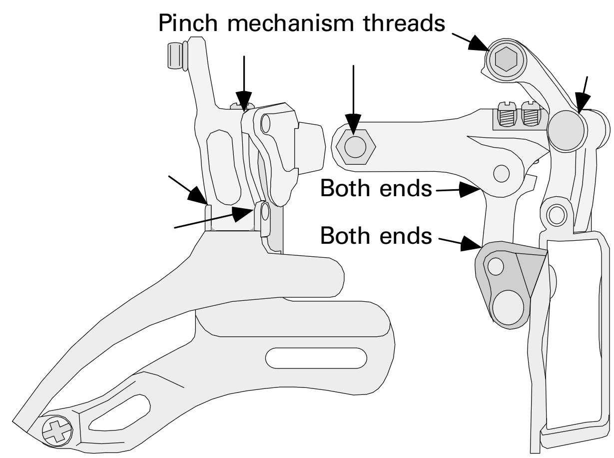
3. [ ] Check reference information to determine that shift-control mechanism is compatible with brand of crankset and number of chainrings.

4. [ ] Check reference information to determine if chain is compatible with chainring set.

Lubrication

5. Lubricate following points:

[ ] Both ends of all four parallelogram pivots.
[ ] Mounting bolt threads.
[ ] Pinch mechanism threads.

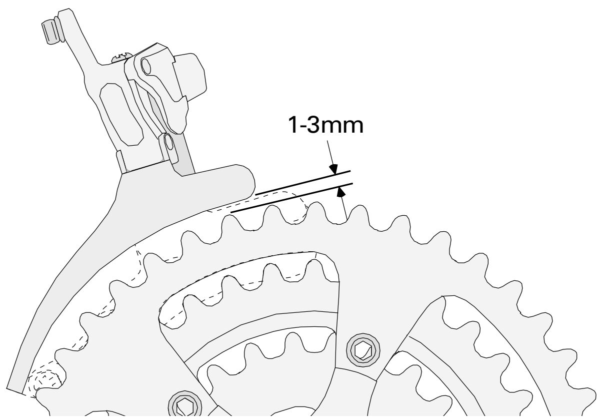


33.12 Oil at all these points.

Setting derailleur height

The derailleur height is critical to the performance of the front derailleur. The height is ideal when the outer cage plate clears the teeth on the outer chainring by 2mm, as it passes over the teeth. The height is acceptable within a clearance range of 1–3mm.

There are several complications to setting the height. The derailleur cage moves upward as it moves out, so if the height is checked when the outer plate is not exactly over the teeth of the outer chainring, then the setting will not be accurate. Another complication is that all the teeth on the outer chainring may not be all equal in height. This may be because the chainring is deliberately not round, or it may be because some teeth are shaped differently to facilitate shifting. When setting the derailleur height, make sure that the crank is rotated to position the tallest teeth under the derailleur cage. The last complication is that the curve of the bottom edge of the outer plate may not be concentric to the curve created by the tips of the chainring teeth. This means that the clearance between the bottom edge of the outer plate and the teeth may not be uniform over the whole length of the outer plate. When setting the height, be sure the clearance is being checked at the point that the bottom edge of the outer plate comes closest to the chainring teeth.



33.13 The correct range of derailleur height.

6. [ ] Place derailleur clamp around seat tube, then install and gently secure mounting bolt (enough so derailleur will not slide down tube).

7. [ ] Check that outer plate is close to parallel to outer chainring, and reposition derailleur if it is not.

8. Perform one of following steps, depending on whether the derailleur is just being installed, or already has cable attached.
[ ] If cable is attached to derailleur, use shifter to position derailleur so that outer plate is directly above outer chainring teeth (raise derailleur if necessary).
[ ] If cable is not attached, use fingers to move derailleur cage out until outer plate is directly of outer chainring teeth (raise derailleur if necessary).

9. [ ] Turn L-screw in (usually innermost screw) until it supports derailleur so that the outer plate is held directly over teeth of outer chainring (release shifter at this time, if cable is attached).

10. [ ] Rotate crank so that tallest teeth are underneath derailleur cage and find point on outer plate that chainring teeth come closest to bottom edge of outer cage plate.

11. [ ] Arrange stack of feeler gauges until they total close to 2mm thickness.

12. Insert stack of feeler gauges between teeth and bottom edge of outer cage plate and determine if they:
[ ] just fit, height is good
[ ] fit loosely, derailleur should be lowered
[ ] fit too tight, derailleur should be raised.

13. [ ] Leave, lower, or raise derailleur on seat tube as determined in previous step, then recheck height.

Setting derailleur rotation

The derailleur's rotational alignment is critical to the shifting performance. The rotational alignment is ideal when the portion of the outer plate that overlaps the chain is parallel to the chain (when the chain is on the outermost chainring and outermost rear cog).

There are several items to consider when to setting rotational alignment.

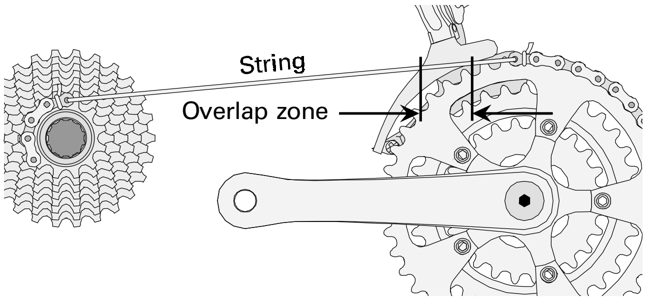
One important consideration is that the outer plate of the derailleur cage is rarely a simple flat shape. Add to that the fact that the chain is not flat. Consequently, it is difficult to say that the two are parallel, or not parallel. Furthermore, the whole length of the outer plate does not overlap the chain all at one. The nose is generally above the chain and from the midpoint to the tail, the outer plate is generally below the chain. The only portion of the cage plate that matters is the short section that would rub the chain if the cage plate were moved in far enough to contact the chain (the overlap zone, see figure 33.14, next page).

Another consideration is the fact that the derailleur tends to move while the mounting bolt is being secured.

Finally, it makes a difference whether the chain is already installed, or the derailleur is being installed before the chain. With the chain already in place, the outer plate must be aligned to the chain. That can be somewhat awkward. With the chain not in place yet, a simple and superior substitute for the chain is used to align the derailleur.

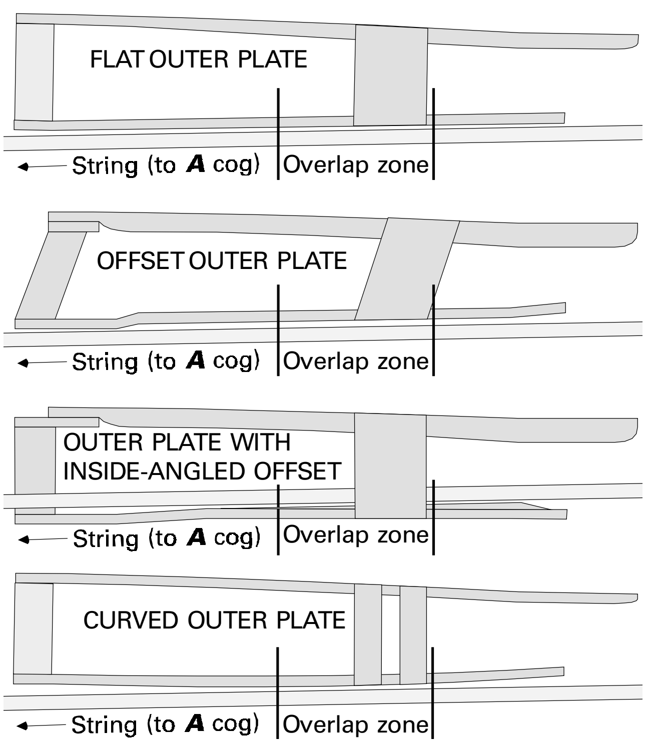
This simple substitute for the chain must be handmade. It cannot be purchased. The materials needed are two short sections of chain and some string. It works best if you use elastic string. Try a store that sells fabric and sewing supplies. One section of chain (3–4") will sit on top of the outer chainring. The other section of chain (3–4") will sit on top of the outermost rear cog. The string needs to be attached to both chain sections. If it is elastic, the length should be set so that it must be stretched slightly for the two segments of the chain to end up where they need to be.

To use the string tool, clamp or tie the wheel and the crank so that they cannot rotate. Place one piece of the chain on the outermost chainring so that the end with the string attached is close to 12:00. Place the other piece of chain on the outermost rear cog so that the slack is pulled out of the string. It is important that the string attaches to both sections of chain in the same way. If the string lines up with a chain roller on one section, it should line up with a chain roller on the other section. If the string comes out the outer face of one section of chain, it should come out the outer face of the other section of chain.



33.14 With the wheel and crank fixed from turning, install the derailleur-alignment-string tool in the fashion shown in this illustration (distance between the freewheel and chainrings is shortened for this depiction).

It is easiest if you leave the string outside of the derailleur cage. That way you may use it to line up the outer face of the outer cage plate. The design of some outer plates requires that the string be inside the derailleur cage. In these cases, line the string up with the inner face of the outer plate. See figure 33.15 to see how different shaped cage plates are lined up with the string.



33.15 Regardless of the shape of the outer plate, rotate the derailleur so that the portion of the outer plate in the overlap zone (see figure 33.14) is parallel to the string (or chain) connecting cog A to chainring H. Note in the the third example that the string needs to be inside the cage because the angle of the inside of the outer plate is different than the angle on the outside of the outer plate.

14. Perform one of following steps, depending on whether chain and cable are installed, or not:
[ ] Shift chain to *A/H* position, and use shifter or cable-tension adjustment to position outer cage plate close to chain without contact occurring.
[ ] Place string tool on outermost chainring and outermost rear cog and adjust L-screw to hold outer cage plate close to string without touching it.

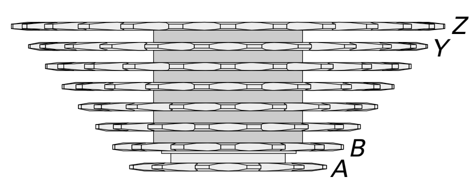
15. [ ] With mounting bolt just loose enough to allow derailleur to twist around seat tube, twist derailleur until outer cage plate is parallel to chain or string.

16. [ ] Secure mounting bolt to 40in-lbs (13lbs@3").

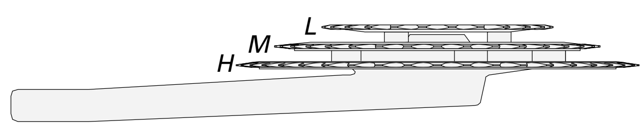
17. [ ] Check rotational alignment again, and reposition and torque again if necessary, until alignment is maintained after torquing mounting bolt.

ADJUSTMENT

The processes of describing cogs and chainrings by their relative positions and describing gear combinations involving different front chainrings and rear cogs can get very wordy and awkward. For this reason, all the following procedures use a code system (illustrated below) to name different chainrings and gear combinations. This code system is described in detail in the earlier section of this chapter, **NAMING COGS AND GEAR COMBINATIONS** (page 33-2). Become acquainted with this method before attempting the following procedures.



Codes for freewheel cogs.

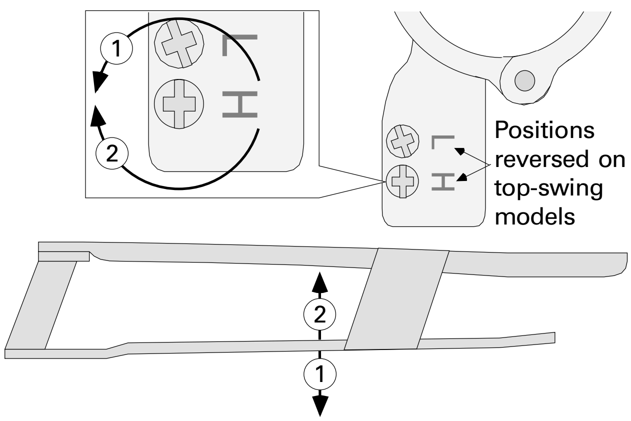


Codes for chainrings.

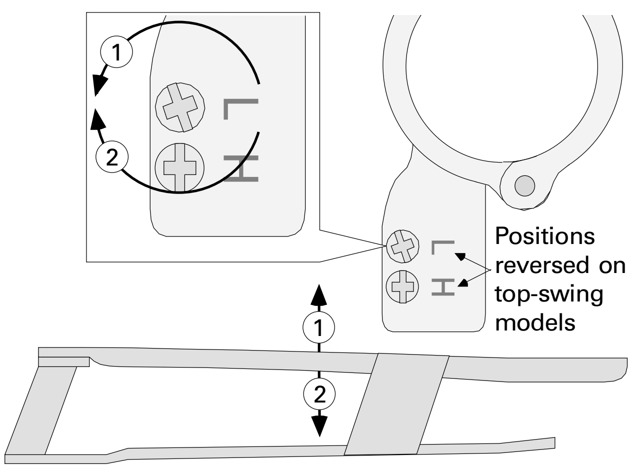
NOTE: before proceeding further, be sure to be acquainted with the section, NAMING COGS AND GEAR COMBINATIONS (page 33-2).

Pre-setting limit screws

The limit screws need to be set in a very approximate fashion before the cable and chain are installed. The purpose of this is to keep the chain from shifting off the chainring set while performing the final adjustments. *Precise adjustment of the limit screws must be done after cable installation. Do not waste effort doing steps #18 and #19 too precisely!* When the H-screw is tightened, it reduces the outward range of motion of the derailleur. When the L-screw is tightened, it reduces the inward range of motion of the rear derailleur. See figures 33.16 and 33.17 for clarification of the consequequences on tightening and loosening each limit screw.

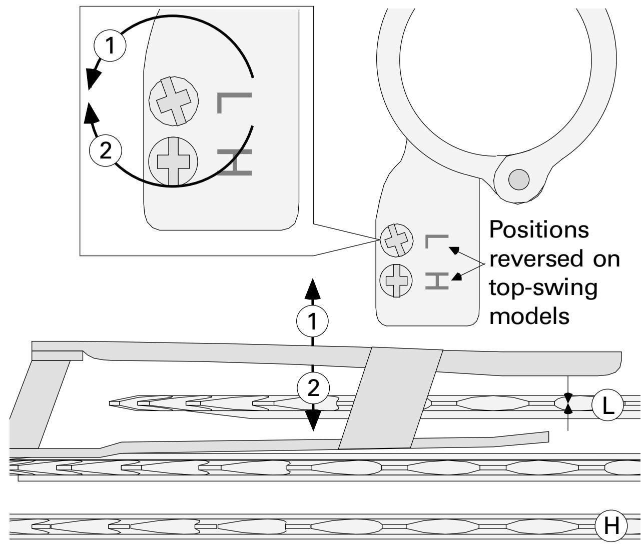


33.16 Turning the H-screw will change the derailleur's outward rest position in the direction indicated by the corresponding numbers.



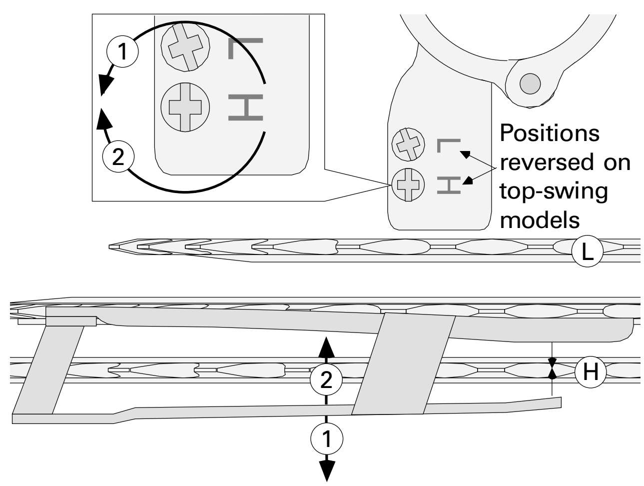
33.17 Turning the L-screw will change the derailleur's most inward position in the direction indicated by the corresponding numbers.

18. [ ] Adjust L-screw so innermost chainring appears in center of cage, halfway between noses of cage plates.



33.18 Adjust the L-screw so that the nose of the derailleur cage centers over the L chainring.

19. [ ] Adjust H-screw so that when derailleur is pushed out to its limit, outermost chainring appears in center of cage, halfway between noses of cage plates.



33.19 Adjust the H-screw so that when the derailleur is pushed outward, the nose of the cage ends up centered over the H chainring.

Cable attachment

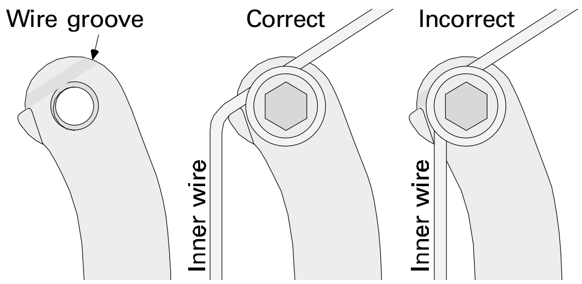
When adjusting an indexing derailleur, cable setup is critical for proper performance. Even if adjusting a derailleur on a bike with the cable already installed, removing the cable and setting it up by the procedures outlined in the preceding chapter (**DERAILLEUR-CABLE SYSTEMS**, page 31-3) is strongly recommended.

20. [ ] Use procedures in DERAILLEUR-CABLE SYSTEMS chapter (page 31-3) to install cable system.

21. [ ] Put front-derailleur shift-control mechanism in fully released position.

22. [ ] Loosen or disassemble pinch mechanism to find groove covered by pinch plate or washer.

Routing the inner wire through the pinch mechanism correctly can be counter-intuitive. The best procedure is to disassemble the pinch mechanism in order to find the groove that the inner wire sits in. The inner wire usually does not maintain a straight line as it goes through the pinch mechanism, but it bends to go over the top of the pinch mechanism. See the illustration below for examples of normal and incorrect cable routing.



33.20 Routing the inner wire through the pinch mechanism.

23. [ ] Lay inner wire into groove and gently secure pinch bolt/nut just enough to keep wire from falling out or slipping. If the pinch plate has a narrow tab that folds over edge of plate with groove, narrow tab always goes counterclockwise of section of wire entering pinch mechanism.

The inner wire needs slack removed, but not too much or it will interfere with the setting of the L-screw (particularly if the preliminary setting of the L-screw was too tight). In the next step, pull *most* of the slack out of the inner wire before torquing the pinch nut/bolt.

24. [ ] Pull of slack out of inner wire by hand and secure pinch mechanism to 35in-lbs (12lbs@3") (check that inner wire is still in groove).

NOTE: Install rear derailleur and attach rear cable system at this time, if not already installed.

Checking chainring wobble

If the chainrings wobble, it interferes with limit-screw setting. The next steps checks for wobble and refer to other chapters for correction of wobble.

25. [ ] Align nose of outer cage plate directly over teeth of outer chainring.

26. [ ] Rotate crank and observe whether outer chainring wobbles >.5mm.

27. [ ] See CHAINRINGS chapter (page23-12) and TAPER-FIT CRANKARMS chapter (page 20-10) for procedures for aligning chainrings.

Chain installation and derailleur-capacity checks

The derailleur should be checked for whether its maximum or minimum capacities have been exceeded.

28. [ ] Install chain and size by procedure in CHAINS chapter (page 26-10).

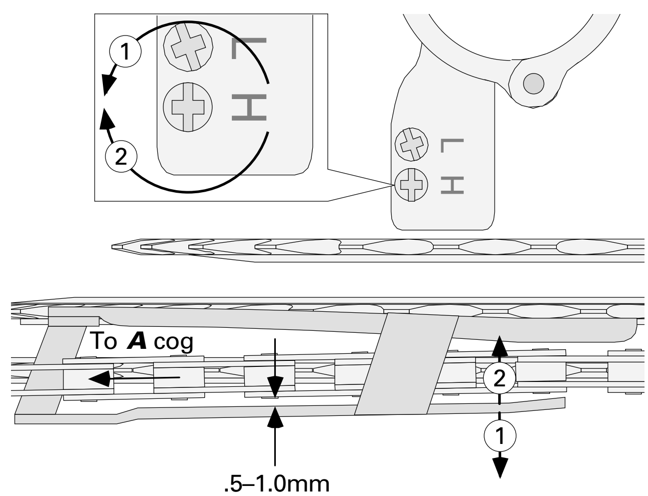
29. [ ] Put chain in *A/L* position, put load on chain, then check if chain touches cross-piece at tail of front-derailleur cage. If so, maximum capacity has been exceeded.

30. [ ] Shift front derailleur until inner cage plate is just above next-to-outermost chainring. If interference with teeth occurs, minimum capacity has been exceeded.

H-screw setting

Set the H-screw to stop the outward motion of the derailleur cage at a point where the outer plate clears the chain by .5–1.0mm (with chain in *A/H* position).

This is complicated by chainring wobble and chain wiggle. The crank must be turned for several revolutions, and stopped at the point that there is the least clearance between the chain and the outer cage plate. If the chainrings don't wobble much and the chain doesn't wiggle much, then the 1.0mm clearance should be safe. On the other hand, if there is a lot of lateral motion of the chain while the cranks are turning, once the closest point is found, the H-screw should be set closer to .5mm of clearance.



33.21 Set the H-screw so that this clearance is achieved when the derailleur stops its outward motion.

The best way to check clearance is to insert a feeler gauge between the cage plate and the chain.

31. [ ] Shift chain to *A* position in rear.

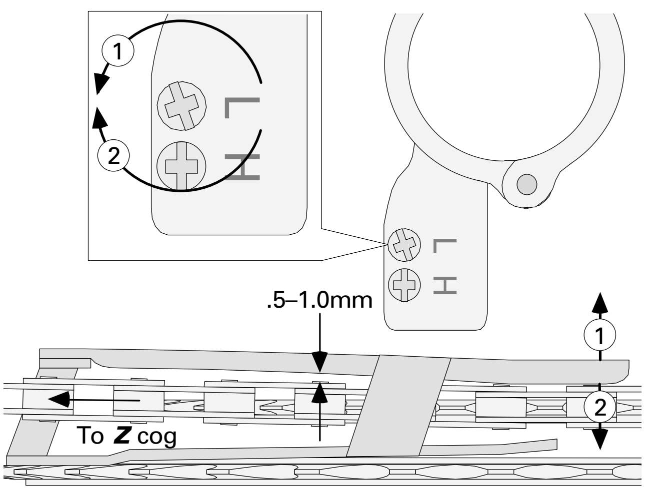
32. [ ] While turning crank, pull on exposed section of inner wire to move front derailleur out as far as it will go, then hold it at this position.

33. [ ] Rotate crank several revolutions and stop at point where least clearance occurs between chain and outer cage plate.
34. [ ] Insert feeler gauge to check clearance between chain and outer cage plate.
35. Correct clearance error by one of following methods:
[ ] Clearance is .5–1.0mm, no change necessary.
[ ] Clearance is <.5mm, turn H-screw counterclockwise about 1/8 turn.
[ ] Clearance is >1.0mm, turn H-screw clockwise about 1/8 turn.
36. [ ] After making adjustment of H-screw, repeat steps 33–35.

L-screw setting

Set the L-screw to stop the inward motion of the derailleur cage at a point where the inner plate clears the chain by .5–1.0mm (with chain in *Z/L* position).

This is complicated by chainring wobble and chain wiggle. The crank must be turned for several revolutions, then stopped at the point that there is the least clearance between the chain and the inner cage plate. If the chainrings don't wobble much and the chain doesn't wiggle much, then the 1.0mm clearance should be safe. On the other hand, if there is a lot of lateral motion of the chain while the cranks are turning, once the closest point is found, the L-screw should be set to get something more like the .5mm clearance.



33.22 Set the L-screw so that this clearance is achieved when the derailleur stops its inward motion.

The best way to check clearance is to insert a feeler gauge between the cage plate and the chain.

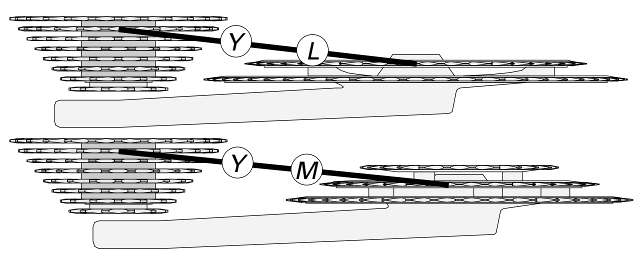
NOTE: If inner-wire is too tight, L-screw cannot be set.

37. [ ] Shift chain to *Z/L* position.
38. [ ] Rotate crank several revolutions and stop at point where least clearance occurs between chain and inner cage plate.
39. [ ] Make sure shift-control mechanism is fully released.
40. [ ] Insert feeler gauge to check clearance between chain and inner cage plate.
41. Correct clearance error by one of following methods:
[ ] Clearance is .5–1.0mm, no change necessary.
[ ] Clearance is <.5mm, turn L-screw counterclockwise about 1/8 turn.
[ ] Clearance is >1.0mm, turn L-screw clockwise about 1/8 turn.
42. [ ] After making adjustment of L-screw, repeat steps 39–41.

Fine-tuning shift to outer chainring

Once the H-screw is set, the chain should shift effortlessly to the *H* chainring. In some cases, the shift may be slow or hesitant. In this case, some further adjustment is needed, but not of the H-screw. Instead, the angle of the nose of the inner cage plate must be changed.

When the chain is in a more inward position in the rear, the angle of the chain retards out-shifting at the chainrings. Consequently, to test whether further tuning is needed, the chain should be on the most inward cog it would normally be on when shifting to the *H* chainring. This is the *Y* cog. The shift to the *H* chainring should always be made from the adjacent inward chainring, which would be the *L* chainring on a double-chainring set, or the *M* chainring on a triple-chainring set.



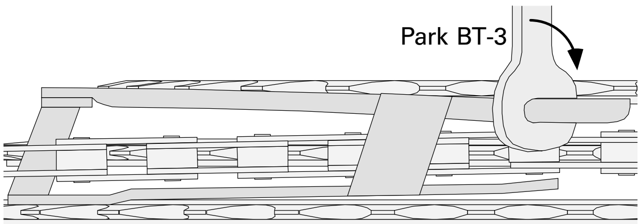
33.23 Correct chain position when checking the shift to the H chainring.

43. [ ] Put the chain in the *Y/L* position (double-chainring sets), or *Y/M* position (triple-chainring sets).

When the rider shifts to the *H* chainring, it is usually because the pedaling speed is getting too high in the current chainring. It is a false test to check the shift to this chainring while pedaling slowly. For this test, the minimum pedaling speed should be 60rpm and there is nothing unrealistic about testing the shift at 80rpm.

44. [ ] While pedaling at 60rpm or better, shift chain to *H* chainring and observe whether chain shifts promptly, or with clatter and/or hesitation.

45. [ ] If shift is too slow, use Park BT-3 to bend nose of inner cage plate closer to chain (without bending it far enough that it will rub when chain is on *H* chainring).



33.24 Bending the nose of the inner plate closer to the chain to improve the shift to the H chainring.

46. [ ] Shift chain in one chainring and check shift to *H* chainring again. If shift hesitates, toe nose further and check shift again.

Cable stressing

Cable stretch is a commonly misused term. There is really never enough force on the inner wire to actually stretch it. Somehow, however, cable systems develop slack rapidly after installation. This development of slack can compromise the indexing adjustment. What causes this slack is: the inner-wire head seats into its socket, and the housing ends and fittings seat into theirs. This can happen gradually as shifting loads are repeatedly put on the cable systems, or it can be simulated by stressing the cable system one time at a substantially higher load than normal. This over-load stressing also tests the cable system for integrity.

Since the systems will be over-loaded, it is important that the shift-control mechanism and the derailleur be in positions that can support the load. The derailleur should be at its outermost position, supported by the H-screw. The shift-control mechanism should be at its fully released position, supported by its own internal stop. To accomplish this, the lever must be operated to put the chain on the *L* chainring, and then the inner wire must be pulled manually (while pedaling) to put the chain on the *H* chainring. Once the chain is in place, stop pedaling and pull out hard on the inner wire a few times. Protect your hand from damage by using a multi-folded rag between your hand and the inner wire.

47. [ ] Make sure front shift control mechanism is fully released.

48. [ ] While pedaling, pull on exposed inner wire at down tube or top tube until chain is on *H* chainring and stop pedaling.

49. [ ] With chain still on *H* chainring, pull hard on exposed inner wire to seat cable heads and housing ends in stops and sockets, and to test integrity of pinch mechanism and cable system.

Basic cable tensioning

Coarse adjustment of the inner-wire tension is done by pulling or releasing wire through the pinch mechanism on the derailleur. Fine tuning will be done afterwards, by using the adjusting barrel on the shift-control mechanism.

50. [ ] Loosen pinch mechanism.

Before starting, the shift-control-mechanism adjusting barrel should be two full turns out from fully in, so that it can be turned in or out to loosen or tighten the inner-wire tension.

51. [ ] Set shift-control-mechanism adjusting barrel so that it is two full turns out from fully in.

The *fourth hand* is a very convenient tool for removing inner-wire slack, but it can easily make the inner wire much too tight. Watch for any outward motion of the derailleur, indicating the fourth hand tool is being squeezed too tightly.

52. [ ] Using fourth hand tool, *gently* pull slack out of inner wire, *being sure to stop before derailleur begins to move*.

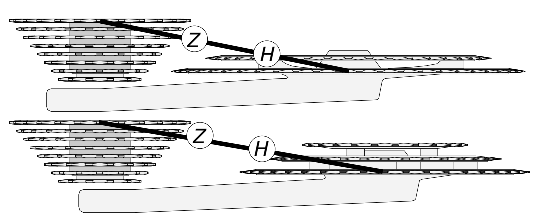
It is easy for the inner wire to slip out of its groove in the pinch mechanism while the tension is being reset. Be certain that the inner wire is in place before torquing the bolt/nut. If it is out of place, then the correct torque may not keep it secure.

53. [ ] Making sure inner wire is still seated in groove in pinch mechanism, secure pinch nut/bolt to 35in-lbs (12lbs@3").

54. [ ] Put chain in *B/H* position (double-chainring sets), or the *B/M* position (triple-chainring sets), then check shift to *L* chainring. If shift hesitates, inner wire was tightened too much in step 52.

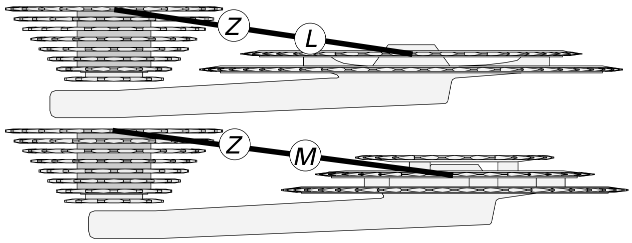
Indexing adjustment

The concept of making an index adjustment is similar to a limit-screw adjustment. There is a range of adjustments that work, but the tightest setting is best, since that allows for the greatest amount of deterioration to happen before the system becomes non-functional. The most effective approach to adjustment, therefore, is to deliberately create symptoms that the inner wire is too tight, then loosen the adjustment by small increments until the symptom is eliminated.



33.25 Starting chain position when checking the indexing adjustment.

55. [ ] Shift chain to *Z/H* position.
56. [ ] Shift chain to next chainring inward.



33.26 Final chain position when checking the indexing adjustment.

57. Check clearance between chain and inner cage plate and check one of following choices:
[ ] Chain rubs derailleur-cage inner plate, cable-adjusting barrel needs to be turned clockwise 1/4 turn.
[ ] Clearance is >.5mm, cable-adjusting barrel needs to be turned counterclockwise 1/4 turn.
[ ] Clearance is >0mm and ≤.5mm, cable tension is correct.
58. [ ] Shift chain back to *H* chainring.
59. [ ] Repeat steps 56–58 until clearance is >0mm and ≤.5mm.

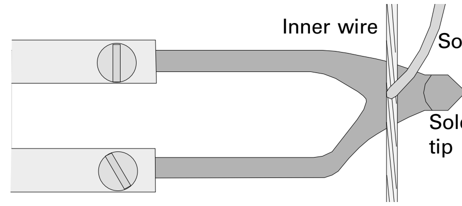
Inner-wire finish

Excess inner wire should be trimmed and finished. Excess length is unsightly and may get caught in the chain. Soldering prevents fraying, and, therefore, allows the cable to be reused whether a wire cap is used or not. Wire caps do not prevent fraying, but they do prevent someone getting poked by the wire.

The fourth hand is place on the inner wire to act as a gauge to determine how much wire to leave. This remaining wire does not need to be any more than what the fourth hand needs to grab.

60. [ ] Put fourth hand tool on inner wire as if removing slack.
61. [ ] Trim inner wire with wire cutters just past fourth-hand tool.

The next step suggests soldering the end of the wire. This is easy to do and prevents fraying. To solder, a soldering gun, thin 40/60 rosin-core solder, and soldering flux are needed. Put flux on the inner wire. Hold the soldering gun tip flat against one side of the wire until the flux sizzles away. Still holding the soldering gun tip flat against one side of the wire, hold the tip of the solder against the other side of the wire until the heated wire causes the solder to melt and flow into the wire. Some wires have are specially coated or made of stainless steel and will not accept solder. In these cases the wire will melt the solder, but the solder will not flow into the wire. Instead, it beads up and runs off the wire.



33.27 Correct soldering technique.

As an easier alternative to using soldering wire, consider using a flux/solder paste mix (Galaxy Fluxo 50/50, or similar). Apply like flux, heat up until flux stops bubbling, then wipe off while still hot. This method will work on some coated wires and stainless-steel wires that the solder-wire method does not work on.

62. [ ] Solder inner-wire end.

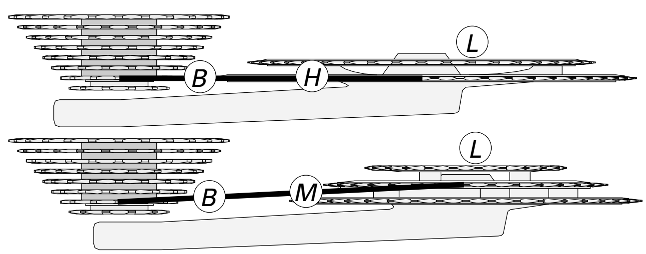
Wire-end caps are sometimes used instead of solder to prevent fraying. This will not work. Crimping the cap onto the wire frequently *causes* fraying. A soldered wire will not fray when the cap is crimped on. The real function of the wire cap is to cover the sharp end of the wire.

63. [ ] Put cap on end of inner wire if desired.

Fine-tuning shift to inner chainring

Occasionally, additional adjustment is needed to get the chain to shift quickly to the innermost chainring. The normal way to improve this shift is to sacrifice the .5–1.0mm clearance between the chain and the inner cage plate that has been set with the L-screw. Be careful; the clearance should never exceed 4mm.

The most difficult time for the chain to shift to the innermost chainring is when the chain is on the outermost portion of the rear cog set. The *B* cog is the furthest-out position that is normal for the chain to be in when shifting to the *L* chainring. When testing the shift to the *L* chainring, the correct starting position is with the chain in the *B/H* position (double-chainring sets), or the *B/M* position (triple-chainring sets).



33.28 Correct chain position to check the shift to the L chainring.

64. [ ] Put chain in *B/H* position (double-chainring sets), or *B/M* position (triple-chainring sets).

The rider will usually shift to the *L* chainring because the pedaling speed is too slow. It is unrealistic to check if the shift is too slow if the test is performed at a high pedaling speed. Too slow a pedaling speed is also unrealistic. Keep the pedaling speed close to 60rpm for the following test.

65. [ ] While pedaling at no more than 60rpm, check shift to *L* chainring.

66. Check one of following results:

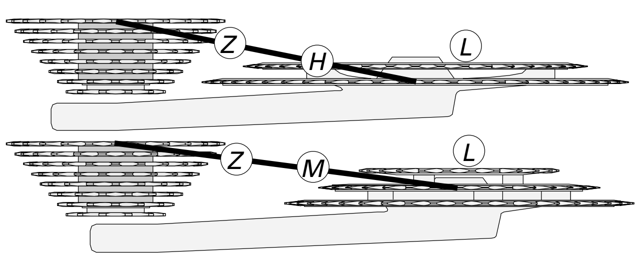
[ ] Shift hesitated, or chain did not complete shift to *L* chainring, L-screw needs to be turned 1/8 turn counterclockwise.

[ ] Shift was good, no further L-screw adjustment needed.

Often it is not possible to fully eliminate hesitation in the shift to the *L* chainring. There are three limits to how much the L screw can be loosened. First, part of the derailleur may bump into itself or the frame, in which case further loosening of the limit screw will not result in additional inward motion of the derailleur. Second, the cable tension, which has already been set for optimal indexing, may create an inner limit that is more restrictive than the screw. Consider a slightly looser indexing adjustment to allow a looser L-screw setting. In both these cases, stop adjusting the screw when the derailleur stops responding with additional inward motion. If the shift is still unacceptable, examine other factors, such as derailleur height and rotation. Third, if the inside clearance in the *Z/L* gear combination exceeds 4mm, stop loosening the screw, because more clearance than 4mm is certain to cause an overshift to occur.

67. [ ] Repeat step 65, and 66 if necessary, until shift is good. Stop if derailleur does not move further, or if chain/inner-cage-plate clearance reaches 4mm (with chain in *Z/L* position).

After loosening the L-screw to improve a hesitant shift to the *L* chainring, it is important to check that the chain does not then over-shift when in other gear combinations. If the L-screw is too loose, the chain will try to shift in past the *L* chainring. This is most likely to occur when the chain is on the inner portion of the rear cog set, because this position for the chain encourages inward motion of the chain. Put the chain in the *Z/H* position (double-chainring sets), or the *Z/M* position (triple-chainring sets) to test the chain's tendency to shift in past the *L* chainring.



33.29 *Correct chain position when checking for an over-shift to the L chainring.*

68. [ ] Shift chain to *Z/H* position (double-chainring sets), or to *Z/M* position (triple-chainring sets).

69. [ ] While pedaling at no more than 60rpm, shift chain repeatedly to *L* chainring to check for tendency of chain to shift too far.

If there is not an L-screw setting that eliminates slow shifting without introducing over-shifting, then there is a likely problem with chainline (chainrings are too far out). It could also be that the tail of the derailleur cage needs to be customized (widened) to reduce the tendency to over-shift.

70. Check one of following options:

[ ] Chain shows no tendency to over-shift in step 69, L-screw setting is final.

[ ] Chain does show tendency to over-shift in step 69, chainline should be checked and modifying width of tail of derailleur cage should be considered.

TESTING INDEX PERFORMANCE

The performance of any indexing front-derailleur system can be tested and measured. The procedures described above are designed to set the indexing adjustment at *the tightest setting that allows for good shifting*. If the indexing system has normal performance, then there are probably looser settings for the cable that also allow proper shifts into all the gears. The range of adjusting-barrel positions from the tightest that provides good shifting to the loosest that will allow shifting into all the gears is called the *Functional Range of Adjustment* (or FRA).

The performance of all systems deteriorates with wear and the accumulation of dirt. When the FRA is narrow, it will take only a small amount of riding before service is needed to restore acceptable shifting. When the FRA is extremely narrow, finding a correct adjustment at all is challenging. When the FRA is broad, it will take much longer before service is needed. Therefore, it is to the rider's and the mechanic's advantage for the system to have a broad FRA.

There are two reasons to measure the FRA. First, it enables an accurate determination of whether parts might need replacement or cleaning on a used system. Second, it permits an evaluation of whether a non-recommended part negatively affects indexing performance.

There is no absolute value for an appropriate FRA. It varies with the brand and quality of equipment, as well as some other factors. For popular systems, an FRA of about two quarter turns of the cable-adjusting barrel should be expected of new equipment. One of the most critical things to getting a decent FRA is proper rotational alignment of the derailleur.

If evaluating properly set-up used equipment that all meets manufacturer's specifications for compatibility, and the FRA is not at least two quarter turns, then something in the system needs to be cleaned or replaced.

If evaluating any equipment, used or new, that *does not* meet manufacturer's specifications for compatibility and the FRA is not at least two quarter turns, then the non-matched equipment probably needs to be replaced.

If considering installing equipment on a system that may not be compatible, measure the FRA before the change, and again afterwards. If it is reduced, then the equipment change will downgrade shift performance. If it is still above one quarter turn, then it may be acceptable even though it is a downgrade of performance. This test process applies to mis-matching chains, derailleurs and shifters, cable systems, and even derailleurs with chainring sets.

MEASURING THE FUNCTIONAL RANGE OF ADJUSTMENT (FRA)

1. [ ] Perform an index adjustment using steps 55–59 of the *INSTALLATION AND ADJUSTMENT* procedure for front derailleurs (page 33-17).

2. [ ] Turn cable-adjusting barrel in 1/4 turn.

3. [ ] Shift chain to *A/H* position.

4. Check for chain rubbing outer cage plate and check one of following options:
[ ] No rub, shift chain back to *M* chainring and repeat steps 2–4.
[ ] Chain rubs, inner-wire tension is too loose, record number of turns to create too loose symptom here: _____ quarter turns.

5. [ ] If measuring FRA to evaluate a component change, install new component and repeats steps 1–4.

FRONT-DERAILLEUR SERVICE

The only service performed on front derailleurs is removal and cleaning of the fully-assembled derailleur; most front derailleurs are not designed to be disassembled to any significant degree. It is a good idea to perform a few inspections before installing the derailleur. Before installing the derailleur, inspect for cracks in the mounting clamp and roughness or gouges in the inner cage plate.

FRONT-DERAILLEUR TROUBLESHOOTING

Cause	*Solution*
SYMPTOM: *The shift to the H chainring is slow.*	
Inner wire is not tight enough.	Shift to *L* chainring and check inner-wire tension.
The inner-cage-plate nose needs toe adjustment.	Trying bending inner cage-plate nose toward chain.
The H-screw is too tight. This is only the cause if the chain is also rubbing the outer cage plate when the chain is in the *A/H* position.	Loosen H-screw only enough to create up to 1.0mm clearance between chain and outer cage plate (when the chain is in the *A/H* position).
The derailleur is mounted too high.	Check and correct derailleur height.
The chainring teeth are worn out.	Compare teeth to a new chainring of the same type.
The inner cage plate is chewed up.	Inspect plate and replace the derailleur if the cage plate is damaged.
SYMPTOM: *The chain is shifting past the H chainring.*	
If the derailleur rotation is correct, then the H-screw is too loose.	Check derailleur rotation, and tighten H-screw to create no more than 1.0mm clearance between the cage and the outer cage plate (when the chain is in the *A/H* position).
If the clearance between the chain and the outer cage plate is correct, then the derailleur is positioned with the tail rotated too far in.	Check and correct derailleur rotation, then set limit screws and cable tension again.

(Continued next page)

FRONT-DERAILLEUR TROUBLESHOOTING (continued)

Cause	Solution
SYMPTOM: *The chain rubs the outer cage plate continuously when the chain is in the A/H position.*	
The H-screw setting is too tight.	Adjust the H-screw so that the chain clears the outer cage plate by at least .5mm.
The inner-wire tension is too low on an indexing derailleur.	Follow the recommended procedure to set the indexing adjustment for the front derailleur.
SYMPTOM: *The chain rubs the outer cage plate intermittently.*	
The chainrings are out of true.	Check and align the chainrings until they wobble less than .5mm.
If clearance is good when checked in the bike stand, then the chainrings, bottom-bracket spindle, and/or frame are flexing under load.	No adjustment can be made to correct this condition.
There is play in the bottom-bracket bearings.	Check and adjust the bottom bracket.
SYMPTOM: *When the H-screw is loosened to eliminate a rub between the chain and outer cage plate, a rub develops between the chain and the inner cage plate.*	
The derailleur's rotational alignment is wrong.	Check and align the derailleur's rotation so that the outer cage plate is parallel to the chain when the chain is in the *A/H* position.
The chainrings have too much wobble.	Check and align the chainrings.
The nose of the inner cage plate is toed towards the chain too much.	Reduce the inner-cage-plate-nose toe and check whether the shift to the *H* chainring is still good when the chain is on the *Y* cog in the rear.
SYMPTOM: *The shift to the L chainring is slow.*	
The L-screw is too tight.	Loosen the L-screw by 1/8 turn increments until the shift improves.
The inner-wire tension is too tight.	Check and adjust the inner-wire tension.
The derailleur rotation is wrong, with the tail of the derailleur too far out compared to the nose.	Check and align the derailleur's rotation so that the outer cage plate is parallel to the chain (when the chain is in the *A/H* position).
The derailleur is too high, particularly if the chainring set is a triple.	Check and correct derailleur height.
There is excess friction in the cable system.	Remove, inspect, and correct any problems with the cable system.
The derailleur is fouled with dirt.	Remove and clean the derailleur.
SYMPTOM: *Loosening the L-screw makes no improvement in the slow shift of the chain to the L chainring.*	
The inner-wire tension is too tight.	Check and adjust the inner-wire tension.
The chainrings are too close to the frame and some part of the derailleur is bumping into the seat tube or itself before the cage has moved far enough.	Check for interference between the frame and the bottom inside pivot of the derailleur's parallelogram, or for a fully compressed parallelogram; if interference exists, replace the bottom bracket with one that moves the chainrings as far out as chainline will allow.
The derailleur is fouled with dirt.	Remove and clean the derailleur.

(Continued next page)

SYMPTOM: *The chain is shifting past the L chainring.*	
The L-screw is too loose.	Tighten the L-screw by 1/8 turn increments until symptom goes away.
If tightening the L-screw results in the chain being slow to shift to the *L* chainring without eliminating the over-shift, then the chainline is off (with the chainrings too far out relative to the rear cogs).	Check and correct the chainline error.
SYMPTOM: *When the L-screw is loosened approximately 1/8 turn to eliminate a slow shift to the L chainring, then the chain develops a tendency to shift past the L chainring.*	
The chainline is off, with the chainrings too far out relative to the rear cogs.	Check and correct the chainline error.
The rotation of the derailleur is wrong, with the tail end too far in compared to the nose.	Check and align the derailleur's rotation so that the outer cage plate is parallel to the chain (when the chain is in the *A/H* position).
The tail of the derailleur cage is too narrow.	Widen the tail of the cage by changing spacers, or by bending the tail end of the outer plate.
SYMPTOM: *The chain rubs the inner cage plate continuously when the chain is in the Z/L position.*	
The L-screw is too tight.	Loosen the L-screw.
The inner-wire tension is too tight.	Check and loosen the inner-wire tension.
There is excess friction in the cable system.	Remove, inspect, and correct problems in cable system.
SYMPTOM: *The rubs the inner cage plate intermittently when the chain is in the Z/L position.*	
Chainring wobble is excessive.	Check and align chainrings.
SYMPTOM: *The chain rubs the outer cage plate when the chain is on the L chainring and one of the outer rear cogs.*	
The L-screw is too loose.	Tighten the L-screw as much as possible without creating a slow shift to the *L* chainring, or a rub between the chain and inner cage plate (when the chain is in the *Z/L* position).
The derailleur's rotational alignment is off, with the tail too far in compared to the nose.	Check and align the derailleur's rotation so that the outer cage plate is parallel to the chain (when the chain is in the *A/H* position).
If the derailleur is non-indexing, it may not be designed to clear the chain in all gear combinations without its position being manually trimmed.	The operator needs to trim the cage position with the shift-control mechanism.
The tail of the derailleur cage is too narrow for the gear set-up and bike.	Add spacers to the tail of the cage or deform the outer plate at the tail end to widen the tail end of the cage.
SYMPTOM: *The shift from the L chainring to the M chainring is slow.*	
Inner-wire tension is too low if the derailleur is indexing.	Check the indexing adjustment of the front derailleur.
The teeth on the *M* chainring are worn out.	Compare teeth to a new chainring of the same type.
SYMPTOM: *The shift from the H chainring to the M chainring is slow.*	
Inner-wire tension is too tight if the derailleur is indexing.	Check the indexing adjustment of the front derailleur.
There is excess friction in the cable system.	Remove, inspect, and correct problems in the cable system.
The derailleur is fouled with dirt.	Remove and clean the derailleur.

(Continued next page)

FRONT-DERAILLEUR TROUBLESHOOTING (continued)

Cause	Solution
SYMPTOM: *The chain rubs the inner cage plate after shifting to the M chainring (the derailleur is indexing).*	
Inner-wire tension is too tight if the derailleur is indexing.	Check the indexing adjustment of the front derailleur.
There is excess friction in the cable system.	Remove, inspect, and correct problems in cable system.
The derailleur is fouled with dirt.	Remove and clean the derailleur.
SYMPTOM: *The chain rubs the outer cage plate when the chain is on the M chainring and is shifted to one of the outer rear cogs.*	
If the derailleur is indexing, the inner-wire tension is too low.	Check and correct the indexing adjustment.
The derailleur's rotational alignment is off, with the tail too far in compared to the nose.	Check and align the derailleur's rotation so that the outer cage plate is parallel to the chain (when the chain is in the *A/H* position).
If the derailleur is non-indexing, it may not be designed to clear the chain in all gear combinations without its position being manually trimmed.	The operator needs to trim the cage position with the shift-control mechanism.
The tail of the derailleur cage is too narrow for the gear set-up and bike.	Add spacers to the tail of the cage, or deform the outer plate at the tail end to widen the tail end of the cage.
SYMPTOM: *There is a tick once per crank revolution, whenever the chain is on the H chainring.*	
The tail of the derailleur cage is interfering with the crank arm.	The H-screw is too loose, or the derailleur is rotated with the tail too far out.
SYMPTOM: *The tail of the derailleur cage hits the crank arm when the derailleur is properly rotated and the H-screw setting is correct.*	
The crankset does not provide enough clearance between the arm and the outer chainring for the derailleur being used.	Change derailleurs to one with a flatter outer cage plate (no tail offset), or compromise the rotational alignment of the derailleur (check for ill consequences if the compromise is made).
SYMPTOM: *There is a continuous scraping sound when the chain is on the H chainring, but the chain is not rubbing either cage plate.*	
The minimum capacity of the derailleur has been exceeded, and the teeth of the next-to-outermost chainring are rubbing on the inner cage plate.	Change the derailleur or the size of the next-to-outermost chainring.
The outer cage plate is rubbing on a chainring guard.	Remove the chainring guard or compromise the derailleur height or rotation (check for ill consequences if the compromise is made).
SYMPTOM: *The chain drags over the cross-piece at the tail of the derailleur cage when the chain is in the A/L position.*	
Chain is dangling when there is no load.	If the symptom only occurs when chain is not under load, it is not a problem.
Derailleur is mounted too high.	Check and correct derailleur-mounting height.
If symptom occurs when derailleur height is correct and there is load on the chain, the maximum capacity of derailleur has been exceeded.	Change the derailleur to one that can handle the difference in largest and smallest chainring sizes, or change size of chainrings so that the difference is within the capacity of the derailleur being used.

EIGHT- AND NINE-SPEED COMPATIBILITY

COMPONENT COMPATIBILITY

The narrower chain and chainring spacing used in the Shimano nine-speed drive trains requires a narrower front derailleur cage for optimal performance. Therefore, Shimano derailleurs marked "Mega-9" are not fully interchangeable with other Shimano derailleurs.

Mega-9 front derailleurs have the same actuation ratio (the amount the derailleur moves for a given amount of cable movement), so there is full compatibility between all Shimano MTB front derailleurs and Shimano MTB front shift levers.

While there is no problem mixing shift levers and derailleurs there is a problem with mixing a Mega-9 front derailleur with a chain that is not nine-speed type. Obvious rubbing will occur that cannot be eliminated by any adjustment.

As long as the chain is changed also, excellent results can be attained when using a Mega-9 front derailleur on a Shimano chainring set that is not nine-speed spacing. Since the nine-speed chain works with all cog sets, this is a very acceptable mix of components.

The reverse combination of using a front derailleur that is not Mega-9 on a full nine-speed drive train will work, but you should expect a compromise in performance. In particular, the shift from the middle chainring to the inner chainring will be slow and unpredictable.

CHAINRING SIZE CAPACITY

In addition to the component compatibility issues, it is important to keep in mind that Mega-9 models of derailleurs sometimes have different minimum and maximum-tooth-difference ratings than the earlier version of the same derailleur. This is due to the fact that at the same time that Shimano introduced nine-speed drive trains, they also switched from compact chainring sets to "Mega" sized chainring sets. For example, the older seven- or eight-speed Deore LX model FD-M567 is rated for a minimum chainring size difference of 10 teeth and the matching crankset is a 22-32-42 configuration, but the more current Mega-9 type Deore LX model FD-M570 is rated for a minimum difference of 12 teeth. Consequently, the FD-M570 will not work on the older crankset, regardless of nine-speed issues.