

# Component Procedures: Alignment

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# Component Procedures: Alignment

## Parts and Labor (itype\_189)

### Labor

Operation	Qualifier Path	Skill	Std Hrs	Wty Hrs
Align	Suspension > Suspension Service > Wheels, Ali?	B	2.5	0.0
Align	Suspension > Suspension Service > Wheels, Ali?	B	1.5	0.0
Align	Suspension > Suspension Service > Wheels, Ali?	B	1.0	0.0
Adjust	Front Suspension > Suspension Service > Toe-I?	B	0.7	0.0

### Camber Description (Article 13657)

Camber is the tilting of the wheels from the vertical when viewed from the front of the vehicle. When the wheels tilt outward at the top, the camber is positive (+). When the wheel tilts inward at the top, the camber is negative (-). The amount of tilt is measured in degrees from the vertical. Camber settings influence the directional control and the tire wear.

Too much positive camber will result in premature wear on the outside of the tire and cause excessive wear on the suspension parts.

Too much negative camber will result in premature wear on the inside of the tire and cause excessive wear on the suspension parts.

Unequal side-to-side camber of 1 degree or more will cause the vehicle to pull or lead to the side with the most positive camber.

Cross Camber is the difference between the left camber value and the right camber value.

Cross Camber = L camber – R camber

### Caster Description (Article 13658)

Caster is the tilting of the uppermost point of the steering axis either forward or backward, when viewed from the side of the vehicle. A backward tilt is positive (+) and a forward tilt is negative (-). Caster influences directional control of the steering but does not affect the tire wear. Caster is affected by the vehicle height, therefore it is important to keep the body at its designed height. Overloading the vehicle or a weak or sagging rear spring will affect caster. When the rear of the vehicle is lower than its designated trim height, the front suspension moves to a more positive caster. If the rear of the vehicle is higher than its designated trim height, the front suspension moves to a less positive caster.

With too little positive caster, steering may be touchy at high speed and wheel returnability may be diminished when coming out of a turn. If one wheel has more positive caster than the other, that wheel will pull toward the center of the vehicle. This condition will cause the vehicle to pull or lead to the side with the least amount of positive caster.

Cross Caster is the difference between the left caster value and the right caster value.

Cross caster = L caster – R caster

### Lead/Pull Description (Article 13659)

At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path.

Lead/pull is usually caused by the following factors:

- Road slope
- Variability in tire construction
- Wheel alignment (front cross caster and camber)
- Unbalanced steering gear
- Electronic Power Steering (EPS) steering position and torque sensor s not calibrated correctly, if equipped.

### Memory Steer Description (Article 13660)

Memory steer is when the vehicle wants to lead or pull in the direction the driver previously turned the vehicle. Additionally, after turning in the opposite direction, the vehicle will want to lead or pull in that direction.

### Scrub Radius Description (Article 13661)

Ideally, the scrub radius is as small as possible. Normally, the SAI angle and the centerline of the tire and the wheel intersect below the road surface, causing a positive scrub radius. With struts, the SAI angle is

much larger than the long arm/short arm type of suspension . This allows the SAI angle to intersect the camber angle above the road surface, forming a negative scrub radius. The smaller the scrub radius, the better the directional stability. Installing aftermarket wheels that have additional offset will dramatically increase the scrub radius. The newly installed wheels may cause the centerline of the tires to move further away from the spindle. This will increase the scrub radius.

A large amount of scrub radius can cause severe shimmy after hitting a bump. Four-wheel drive vehicles with large tires use a steering damper to compensate for an increased scrub radius. Scrub radius is not directly measurable by the conventional methods. Scrub radius is projected geometrically by engineers during the design phase of the suspension.

### **Setback Description (Article 13662)**

Setback applies to both the front and the rear wheels . Setback is the amount that one wheel may be aligned behind the other wheel. Setback may be the result of a road hazard or a collision. The first clue is a caster difference from side-to-side of more than 1 degree.

### **Thrust Angles Description (Article 13663)**

The front wheels aim or steer the vehicle. The rear wheels control tracking. This tracking action relates to the thrust angle (3). The thrust angle is the path that the rear wheels take. Ideally, the thrust angle is geometrically aligned with the body centerline (2).

In the illustration, toe-in is shown on the left rear wheel , moving the thrust line (1) off center. The resulting deviation from the centerline is the thrust angle.

If the thrust angle is not set properly the vehicle may “dog track”, the steering wheel may not be centered or it could be perceived as a bent axle. Thrust angle can be checked during a wheel alignment.

Positive thrust angle means the thrust line is pointing to the right hand side (RHS) of the vehicle.

Negative thrust angle means the thrust line is pointing to the left hand side (LHS) of the vehicle.

If the thrust angle is out of specification, moving the axle to body relationship will change the thrust angle reading.

If the vehicle is out in the Positive (+) direction-moving the RHS forward and/or LHS rearward will move the thrust angle towards zero degrees.

If the vehicle is out in the Negative (-) direction-moving the RHS rearward and/or LHS forward will move the thrust angle towards zero degrees.

### **Toe Description (Article 13664)**

Toe is a measurement of how much the front and/or rear wheels are turned in or out from a straight-ahead position. When the wheels are turned in, toe is positive (+). When the wheels are turned out, toe is negative (-). The actual amount of toe is normally only a fraction of a degree. The purpose of toe is to ensure that the wheels roll parallel.

Toe also offsets the small deflections of the wheel support system that occur when the vehicle is rolling forward. In other words, with the vehicle standing still and the wheels set with toe-in, the wheels tend to roll parallel on the road when the vehicle is moving.

Improper toe adjustment will cause premature tire wear and cause steering instability.

### **Torque Steer Description (Article 13665)**

A vehicle pulls or leads in one direction during hard acceleration. A vehicle pulls or leads in the other direction during deceleration.

The following factors may cause torque steer to be more apparent on a particular vehicle:

- A slightly smaller diameter tire on the right front increases a right torque lead. Inspect the front tires for differences in the brand, the construction, or the size. If the tires appear to be similar, change the front tires from side-to-side and retest the vehicle. Tire and wheel assemblies have the most significant effect on torque steer correction.

- A large difference in the right and left front tire pressure

- Left-to-right differences in the front view axle angle may cause significant steering pull in a vehicle. The pull will be to the side with the most downward sloping axle from the differential to the wheels . Axles typically slope downward from the differential. The slope of the transaxle pan to level ground may be used as an indication of bias axle angles. The side with the higher transaxle pan, shown on the left side of the illustration, has the most downward sloping axle angle.

### **Wander Description (Article 13666)**

Wander is the undesired drifting or deviation of a vehicle to either side from a straight path with hand

pressure on the steering wheel . Wander is a symptom of the vehicle's sensitivity to external disturbances, such as road crown and crosswind, and accentuated by poor on-center steering feel.

## **Wheel Alignment Measurement (Article 13672)**

Steering and vibration complaints are not always the result of improper alignment. One possible cause is wheel and tire imbalance. Another possibility is tire lead due to worn or improperly manufactured tires . Lead/pull is defined as follows: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path. Lead is the vehicle deviation from a straight path on a level road without pressure on the steering wheel. Refer to Radial Tire Lead/Pull Correction in order to determine if the vehicle has a tire lead problem.

Before performing any adjustment affecting wheel alignment, perform the following inspections in order to ensure correct alignment readings:

- Inspect for visible damage to the suspension components and replace as necessary.
- Inspect the tires for the proper inflation and irregular tire wear. Refer to Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label and Tire Diagnosis - Irregular or Premature Wear .
- Inspect the runout of the wheels and the tires. Refer to Tire and Wheel Runout Specifications .
- Inspect the wheel bearing s for backlash and excessive play. Refer to Wheel Bearings Diagnosis .
- Inspect the ball joint s for looseness or wear.
- Inspect the tie rod end s for looseness or wear.
- Inspect the control arm s and stabilizer shaft for looseness or wear.
- Inspect the steering gear for looseness at the frame. Refer to Fastener Specifications .
- Inspect the struts/ shock absorber s for wear, leaks, and any noticeable noises. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle .
- Inspect the vehicle trim height. Refer to Trim Height Inspection .
- Inspect the steering wheel for excessive drag or poor return due to stiff or rusted linkage or suspension components.
- Inspect the fuel level. The fuel tank should be full or the vehicle should have a compensating load added. Give consideration to excess loads, such as tool boxes, sample cases, etc. If normally carried in the vehicle, these items should remain in the vehicle during alignment adjustments. Give consideration also to the condition of the equipment being used for the alignment. Follow the equipment manufacturer's instructions. Satisfactory vehicle operation may occur over a wide range of alignment settings. However, if the setting exceeds the service allowable specifications, correct the alignment to the service preferred specifications. Refer to Wheel Alignment Specifications .

Perform the following steps in order to measure the front and rear alignment angles:

- Install the alignment equipment according to the manufacturer's instructions.
- Record the "Before" and "After" alignment measurements.
- When performing adjustments to vehicles requiring a 4-wheel alignment, set the rear toe adjustment first in order to obtain proper front alignment angles.
- Jounce the front and the rear bumpers 3 times prior to checking the wheel alignment.

## **Front Camber Adjustment (Article 13668)**

Adjustment Procedure

- Before performing any adjustment affecting the wheel alignment, refer to Wheel Alignment Measurement .
- Install the service only camber adjusting bolt (3) (M10x1.5x40) into the threaded hole at the top of the knuckle and gently tighten until it is snug against the strut body. [Click for full-size image](#)
- Loosen the strut to the knuckle bolts (2). Refer to Strut Assembly Removal and Installation .
- Adjust the front camber to specifications using the camber adjusting bolt (3), refer to Wheel Alignment Measurement .
- Tighten the strut-to-knuckle nuts (1) to:
  - First Pass: 80 Nm (59 lb ft)
  - Final Pass: plus 180 degrees
- Remove the service only camber adjusting bolt (3).
- Adjust the front toe. Refer to Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment .

## **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment (Article 13671)**

- Before performing any adjustment affecting the wheel alignment, refer to Wheel Alignment Measurement .
- Ensure that the steering wheel is set in a straight ahead position. [Click for full-size image](#)
- Loosen the tie rod jam nut (1).
- Adjust the toe to specification by turning the tie rod (2). Refer to Wheel Alignment Specifications .

- Tighten the tie rod jam nut (1) to: 68 Nm(50 lb ft) .
- Steering Wheel Angle Sensor Centering

## Rear Camber Adjustment (Article 13669)

- When major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.
- When performing work in the engine compartment or under the vehicle, ensure that the hood is fully open, or opened to its secondary latch. When the hood is opened to the secondary latch, the vehicle will disable the remote start features from the key fob and OnStar mobile app. Failure to open the hood, or open the hood to the secondary latch while doing a repair in the engine compartment or under the vehicle can result in inadvertent vehicle starting which could result in personal injury or damage to a vehicle.
- Before performing any adjustment affecting the wheel alignment, refer to Wheel Alignment Measurement .
- Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
- The lower control arm to the subframe retaining bolt (1) and nut (2) eccentric washers (3) are used to adjust rear suspension camber.
- Nuts with micro-encapsulated thread sealant must be discarded after removal.
- Remove the lower control arm to the subframe retaining nut (2). Discard the nut. Click for full-size image
- Install NEW lower control arm to the subframe retaining nut (2). Do not fully tighten at this stage.
- Remove the safety stands.
- Lower the vehicle to the ground.
- Bounce the vehicle several times to settle the suspension.
- Determine the actual rear suspension camber angle.
- Adjust the rear suspension camber to specification by turning the lower control arm to subframe retaining bolt (1). For rear suspension camber specifications, refer to Wheel Alignment Specifications .
- The weight of the vehicle must be on a level surface such as an alignment rack and on all four wheels before fully tightening the bolts and nuts that have been partially tightened. Failure to comply with this requirement may adversely affect the ride and handling characteristics of the vehicle.
- Do not allow the lower control arm to subframe retaining bolt (1) to turn while tightening.
- Tighten the lower control arm to subframe retaining bolt (1) and nut (2) to 115 Nm (85 lb ft) .
- Verify that camber is still within specifications. Refer to Wheel Alignment Specifications .
- If further adjustment is required, adjust as necessary.

## Rear Toe Adjustment (Article 13670)

- Before performing any adjustment affecting the wheel alignment, refer to Wheel Alignment Measurement .
- Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
- Remove the safety stands.
- Lower the vehicle to the ground.
- Bounce the vehicle several times to settle the suspension.
- Determine the actual rear suspension toe setting.
- Adjust the rear suspension toe to specification by turning adjustment cam (1). Refer to Wheel Alignment Specifications . Click for full-size image
- Tighten the adjuster link nut to 115 Nm (85 lb ft) .
- Verify that the toe is still within specifications. Refer to Wheel Alignment Specifications .
- Readjust if necessary.

## Wheel Alignment Specifications (Article 13676)

Alignment Condition: Full tank of fuel, no passengers and placed on flat level surface.

RPO Restriction Wheels Caster  $\pm 0.75^\circ$  Cross Caster  $\pm 0.75^\circ$  Camber  $\pm 0.75^\circ$  Cross Camber  $\pm 0.75^\circ$  Total Toe  $\pm 0.2^\circ$  Steering Wheel Angle  $\pm 3.5^\circ$  Thrust Angle  $\pm 0.3^\circ$

Left Right (Left – Right) Left Right (Left – Right) (Left + Right) (Left – Right)/2

FE2 without WRS Front 5.9° 5.9° 0.0° –0.2° –0.2° 0.0° 0.2° 0.0° —

Rear — — — –0.75° –0.75° — 0.2° — 0.0°

FE2 with WRS Front 5.9° 5.9° 0.0° –0.2° –0.2° 0.0° 0.2° 0.0° —

Rear — — — –0.4° –0.4° — 0.2° — 0.0°

FE3 Front 5.9° 5.9° 0.0° –0.8° –0.8° 0.0° 0.2° 0.0° —

FE4 Front 5.9° 5.9° 0.0° –0.8° –0.8° 0.0° 0.2° 0.0° —

FE5 Front 5.6° 5.6° 0.0° –1.0° –1.0° 0.0° 0.2° 0.0° —

Rear — — — –0.5° –0.5° — 0.2° — 0.0°

FE6 Front 5.6° 5.6° 0.0° -1.0° -1.0° 0.0° 0.2° 0.0° —

## Trim Height Specifications (Article 13615)

Model Options Tire Size-Front Tire Size-Rear 'P' Height ± 12 mm Cross 'P' ± 10 mm 'R' Height ± 12 mm Cross 'R' ± 10 mm

1EA37/1EF67 FE2, ROB P245/55R18 P245/55R18 753 mm (29.64 in) 755 mm (29.72 in)

1EA37/1EF67 FE2, ROA, P245/50ZR19 P245/50ZR19 757 mm (29.80 in) 759 mm (29.88 in)

1EA37/1EF67 FE2, ROC P245/45ZR20 P275/40ZR20 757 mm (29.80 in) 759 mm (29.88 in)

1ES00 FE3/FE4, ROC P245/45ZR20 P275/40ZR20 757 mm (29.80 in) 759 mm (29.88 in)

1ES37 FE4/FE6, RKC P285/35ZR20 P285/35ZR20 748 mm (29.44 in) 751 mm (29.56 in)

1ES00 FE5, RPG 285/35ZR20 305/35ZR20 743 mm (29.25 in) 757 mm (29.80 in)

All measurements are for reference only and intended to be a guide.

Model Options 'Z' Height ± 10 mm Cross 'Z' ± 10 mm 'D' Height ± 10 mm Cross 'D' ± 10 mm

1EA00 FE2/FE3/FE4/FE6 55 mm (2.16 in) 16 mm (0.62 in)

1ES00 FE5 51 mm (2.00 in) 16 mm (0.62 in)

## All New Technical Service Bulletins (itype\_432)

Tsbs

- Wheel Alignment Specifications, Requirements and Recommendations for GM Vehicles (05-03-07-009L, 2025/02/24)

## All Technical Service Bulletins (itype\_100)

Tsbs

- Wheel Alignment Specifications, Requirements and Recommendations for GM Vehicles (05-03-07-009L, 2025/02/24)

## Preliminary Alignment Inspection (Article 13667)

Steering and vibration complaints are not always the result of improper alignment. One possible cause is wheel and tire imbalance. Another possibility is tire lead due to worn or improperly manufactured tires. Lead/pull is defined as follows: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path. Lead is the vehicle deviation from a straight path on a level road without pressure on the steering wheel. Refer to Radial Tire Lead/Pull Correction in order to determine if the vehicle has a tire lead problem.

Before performing any adjustment affecting wheel alignment, perform the following inspections in order to ensure correct alignment readings:

- Inspect for visible damage to the suspension components and replace as necessary.
- Inspect the tires for the proper inflation and irregular tire wear. Refer to Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label and Tire Diagnosis - Irregular or Premature Wear .
- Inspect the runout of the wheels and the tires. Refer to Tire and Wheel Runout Specifications .
- Inspect the wheel bearing s for backlash and excessive play. Refer to Wheel Bearings Diagnosis .
- Inspect the ball joint s for looseness or wear.
- Inspect the tie rod end s for looseness or wear.
- Inspect the control arm s and stabilizer shaft for looseness or wear.
- Inspect the steering gear for looseness at the frame. Refer to Fastener Specifications .
- Inspect the struts/ shock absorber s for wear, leaks, and any noticeable noises. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle .
- Inspect the vehicle trim height. Refer to Trim Height Inspection .
- Inspect the steering wheel for excessive drag or poor return due to stiff or rusted linkage or suspension components.
- Inspect the fuel level. The fuel tank should be full or the vehicle should have a compensating load added. Give consideration to excess loads, such as tool boxes, sample cases, etc. If normally carried in the vehicle, these items should remain in the vehicle during alignment adjustments. Give consideration also to the condition of the equipment being used for the alignment. Follow the equipment manufacturer's instructions. Satisfactory vehicle operation may occur over a wide range of alignment settings. However, if the setting exceeds the service allowable specifications, correct the alignment to the service preferred specifications. Refer to Wheel Alignment Specifications .

Perform the following steps in order to measure the front and rear alignment angles:

- Install the alignment equipment according to the manufacturer's instructions.
- Jounce the front and the rear bumpers 3 times prior to checking the wheel alignment.

## Trim Height Inspection (Article 13611)

### Trim Height Measurement

Trim height is a predetermined measurement relating to vehicle ride height. Incorrect trim heights can cause the vehicle to bottom out over bumps, damage to the suspension components and symptoms similar to wheel alignment problems. Check the trim heights when diagnosing suspension concerns and before checking the wheel alignment.

Perform the following before measuring the trim heights:

- Set the tire pressure to the specifications shown on the certification label. Refer to Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label .
- Check the fuel level. Add additional weight if necessary to simulate a full tank.
- Make sure the passenger and rear compartments are empty, except for the spare tire.
- Make sure the vehicle is on a flat and level surface, such as an alignment rack.
- Check that all the vehicle doors are securely closed.
- Check that the vehicle hood and rear deck lids are securely closed.
- Check for installed after market accessories or modifications that could affect trim height measurement:
  - Larger or smaller than production wheels and tires
  - Lifting or lowering kits
  - Wheel opening flares or ground affects

### Measuring the P and R Dimension

#### Measurement Definitions

P Height: The vertical distance from the ground to the top of the wheel opening through the centerline of the front wheel.

R Height: The vertical distance from the ground to the top of the wheel opening through the centerline of the rear wheel.

Use the following procedures to measure the P and R dimensions:

- Push the front bumper down a minimum of 25 mm (1 in) , and release. Perform this step three times.
- Measure and record the trim height per the Measurement Definitions above.
- Lift the bumper up a minimum of 25 mm (1 in) , and release. Perform this step three times.
- The true P height measurement is the average of the measurements taken in step 2 and 4. Refer to Trim Height Specifications .
- Repeat the above steps at the rear of the vehicle for the R heights.
- If the P and R heights are outside of the specifications, measure the Z and D heights.

### Measuring the Z Dimension

The Z Height: The vertical distance from the lowest point of the ball joint housing (2) to the center of the front lower control arm rear bolt head (1).

Use the following procedures to measure the Z dimensions:

- Push the front bumper down a minimum of 25 mm (1 in) . Perform this step three times.
- Lift the front bumper a minimum of 25 mm (1 in) . Perform this step three times.
- The true Z height dimension is the average of the measurements taken in steps 2 and 4. Refer to Trim Height Specifications .
- If these measurements are out of specifications, inspect for the following conditions:
  - Worn or damaged suspension components
  - Collision damage

### D Height Measurement

The D Height: The vertical distance from the center of the lower control arm inner bushing bolt head (1) to the center of the lower control arm outer bushing bolt head (2).

Use the following procedure to check the D dimension:

- Push the rear bumper down a minimum of 25 mm (1 in) . Perform this step three times.
- Lift the rear bumper up a minimum of 25 mm (1 in) , and release. Perform this step three times.
- The true D height is the average of the measurements taken in steps 2 and 4. Refer to Trim Height Specifications .

## OEM Policies and Procedures (itype\_120)

### Tsbs

- Wheel Alignment Specifications, Requirements and Recommendations for GM Vehicles (05-03-07-009L, 2025/02/24)