

Wheel Alignment

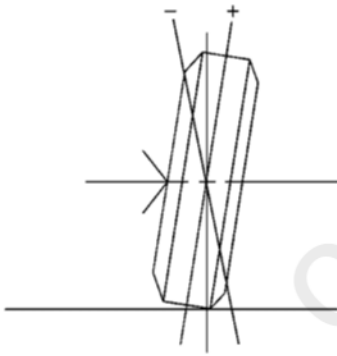
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Description and Operation

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Camber Description



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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 positiveâ€%(+). When the wheel tilts inward at the top, the camber is negativeâ€%(). 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.

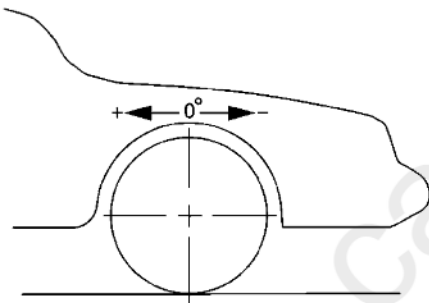
Too much negative camber will result in premature wear on the inside of the tire and cause excessive wear on the suspension parts.

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

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Caster Description



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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.

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Lead/Pull Description

Note:

Vehicles will tend to lead/pull in the direction of the road slope as part of normal operation.

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

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Memory Steer Description

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.

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Scrub Radius Description

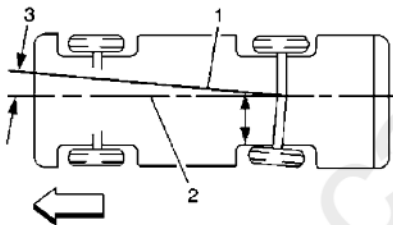
Ideally, the scrub radius is as small as possible. Normally, the SAI angle and the centerline of the tire and the wheel intersect below the road surface, causing a positive scrub radius. With struts, the SAI angle is much larger than the long arm/short arm type of suspension. This allows the SAI angle 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.

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Thrust Angles Description



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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.

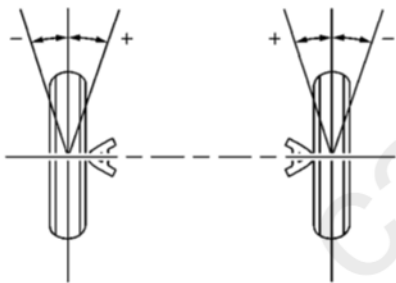
If the thrust angle is out of specification, moving the axle to body relationship will change the thrust angle reading.

If the vehicle is out in the Positive⁽⁺⁾ direction-moving the RHS forward and/or LHS rearward will move the thrust angle towards zero⁰degrees.

If the vehicle is out in the Negative⁽⁻⁾ direction-moving the RHS rearward and/or LHS forward will move the thrust angle towards zero⁰degrees.

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Toe Description



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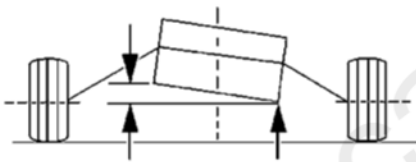
Toe is a measurement of how much the front and/or rear wheels are turned in or out from a straight-ahead position. When the wheels are turned in, toe is positiveâ€‰‰(+). When the wheels are turned out, toe is negativeâ€‰‰(). The actual amount of toe is normally only a fraction of a degree. The purpose 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.

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Torque Steer Description



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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.

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Wander Description

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.

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Repair Instructions

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Wheel Alignment Measurement

Steering and vibration concerns are not always the result of incorrect 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](#).

Before performing any adjustments 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 [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 bearings for backlash and excessive play. Refer to [Wheel Bearings Diagnosis](#).
- Inspect the ball joints for looseness or wear.
- Inspect the tie rod ends for looseness or wear.
- Inspect the control arms and stabilizer shaft for looseness or wear.
- Inspect the steering gear for looseness at the frame. Refer to [Fastener Specifications](#).
- Inspect the struts/shock absorbers 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:

1. Install the alignment equipment according to the manufacturer's instructions.
2. Jounce the front and the rear bumpers 3 times prior to checking the wheel alignment.
3. Measure the alignment angles and record the readings.
4. Note:
Record the "Before" and "After" alignment measurements.
5. Adjust alignment angles to vehicle specifications, if necessary. Refer to [Wheel Alignment Specifications](#).

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Front Caster Adjustment

The front caster is not adjustable. If the front caster angle is not within specifications, inspect for suspension support misalignment or front suspension damage. Replace any damaged suspension components as necessary.

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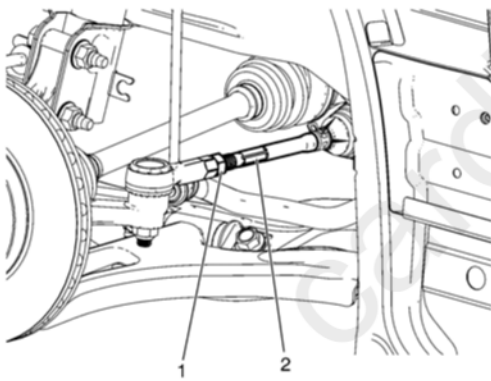
Front Camber Adjustment

The front camber is not adjustable. If the front camber angle is not within specifications, inspect for suspension support misalignment or front suspension damage. Replace any damaged suspension components as necessary.

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Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment



1. [Click here for full size](#)
2. Ensure that the steering wheel is set in a straight ahead position and centered.
3. Loosen the tie rod jam nut (1).
4. Adjust the toe to specification by turning the adjuster (2). Refer to [Wheel Alignment Specifications](#).
5. Caution:
Refer to [Fastener Caution](#).
6. Install the tie rod jam nut (1) and tighten to 75 N-m (55 lb-ft).
7. Check and center the steering angle sensor. Refer to [Steering Wheel Angle Sensor Centering](#).

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Specifications

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Wheel Alignment Specifications

RPO Restriction	Wheels	Caster		Cross Caster	Camber		Cross Camber	Total Toe	Steering Wheel Angle	Thrust Angle
		Left	Right	(Left - Right)	Left	Right	(Left - Right)	(Left + Right)		(Left - Right)/2
FE4	Front	$3.55^{\circ} \pm 1.0^{\circ}$	$3.55^{\circ} \pm 1.0^{\circ}$	$\pm 1.0^{\circ}$	$-0.20^{\circ} \pm 1.0^{\circ}$	$-0.20^{\circ} \pm 1.0^{\circ}$	$\pm 1.0^{\circ}$	$0.10^{\circ} \pm 0.3^{\circ}$	$0.00^{\circ} \pm 2.5^{\circ}$	$^{\circ}$
	Rear	$^{\circ}$	$^{\circ}$	$^{\circ}$	$-1.45^{\circ} \pm 0.5^{\circ}$	$-1.45^{\circ} \pm 0.5^{\circ}$	$^{\circ}$	$0.24^{\circ} \pm 0.35^{\circ}$	$^{\circ}$	$0.00^{\circ} \pm 0.4^{\circ}$
FE1	Front	$3.46^{\circ} \pm 1.0^{\circ}$	$3.46^{\circ} \pm 1.0^{\circ}$	$\pm 1.0^{\circ}$	$0.05^{\circ} \pm 1.0^{\circ}$	$0.05^{\circ} \pm 1.0^{\circ}$	$\pm 1.0^{\circ}$	$0.16^{\circ} \pm 0.3^{\circ}$	$0.00^{\circ} \pm 2.5^{\circ}$	$^{\circ}$
	Rear	$^{\circ}$	$^{\circ}$	$^{\circ}$	$-1.45^{\circ} \pm 0.5^{\circ}$	$-1.45^{\circ} \pm 0.5^{\circ}$	$^{\circ}$	$0.16^{\circ} \pm 0.35^{\circ}$	$^{\circ}$	$0.00^{\circ} \pm 0.4^{\circ}$

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Fastener Specifications

Reusable Threaded Fastener Tightening Specifications

Application	Specification
	Metric (English)
Note:	
All fasteners listed in this table can be reused after removal.	
Steering Linkage Inner Tie Rod Jam Nut	75â€%N-mâ€%(55â€%lbâ€%ft)

TRANSMISSION

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