PACCAR

Service Manual

SM016-039

(01/ 2023)

Front Suspension

Kenworth
• T680 • T880 • W990
Peterbilt
• 365 • 367 • 389 • 520 • 567 • 579

Kenworth
• T180 • T280 • T380 • T480
Peterbilt
• 535 • 536 • 537 • 548

Chapter 8 | Maintenance

Inspection

For all vehicles, mandatory maintenance procedures include retightening all U–bolts and inspecting the suspension for loose fasteners, abnormal wear, or damage. However, even with proper maintenance, the service life of the leaf springs is affected by many factors, such as fatigue, vehicle gross weight, type of load, road conditions, and vehicle speed. Check for cracks, wear marks, splits, or other defects on the spring surface. Defective parts must be replaced. Because repaired springs cannot be fully restored to their original service life, replace the complete assembly if cracks or other defects are detected.

General Inspection

- Check shackle side clearance and adjust if necessary.
- Visually inspect front springs. Check for cracks, rust nicks, and unusual wear patterns or spring scrubbing.
- Visually inspect shock absorbers and rubber bushings.
- Check front axle U-bolt torque. Refer to *Suspension Torque* to see U-bolt torque specifications.
- Check shock absorbers for proper action. Examine the body of the shock absorber. Fully extend and compress it. If any dents, signs of warping, or fluid leakage is detected, replace the shock absorber (refer to Assembly/Disassembly).

Shock Absorber Inspection

- Inspect the mounting brackets for loose, worn, bent, or broken parts.

> i NOTE
>
> Install beveled washers with the bevel facing away from the shock absorber, which allows the rubber bushing in the shock absorber mount to flex and absorb lateral forces as designed.

- To test the shock absorber perform a post driving thermal test in addition to visual checks. Check for fluid drips or lines of fluid onto the shock absorber body. Replace shock absorber if there is any unusual fluid loss or unusual noises.

  > i NOTE
  >
  > Minor fluid coating on the outside of the shock is acceptable and is not a warrantable failure.

- If the shock absorber is tested off the vehicle, make sure tests are performed with the shock absorber in the same orientation as when operating on the vehicle. Upside down or horizontal testing may trap air and give false results.
- If a shock absorber needs replacement, always replace both shock absorbers (left and right) at the same time. If one shock absorber has worn out, the other is usually not far behind. If a shock absorber fails early (less than 25,000 miles), the problem may be a manufacturing defect. In this case, only one shock absorber needs to be replaced.

Air Spring and Height Control Valve Inspection

1. Visually inspect the air springs for the following:
   - Oil
   - Hydraulic fluid

- Surface contamination
- Cracks on surface
- Unusual wear patterns

2. Visually inspect the height control valve for the following:

- Dirt or contamination
- Hoses misconnected
- Linkage damaged

i NOTE
Look for drip or lines of fluid. Minor fluid coating on the outside is acceptable.

Bushing Lubrication

i NOTE
Before lubricating perform all inspection and measurement tasks.

- If equipped with greasable spring pin bushings, grease all spring pins with approved chassis grease until it flows out of both ends of the bushing. Look for signs of rust or water in the flushed grease. If a pin is not greasable, remove, clean, and inspect it.
- Make sure the grease groove and the grease hole are clear. Clean bushing, pre-lube pin, and install.
- Grease until grease flows out from both ends of the bushing.

Ackermann Angle

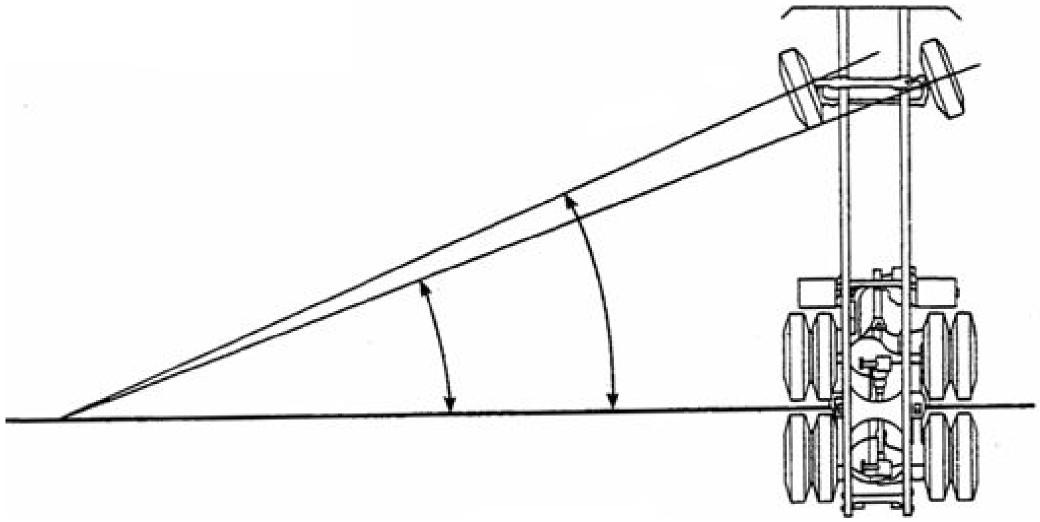
Ackermann angle is the geometry of the four bar linkage consisting of the front axle, two knuckle assemblies, and tie rod assembly. It is designed to provide free rolling of front tire in a turn. Ackermann geometry is dependent upon the steering axle track-width and wheelbase of the vehicle.

Ackermann geometry causes both spindle center lines to intersect at the same point in conjunction with the centerline of the rear, (single) axle or mid-point of tandem axles. Inside the tire on a turn has a shorter turn radius than the tire on the outside.

Characteristics:

- Prevents excessive front tire scrubbing on turns
- Forces rear axles to articulate, on bushings
- Produces reduced amount of rear tire scrub
- Checked during wheel alignment

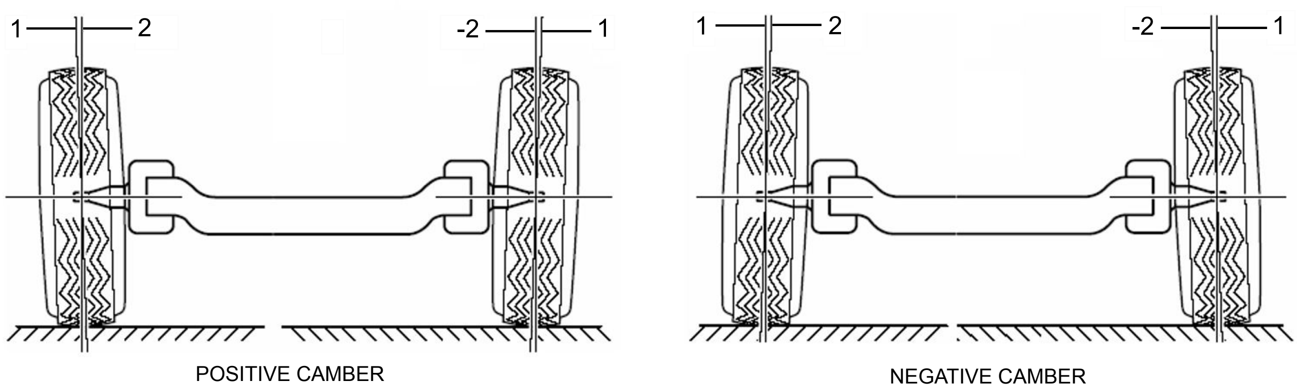
Figure 26: Ackermann Angle Diagram



Camber

Camber is the angle formed by the inward or outward tilt of the wheel reference to a vertical line. Camber is positive when the wheel is tilted outward at the top and is negative when the wheel is tilted inward at the top.

Figure 27: Camber Diagram



The camber angle is built into axles and is not adjustable. The camber angle:

- Reduces side thrust
- Compensates for wear on steering knuckle
- Compensates for wear on wheel bearings
- Shifts weight to inner wheel bearing
- Used along with caster to correct pulling due to road crown

An incorrect camber can cause:

- Excessive tire wear
- Wander (pulls to side with most positive camber)
- Hard steering
- Excessive tire heat

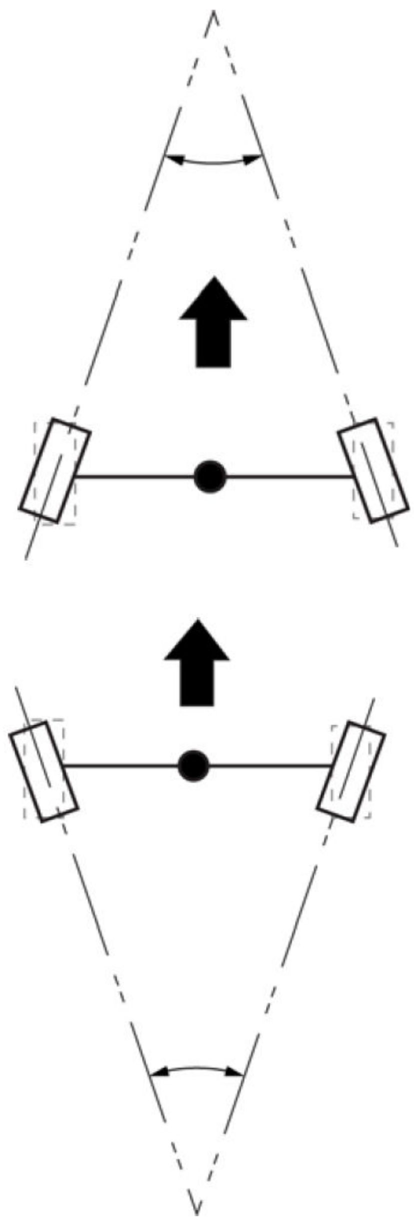
Toe

Toe-in is when the wheels are closer together in the front than in the back. Excessive toe-in wears the outside edge of the tires.

Toe-out is when the wheels are closer together in the back than in the front. Excessive toe-out wears the inside edge of the tires.

Total toe is the sum of the toe-in for the left side and toe-in for the right side of the steer axle.

Figure 28: Toe Diagram

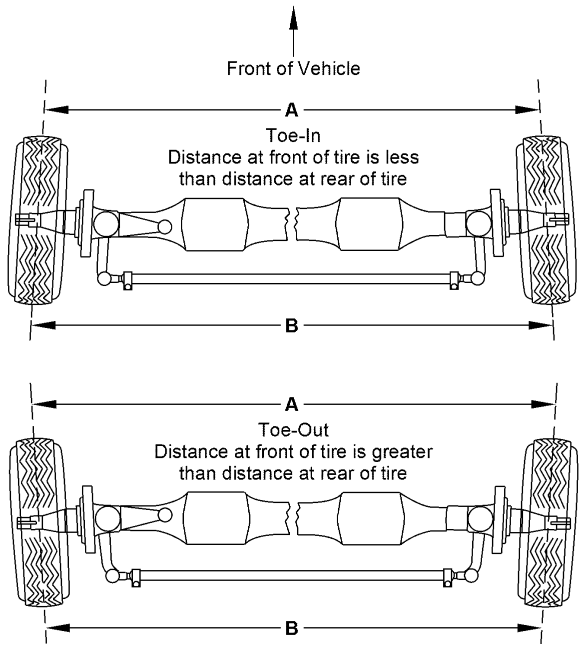


> **NOTE**
>
> A toe-in condition causes tires to show a feathered condition that when felt by hand, feels smooth from the outside to the inside. Inversely, a toe-out condition will feather and feel smooth from the inside to the outside of the tire.

Toe Setting

> **NOTE**
>
> For toe setting specifications, see *Specifications for Wheel Alignment* on page 70.

1. Use a work bay with a level floor.
2. Drive the vehicle into bay slowly and straight ahead. Try to roll to a stop without the use of brakes.
3. Chock the rear wheels.
4. Place a 5" (127 mm) long piece of masking tape parallel to the center tread rib on the rear of both tires, midway the tire height.
5. Position a trammel bar behind the front tires. The pointers should be raised/lowered until they are at the hub's centerline height.
6. With the trammel bar pointers at the hub's centerline height, place the pointers at the outside edges of the masking tape and secure the pointer set screws.
7. Mark the location of one of the pointers with a simple horizontal mark on the masking tape.
8. Remove the trammel bars from behind the wheels.
9. Roll the truck forward until the mark on the tape travels 180º.
10. Position the trammel bar at the front of the tires. Position the pointer to the edge of the tape on the side that has the horizontal mark. The pointer and the mark should be at the same height.
11. Measure the toe between the pointer and the edge of the tape on the opposite tire to get the total toe measurement.
12. If the toe measurement is incorrect, loosen the tube clamp and bolt on the end of each of the cross tubes. Turn the cross tubes until the specified distance is reached.
13. Make sure the threaded portion of the tie ends are inserted completely and are visible in the complete cross tube slot. Tighten the bolt and nut on the ends of the cross tube to the specified torque.
14. Check the toe settings again.



Total Toe for Front Driving Axles

The total toe for front driving steer axles that are not full time must be as follows:

Toe-in 0.06 in., 0.08°, or 1.4 mm/m. The tolerance should be ±0.04 in., ±0.05°, or ±0.9 mm/m. Use of tighter tolerances (narrow gaging) specified is acceptable and recommended if the alignment is being done without full floating (3 axis) turnplates.

The total toe for front driving steer axles that are full time must be as follows:

Toe-out 0.06 in., 0.08°, or 1.4 mm/m. The tolerance should be ±0.04 in., ±0.05°, or ±0.9 mm/m. Use of tighter tolerances (narrow gaging) specified is acceptable and recommended if the alignment is being done without full floating (3 axis) turnplates.

Total Toe, GNK Front Driving Axles

The total toe for GNK front driving steer axles should be as follows:

Toe-in 0.03 in., 0.04°, or 0.7 mm/m. The tolerance should be ±0.04 in., ±0.05°, or ±0.9 mm/m. Use of tighter tolerances (narrow gaging) specified is acceptable and recommended if the alignment is being done without full floating (3 axis) turnplates.

Total Toe Sisu Front Driving Axles

The total toe for Sisu front driving steer axles should be as follows:

Toe-in 0.0 in., 0.01°, or 0.01 mm/m. The tolerance should be ±0.04 in., ±0.05°, or ±0.9 mm/m. Use of tighter tolerances (narrow gaging) specified is acceptable and recommended if the alignment is being done without full floating (3 axis) turnplates.

Total Toe for Non-Driving Axles

Refer to DealerNet for total toe values and their tolerances.

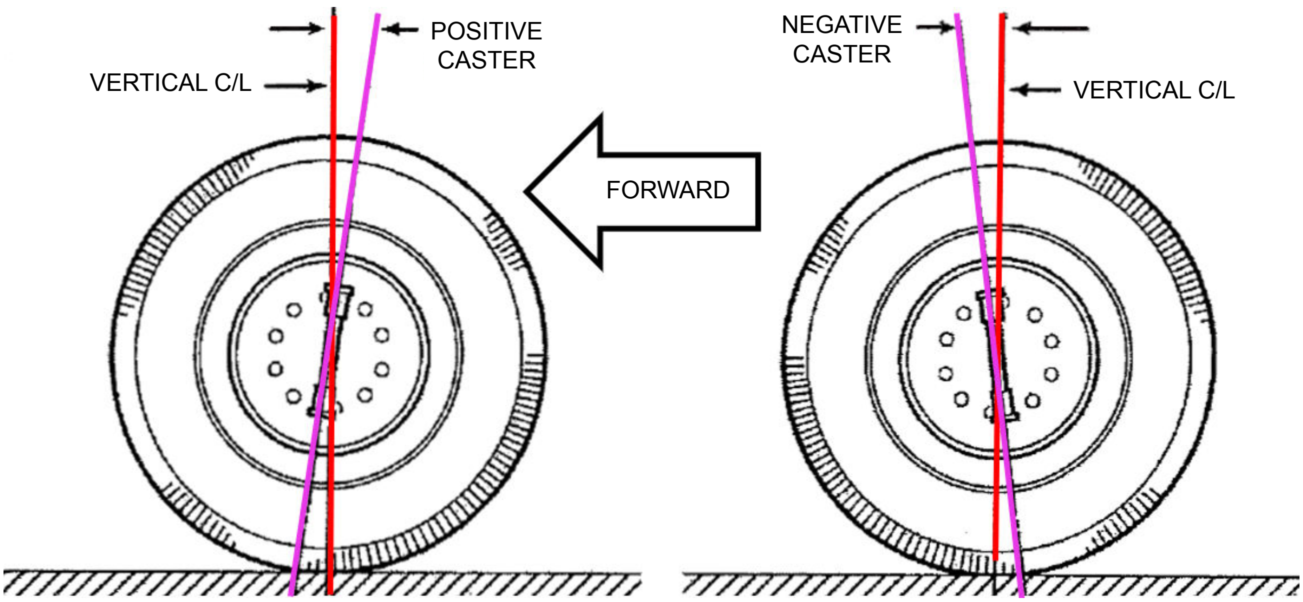
NOTE

The tie rod may be turned for adjustment. After adjusting the clamps, the tie rod should be tightened to the torque values shown in *Tie-Rod Clamp Bolt Torque Values* on page 69.

Caster

Caster is the forward or rearward tilt of the steering axle kingpin in reference to a vertical line. The angle is measured in degrees. Caster is positive when the top of the steering axis is tilted rearward and is negative when the tilt is forward.

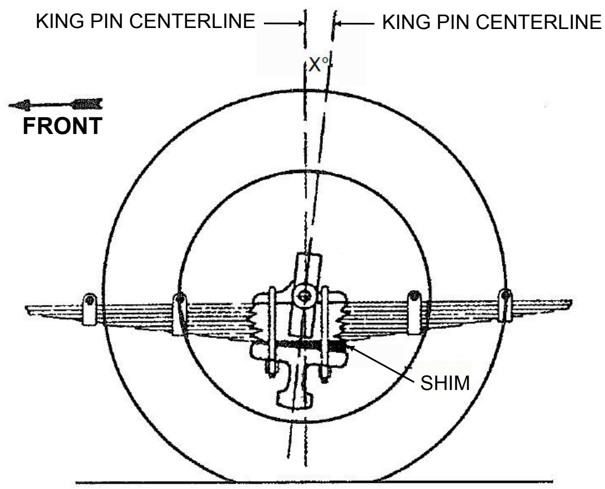
Figure 29: Caster Positive and Negative Diagram



Some characteristics of the caster are:

- Springs and spacer blocks have positive caster built-in.
- Caster wedges are used for corrections after manufacturing.
- Incorrect caster usually does not affect tire wear.
- Adds straight-ahead stability.
- Provide self-aligning forces for steer tires.
- Stabilizes vehicle when braking and accelerating.

Figure 30: Caster Front Diagram



Excessive positive caster can cause shimmy, excessive steering effort, and is normally a vehicle performance and handling consideration. Uneven positive caster may create a steering pull towards the side of the lower caster.

Caster Adjustment

Shims should be installed in combinations to adjust caster to the nearest 0.25°. Tapered shims are available with 0.5°, 0.75°, 1°, 1.5°, 2.5°, and 4.0° of taper.

Shims must be installed between the spring and spacer block or between the spring and axle for suspensions without spacer block.

A minimum number of shims must be used for the installation.

To increase the caster angle, increase the rearward shim or decrease the forward shim thickness.

Both the forward and the rear U-bolts on a spring should be tightened in sequential increments to maintain uniform caster angle. Caster angle should be varied as much as 0.5° by the sequence of tightening the front spring U-bolts.

The side to side difference in caster must be 1° maximum. Right-hand caster should always be equal to or greater than left-hand caster.

See *Caster Specifications*.

Kingpin Inclination

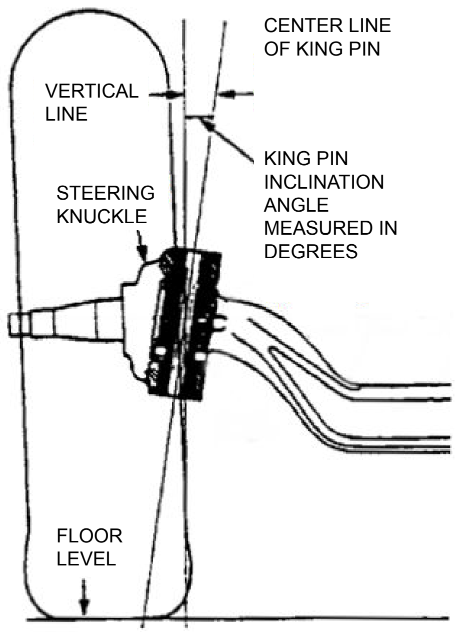
The kingpin inclination is the inward tilt of the kingpin from the vertical. This front suspension parameter has a pronounced effect on steering effort and returnability. As the front wheels are turned around an inclined kingpin, the front of the truck is lifted. This lifting of the vehicle is experienced as steering effort when the turn is executed and exhibits itself as recovery force when the steering wheel is released.

Kingpin inclination characteristics:

- The kingpin is inclined from a vertical position toward the chassis centerline at the top and outward at the bottom.
- Helps to place the center of the tire contact patch close to the kingpin pivot at the ground.

- Helps with steering to return to neutral position after a turn.
- Built into axle and is not adjustable.
- In turns, steering geometry will cause vehicle to lean into turn.
- Causes vehicles center of gravity to change.
- Center of gravity and vehicle leaning will help to force vehicle back to straight ahead after turn.

Figure 31: Kingpin Inclination Diagram

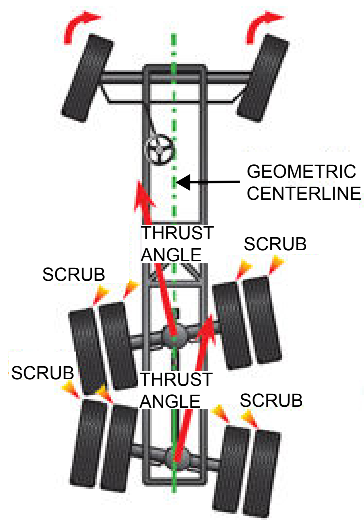


Thrust Angle

Thrust angle is formed by the centerline of the vehicle frame (geometric centerline) and the direction that an axle points. The ideal value for the angle is 0° or when the axle centerline is at 90° or perpendicular to the geometric centerline.

A steering correction is required to offset the effect of the thrust angles and keeps the vehicle traveling in a straight line.

Figure 32: Thrust Angle Diagram

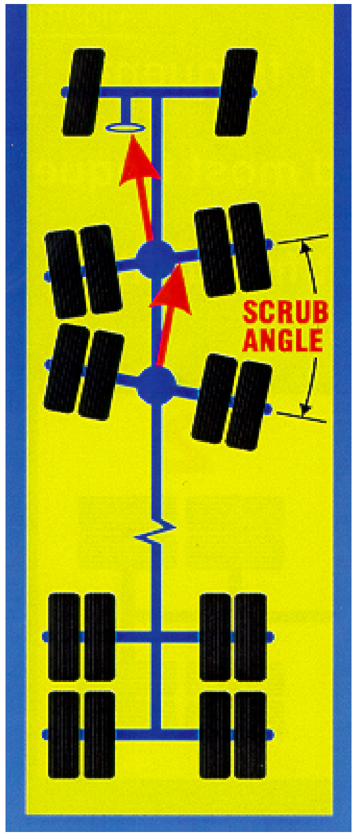


Scrub Angle or Parallelism

As indicated by the term parallelism, the ideal condition is when the two thrust lines form a 0° angle, or are parallel to each other. Positive skew or tram is when the distance between the right axle ends is less than the distance between the left.

Any scrub angle other than 0° will cause the tandem axles to work against each other. The steer axle must be turned to offset the push of the tandem axles to keep the vehicle moving straight ahead. This causes every tire on the vehicle to scrub.

Figure 33: Scrub Angle or Parallelism Diagram



NOTE

Thrust and tandem scrub will cause steer tires "with 0 toe" to show same sided feathered wear or one tire will appear toed in and one will appear toed out.

- If the steer axle is toed out with a right thrust, then the left steer axle tire will show a feathered toe out type wear and the right tire will wear evenly.
- If the steer axle is toed in, then a right thrust will cause the right steer tire to show a toed in feathered wear while the left tire will wear evenly.

Adjusting Peterbilt Front Air Leaf Spring Ride Height

The ride height for the Peterbilt front Air Leaf suspension is controlled by setting the spacing between the centerlines of the upper and lower shock studs. A go/no-go gauge is available for checking this spacing; however, a tape measure can be used if the gauge is not available.

For vehicles with 3.5 in. (88.9 mm.) drop axles, the above procedure will set the ride height of the Peterbilt front Air Leaf suspension to be 9 - 9.5 in. (228.6-241.3 mm.) plus the thickness of any spacer installed between the axle and leaf spring.

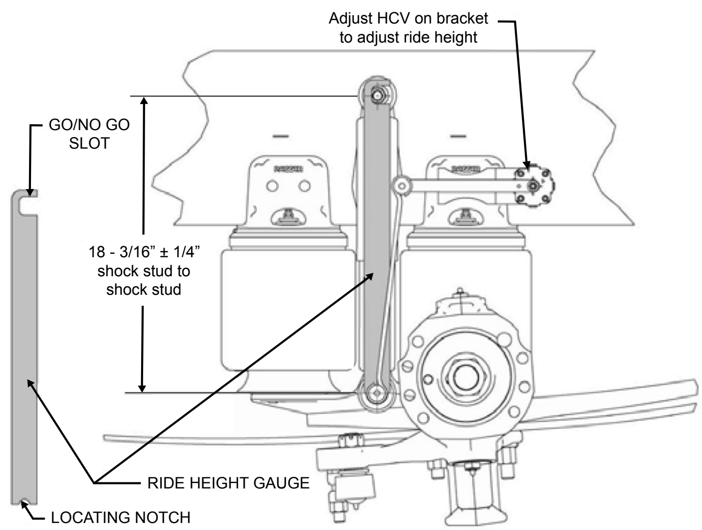
For 5 in. (127mm) drop axles, the resulting ride height will be 7.5-8 in. (190.5-203.2 mm.) plus the thickness of the installed spacer. Ride height is defined as the vertical distance from the bottom of the frame rail to the intersection of the spindle and kingpin axes.

1. Measure the distance from the centerline of the upper shock stud to the centerline of the lower shock stud using a tape measure. This distance should be 17 15/16 - 18 7/16 in. (455.6 - 468.3 mm). This spacing is correct regardless of the spacers installed between the leaf spring and axle, or the axle drop configuration 3.5 in. or 5 in. (88.9 mm. or 127 mm). If

the stud spacing is not within the specified range, adjust ride height. Proceed to step 2. If using the gauge, place the locating notch of the gauge on the end of the upper or lower shock stud and rotate the gauge until the end of the other stud slips into the go/no-go slot at the opposite end of the gauge. If the stud slips into the slot, ride height is set correctly. If the stud does not slip into the slot, ride height adjustment is needed, proceed to step 2.

2. Loosen the 0.25 in. (6.35 mm) nuts that secure the HCV to the HCV mounting bracket.
3. Rotate the HCV on the bracket while monitoring the stud spacing with the tape measure or ride height gauge. When the stud spacing is correct, secure the position of the HCV on the bracket by retightening the 0.25 in. (6.35 mm) nuts.

Figure 34: Front Air Leaf Spring Ride Height Adjustment



Adjusting Kenworth AG130 Ride Height

The ride height for the Kenworth AG130 suspension is controlled by setting the spacing between the center-lines of the upper and lower shock studs.

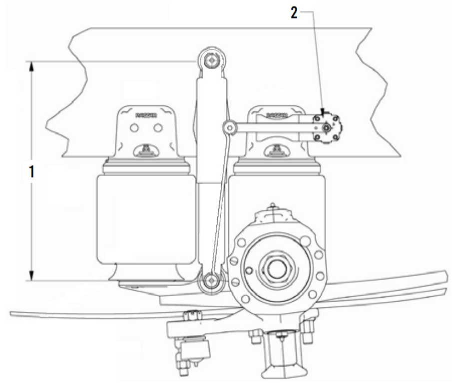
For vehicles with 3.5 in. (88.9 mm) drop axles, the above procedure will set the ride height of the AG130 suspension at 10 - 10.5 in. (254 - 266.7 mm) plus the thickness of any spacer installed between the axle and leaf spring.

For 5 in. drop axles, the resulting ride height will be 8.5 - 9 in. (215.9 - 228.6 mm) plus the thickness of the installed spacer. Ride height is defined as the vertical distance from the bottom of the frame rail to the intersection of the spindle and kingpin axes.

1. Measure the distance from the center-line of the upper shock stud to the center-line of the lower shock stud using a tape measure. This distance should be 17 15/16 - 18 7/16 in. (455.6 - 468.3 mm). This spacing is correct regardless of the spacers installed between the leaf spring and axle, or the axle drop configuration 3.5 in. or 5 in. (88.9 mm or 127 mm). If the stud spacing is not within the specified, adjust ride height. Proceed to step 2.
2. Loosen the 0.25 in. (6.35 mm) nuts that secure the height control valve HVC to the HCV mounting bracket.

3. Rotate the HCV on the bracket while monitoring the stud spacing with the tape measure or ride height gauge. When the stud spacing is correct, secure the position of the HCV on the bracket by retightening the 0.25 in. (6.35 mm) nuts.

Figure 35: Ride Height Adjustment



Leveling Front Taper-Leaf Suspension

1. Loosen the shackle bushing pinch bolts at the same time and allow the bushings to relax.
2. Assure the chassis weight is loaded by the suspension for the bushings to properly settle.
3. Torque the pinch bolts.
4. Reset the ride height.
5. Check the shock stud distance and adjust ride height if necessary.
   Refer to *Adjusting Peterbilt Front Air Leaf Spring Ride Height* on page 88 or *Adjusting Kenworth AG130 Ride Height* on page 89.
6. Measure the saddle height on each side from the bottom of the frame rail to the top of the saddle between the air springs. The saddle height should be 0.375 - 0.75 in. (9.5 - 19.0 mm).
7. If the saddle height is not within specification, add one spacer to the side with the greater saddle height.

i NOTE
For 10 mm use B80-1005-1000 and for 20 mm use B80-1005-2000 spacer between the spring and axle.

Leveling Front Air Leaf Suspension/AG130 Front Air Suspension

Before making any changes to level the front end, test drive the truck and determine if there is any tendency for the truck to pull left or right. If there is any significant pull, perform a vehicle alignment.

1. Park the truck on a flat and level surface.
2. Measure the vertical distance from the ends of the bumper to the ground.
3. If the difference between the two measurements is less than one inch, the truck is within tolerance for leveling and no action is required. If the difference exceeds one inch, or a more accurate adjustment is necessary, proceed to step 5.

4. Install a flat shim between the leaf spring and the axle seat on the low side. Select a flat shim that is close to the difference in bumper height, measured in inches.
5. Drive the truck a short distance to settle the suspension and park in the same spot.
6. Measure the difference in the height of the bumper ends. If the difference is within the specifications, no further shimming is needed.
7. After the truck is within the specifications, check the suspension ride height and adjust if necessary.
8. Test-drive the truck on a flat and level road and note any tendency to pull left or right. If no pulling is noted, no further adjustment is needed. If the truck pulls to the left or the right, proceed to step 9.
9. Go to the step noted in the table below corresponding to the location where the tapered shim was installed and the direction of pull.

Table 25: Shim Pull Directions

	Pulls left	Pulls right
Shim on left side	Go to step 10	Go to step 13
Shim on right side	Go to step 11	Go to step 10

10. Replace the existing shim with a shim having ½ to 1 degree less taper. Add a flat spacer (or increase the thickness of an existing spacer) to bring the truck to near level. Return to step 7.
11. Remove the tapered shim from the right side. Install a shim having a slightly larger angle on the left side but with the thicker end of the shim to the rear. Check for lean and adjust the angle of the shim until the lean is within tolerance. Check ride height and adjust as needed.
12. Test-drive the truck and check for pull. If the truck still pulls left, increase the angle of the shim on the left and add a flat spacer on the right side as required to level the truck. Check ride height and adjust if necessary. Repeat this step as needed until both the pull and lean are eliminated.
13. Remove the tapered shim from the left side. Install a shim having a slightly larger angle on the right side, but with the thicker end of the shim to the rear. Check for lean and adjust the angle of the shim until the lean is within tolerance. Check ride height and adjust as needed.
14. Test-drive the truck and check for pull. If the truck still pulls right, increase the angle of the shim on the right and add a flat spacer on the left side as required to level the truck. Check ride height and adjust if necessary. Repeat this step as needed until both the pull and lean are eliminated.

NOTE

AG130 suspensions have a 1 in. spacer from factory. If at any point during this procedure the total thickness of the original and the added flat spacers on the left and right sides exceeds 2 in., the leaf spring assemblies should be removed and inspected. If the forward arch dimensions differ by more than 6 mm (0.25 in.), the spring with the largest arch dimension should be installed on the side that originally sat low.

When reinstalling the leaf springs, all spring and shackle pinch bolts should not be tightened until the suspension is sitting at its nominal ride height in order to avoid torsional preloads in the rubber-bushed spring pins.

Front Wheel Alignment

1. Visually inspect the following before starting the alignment:
   - All fasteners are installed and tightened to the specific torque.
   - Leaf springs are free of wear and damage.
   - Air springs are free of wear, contamination, or damage.
   - Shock absorbers are free of wear or damage.
   - Vehicle ride height is within specification.
   - Spring mounts are free of wear or damage.
2. Inspect the maximum turn angle and adjust if necessary. Follow the next steps:
   a. Place the truck onto turntables.
   b. Measure the wheel cut. Wheel cut is measured at the inside wheel; therefore, the tires must be turned to the full lock position for right hand and left-hand direction.
   c. Increase the wheel cut by loosening the jam nuts and screw the axle stops clockwise.
   d. Tighten the jam nuts.
   e. Decrease the wheel cut by loosening the jam nuts and screw the axle stops out counterclockwise.
   f. Tighten the jam nuts.
   g. Measure the wheel cut and inspect for any interference with related steering components.
3. Check the pressure relief in the power steering system and reset if necessary. Refer to the proper Power Steering Service Manual.
4. Inspect the kingpin inclination. This angle is not adjustable.
5. Inspect the camber angle. This angle is not adjustable.
6. Verify ride heights for front and rear suspensions. Adjust if necessary.
7. Inspect the caster angle and adjust if necessary.
8. Inspect the toe and adjust if necessary.

> **i NOTE**
>
> If the truck is jacked up and set on turn plates, it is relaxed and no longer receives forward resistance similar to road-like conditions. Toe should be measured in conditions closest to road-like:
>
> - Toe, thrust, and scrub should be measured after setting up the truck for measuring ride height pulling the truck forward slowly to its full length and coming to a slow stop with little to no brake pressure, chocking the steer tires.
> - If there is movement (even within the specified movement) in the kingpins, bushings, tie-rod ends, etc., the forward movement will pull the kingpins, bushings and tie-rod ends to show true alignment measurements that exist while traveling on the road.