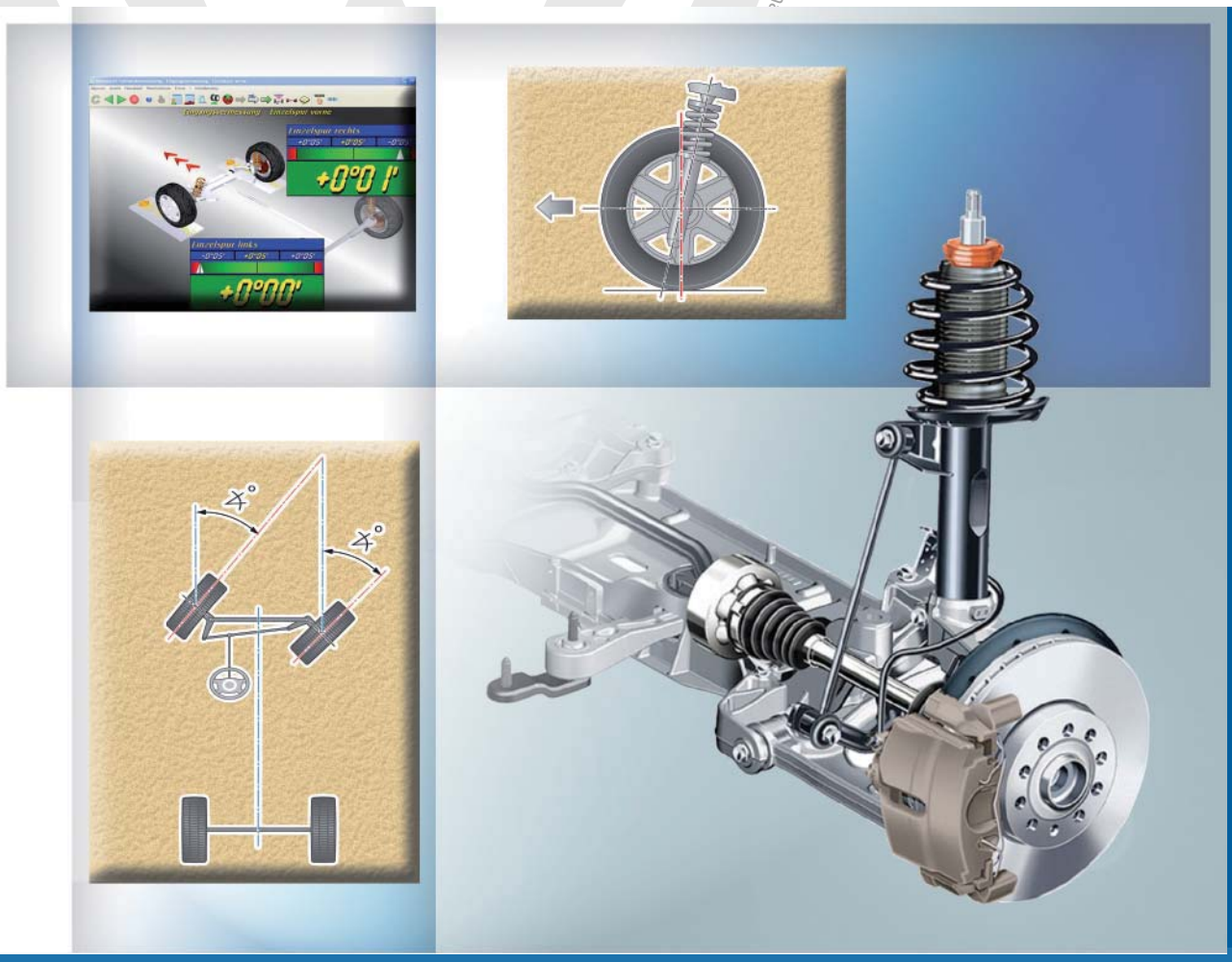
Service Training

Self Study Program 860103

Wheel Alignment - Basics



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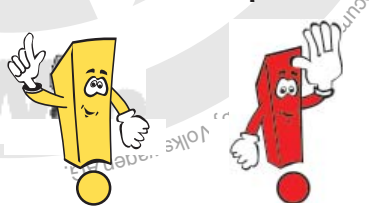
Contents



This Self-Study Program provides information regarding the design and function of new models.
This Self-Study Program is not a Repair Manual.

This information will not be updated.
For maintenance and repair procedures, always refer to the latest electronic service information.

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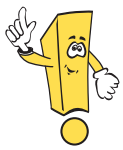
Today's modern vehicles have complex and advanced suspension systems that must be comfortable, sporty and safe.

We now have ways of measuring the suspension geometry and for correcting misaligned settings. This will assure that the suspension systems can be checked and adjusted throughout the entire vehicle's life.

S448_002

In this Self-Study Program, you will learn about the following wheel alignment areas:

- Suspension terminology
- Preparation of the wheel alignment system
- Checking the wheel alignment system
- Why alignment is performed
- The tools used for wheel alignment
- How the alignment principle works



Always refer to the latest Service Information when diagnosing vehicles and performing vehicle repairs.

Basics

Introduction

The suspension system is the connecting link between the vehicle and the road. Wheel contact forces, driving forces and lateral forces in corners are all transferred through the suspension onto the road via the wheels.

The suspension system is subjected to a number of forces and movements.

As vehicle performance, comfort and safety have increased, the suspension system has become very important.

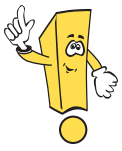
The newer suspension designs have resulted in complex alignment processes and smaller adjustment tolerances.

A special wheel alignment stand is necessary to check and/or realign the components. The suspension should only be adjusted after repairs or problems with the suspension.

Suspension design

The suspension consists of

- Wheel mountings
- Wheels
- Springs
- Shock absorbers
- Front and rear axles
- Steering
- Brakes including controls
- Subframes



Kinematics - One of the studies of motion.

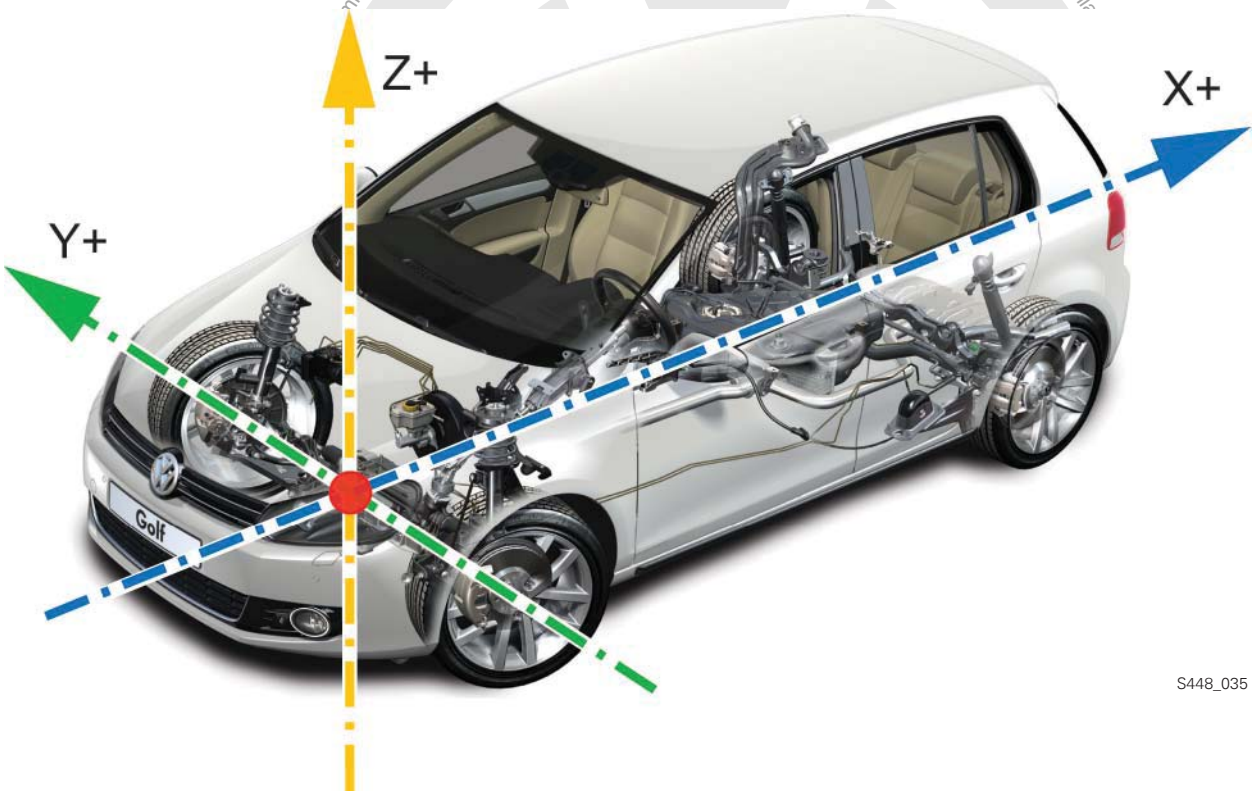
Design Configuration – Vehicle Position in an X-Y-Z Axis System

The design configuration is created during the development of a vehicle. It is described by an X-Y-Z axis system.

The Z- and the X-axes run through the center of the front axle, and the Y-axis normally runs directly through the center of the front wheels. The design configuration corresponds with the vehicle position at the nominal ride height.

All adjustment information comes directly from this nominal data created during the design configuration.

The suspension terminology used in the next couple of pages comes directly from specifications created during the vehicle design configuration.



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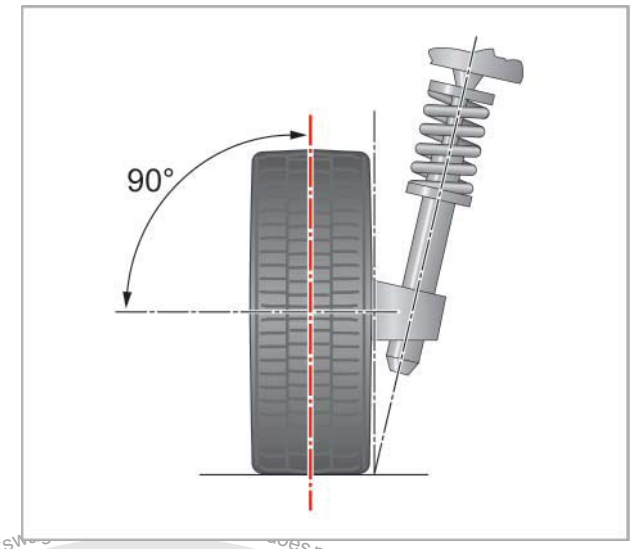
Ride height

The ride height has a decisive influence on the results of the wheel alignment. It is influenced by the load carried in the vehicle, by the contents of the fuel tank or other liquid containers and also by temperature differences that can cause the suspension measurements of toe, camber and caster, to change.

Suspension-related Terms

Wheel center plane

The wheel center plane intersects the wheel rotational axis vertically in the center of the tire.



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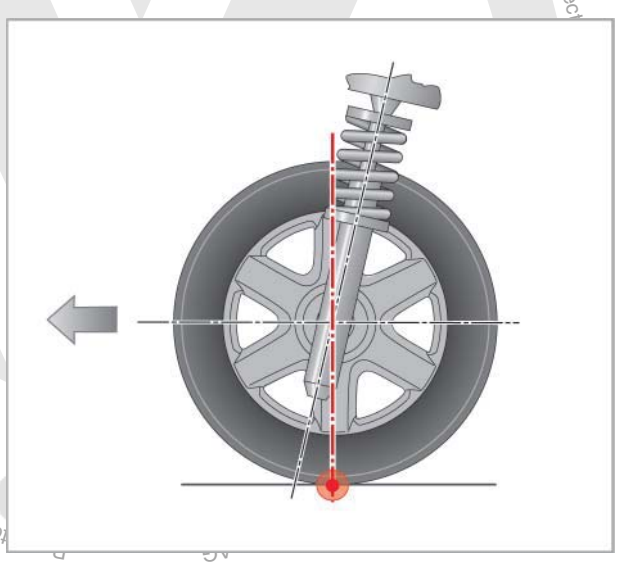
Wheel contact point

The wheel contact point is the point where a vertical line passing through the wheel center plane intersects the rotational axis and the road surface.



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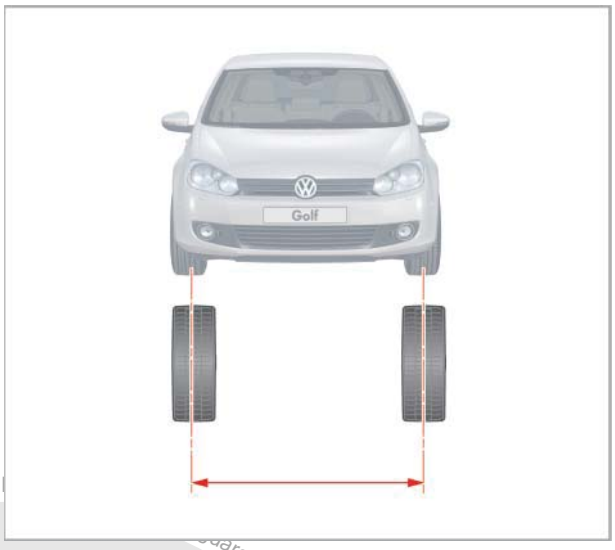
Track width

The track width is the measurement from tire center to tire center on each axle.

On vehicles with independent wheel suspension using traverse or semi-trailing links, the track width varies during compression and extension cycles.



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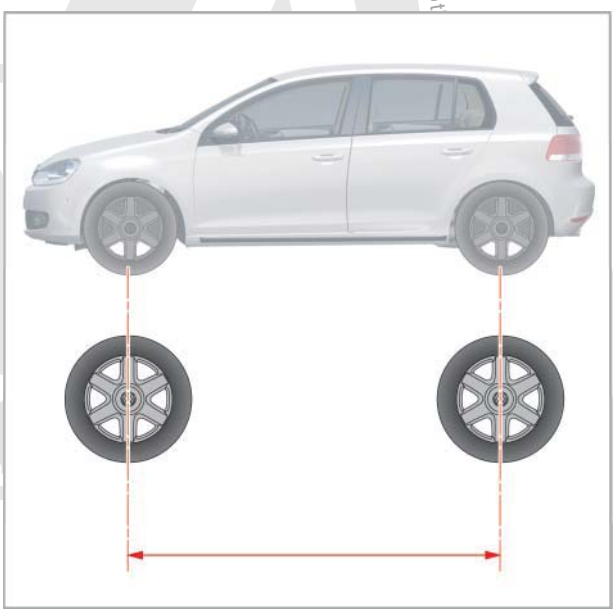
Wheelbase

The wheelbase is the distance between the centers of the wheels on the front axle and the rear axle.



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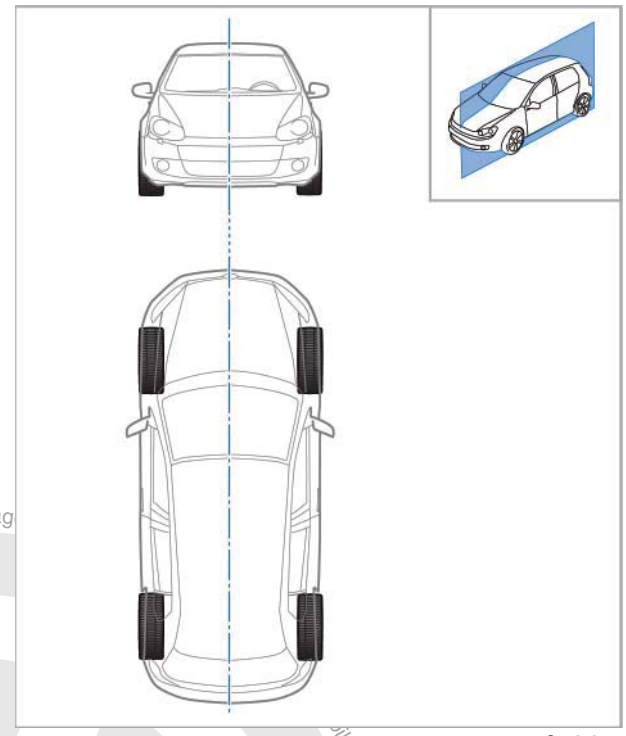
Vehicle longitudinal median plane

The longitudinal median plane of the vehicle is a fixed vehicle-related plane that is vertical to the road and passes through the center of the track width of the front and rear axle (X/Z plane).



S448_014

Thrust axis

The thrust axis bisects the total toe angle of the rear axle.

The rear axle defines the tracking of the vehicle. For this reason, all measurements for the front wheels and for some assist systems are related to the thrust axis. Ideally, the thrust axis should be along the vehicle longitudinal median plane.

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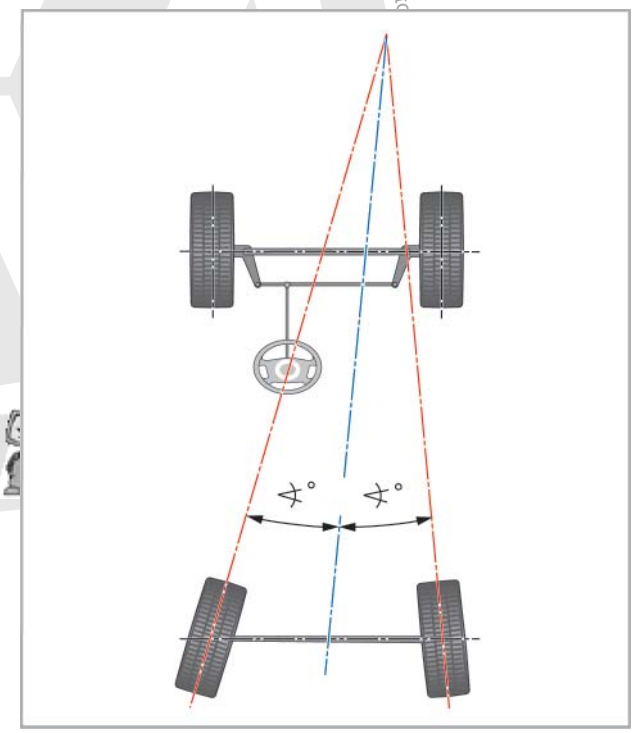
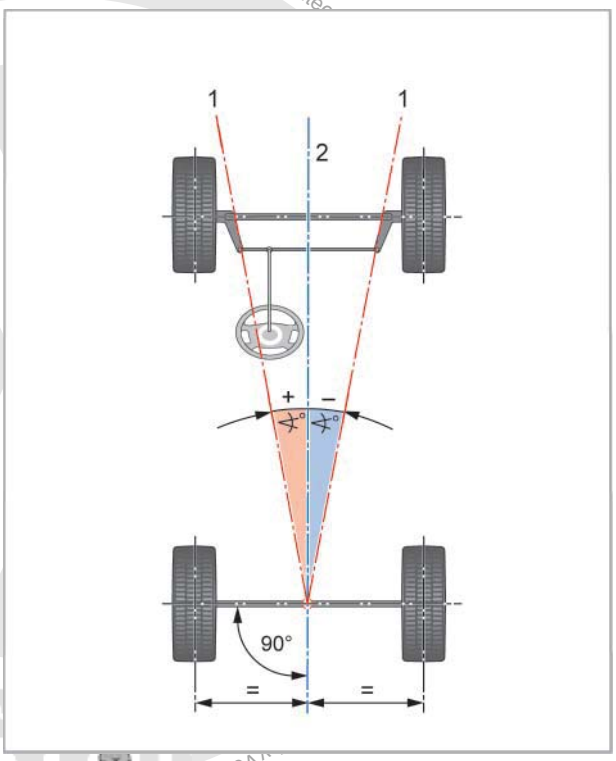


Thrust axis deviation

The thrust axis deviation is the angle between the vehicle longitudinal median plane (2) and the thrust axis (1).

It results from the thrust axis, the lateral offset and the angle of the rear axle.

If the thrust axis deviation is oriented to the front left, it is called positive. If it is oriented to the front right, it is called negative.

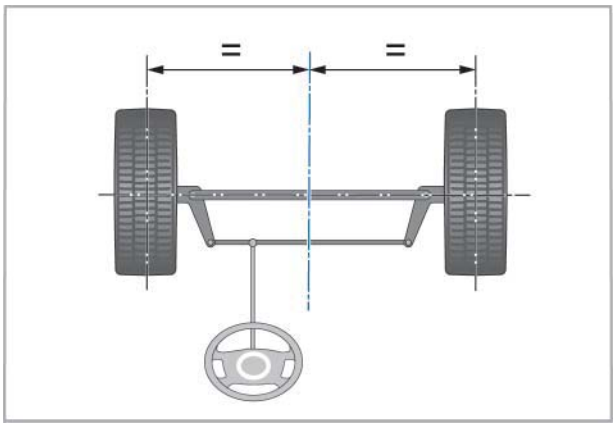


S448_015

Straight-ahead driving

This wheel position is a reference position in which the two front wheels have the same toe angles to the vehicle longitudinal median plane.

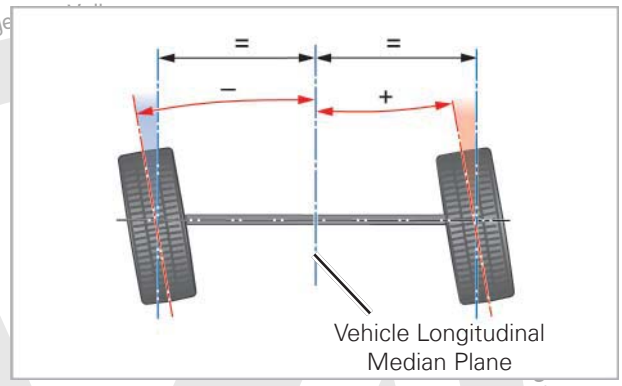
The rear axle is aligned in this position.



S448_016

Toe Angle of Rear Wheels

The toe angle of the rear wheels is the angle between the vehicle longitudinal median plane and a line intersecting the wheel center plane.



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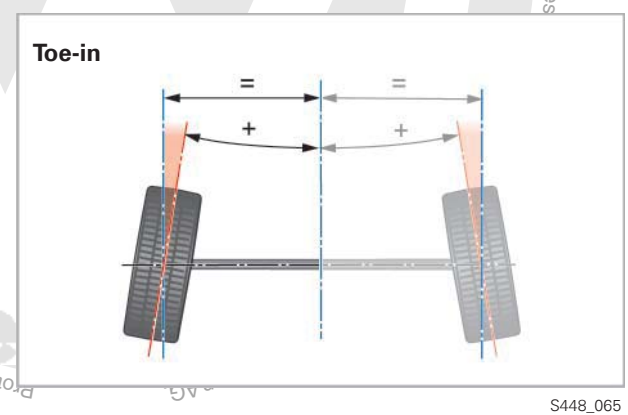
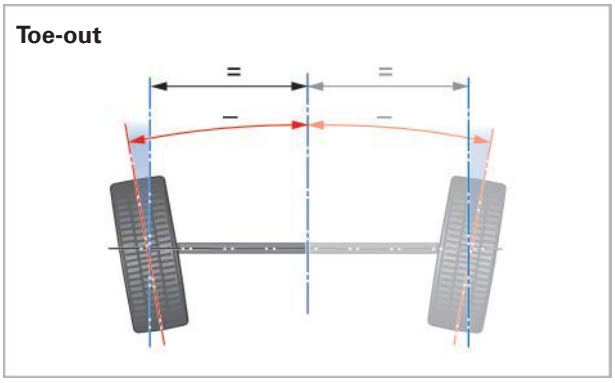
Positive (toe-in) results when the front part of the wheel points towards the vehicle longitudinal median plane.



S448_065

Negative (toe-out) results when the front part of the wheel points away from the vehicle longitudinal median plane.



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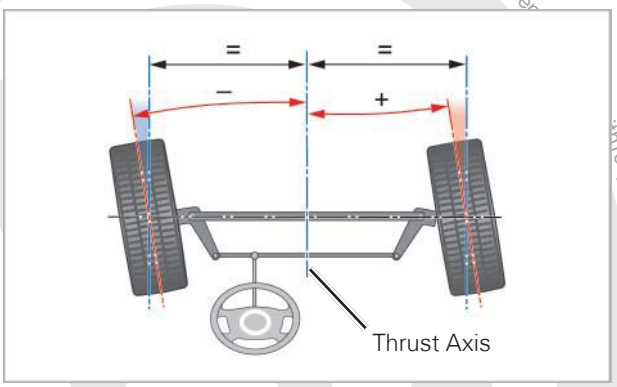
Individual Toe Angle of Front Wheels

The individual toe angle of the front wheels is the angle between the thrust axis and a line running along the wheel center plane.



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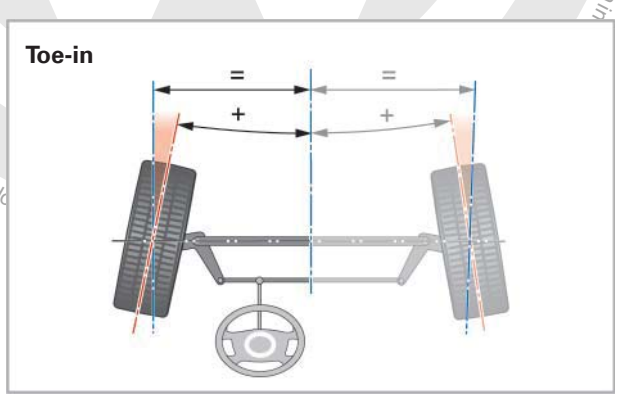
Positive (toe-in) results when the front part of the wheel points towards the thrust axis.



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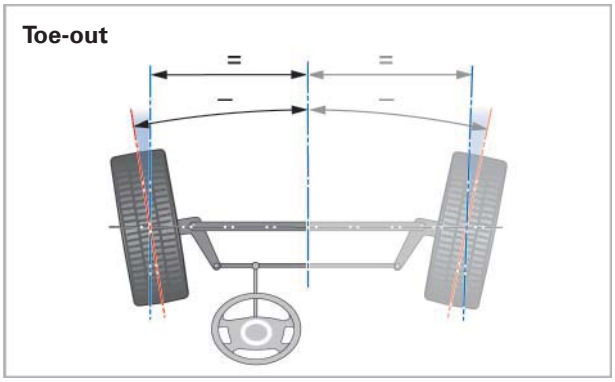
Negative (toe-out) results when the front part of the wheel points away from the thrust axis.



S448_017

Total toe

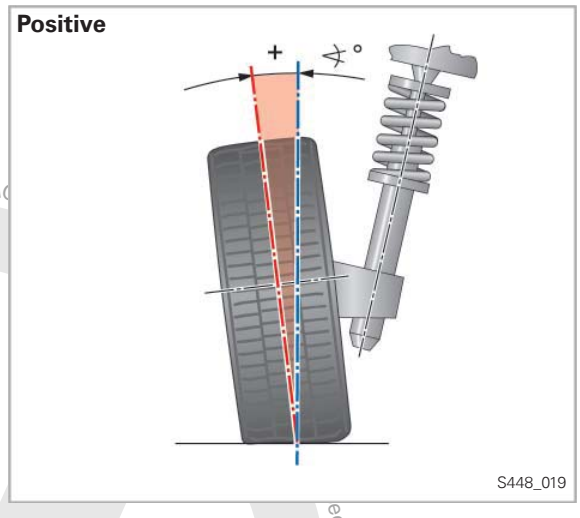
The total toe is the sum of the angles of the left and right wheels on an axle. The negative or positive sign in front of the individual toe angles is important.

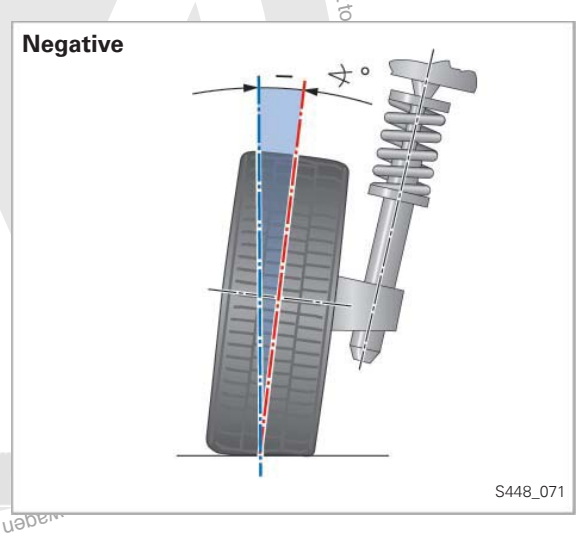
Camber

Camber is the angle between the wheel center plane and a vertical line passing through the wheel contact point with the road surface.

Camber can be positive or negative.

- Positive (+) is when the upper part of the wheel is inclined away from the wheel center plane to the outside
- Negative (+) is when the upper part of the wheel is inclined away from the wheel center plane to the inside

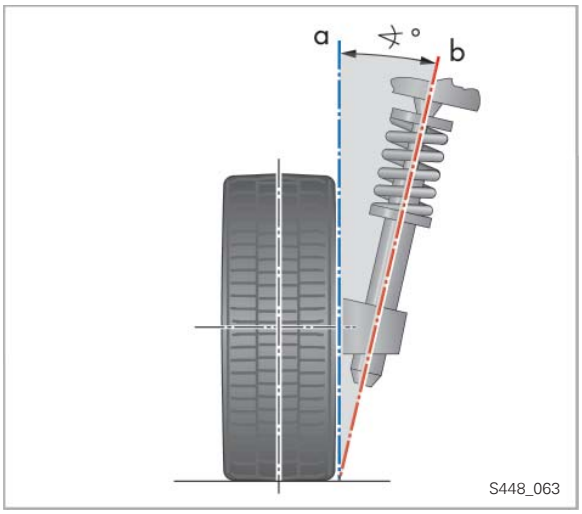




Steering Axis Inclination (SAI)

The steering axis inclination (also called king pin inclination) is the angle of inclination of the steering axis (b) from the true vertical (a) (parallel to the vehicle longitudinal median plane).

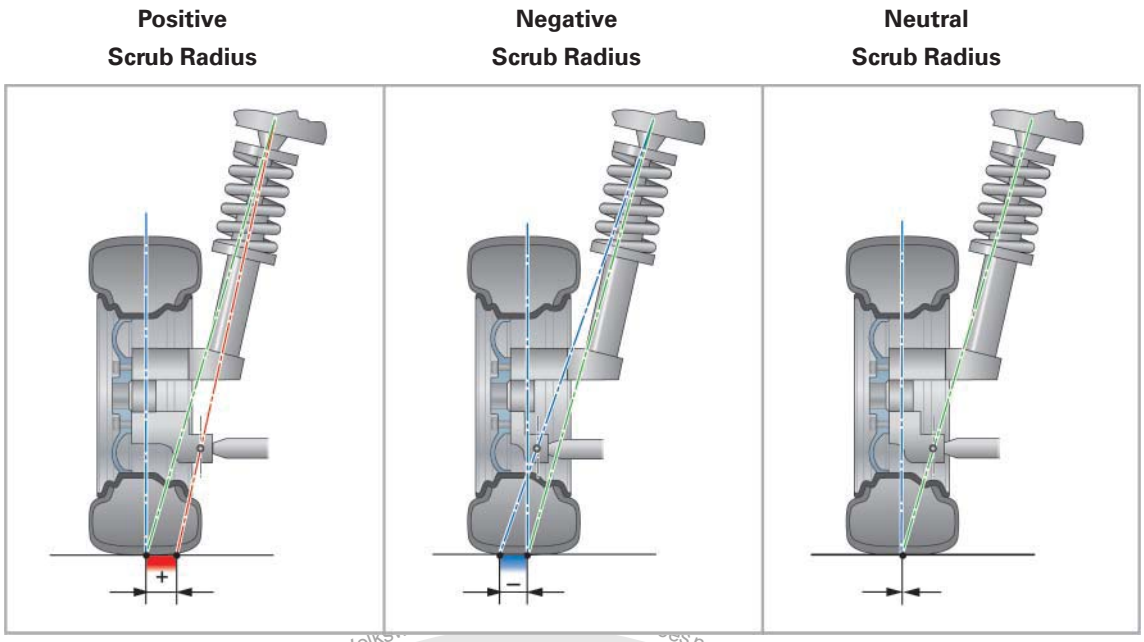
The steering axis inclination causes the vehicle to lift when steered, generating steering return forces. This results in automatic centering of the wheel in a hands-off situation.



Scrub Radius

The scrub radius is the distance from the wheel contact point to the point where the extended steering axis meets the road surface.

The scrub radius can be positive (+), negative (–) or zero. The scrub radius results from the camber, steering axis inclination and wheel offset.

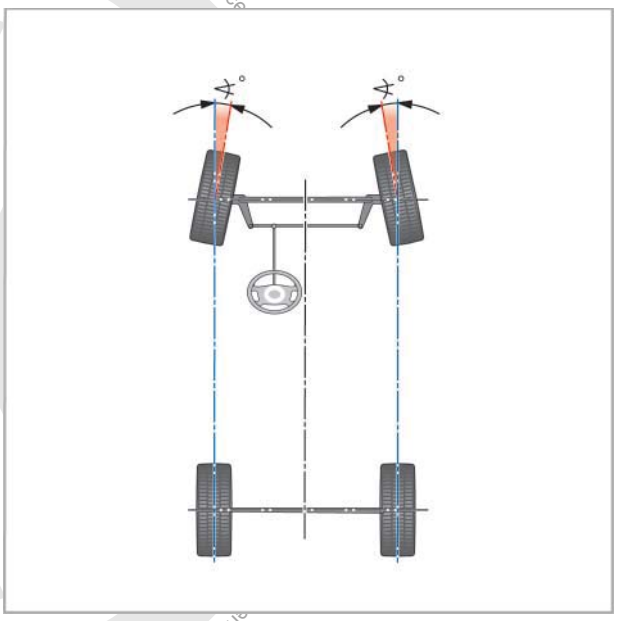


S448_021

Scrub radius – tracking stability

If the scrub radius is negative, the wheel with the greater frictional value is turned more to the inside – autonomous countersteer results – the driver just has to hold onto the steering wheel.

When the scrub radius is zero, the transfer of interfering forces to the steering will be prevented if the brakes pull to one side or there is a faulty tire.



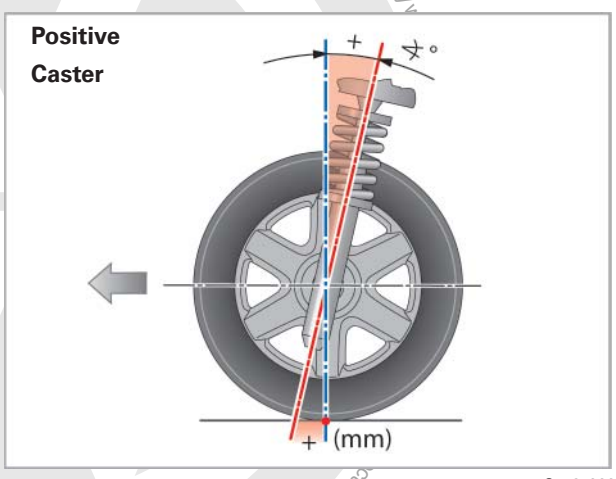
S448_022

Caster

Caster is the inclination of the steering axis along the vehicle longitudinal axis from a vertical line to the road surface.

Caster can be positive or negative.

- Positive: The "wheel contact point is behind the point at which the steering axis intersects the road surface" – the wheels are pulled => tracking stability
- Negative: The "wheel contact point is in front of the point at which the steering axis intersects the road surface" – the wheels are pushed



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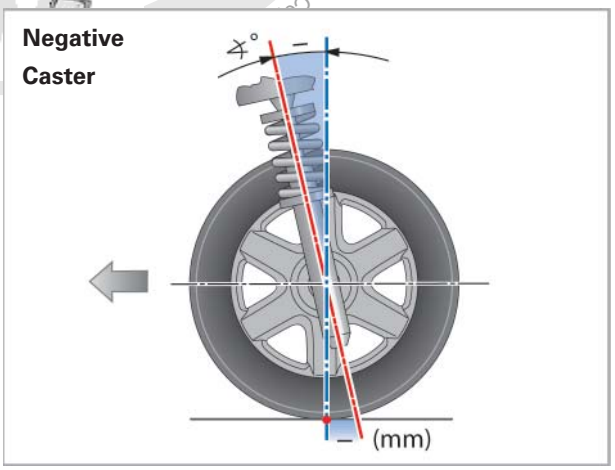

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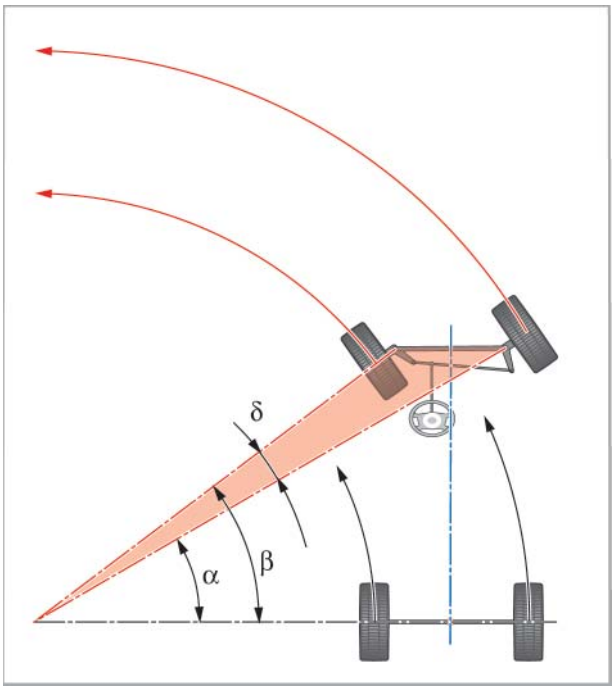


S448_024

Toe-out on turns

Toe-out on turns is the difference between the angles of the inside and outside wheels when the vehicle is cornering.

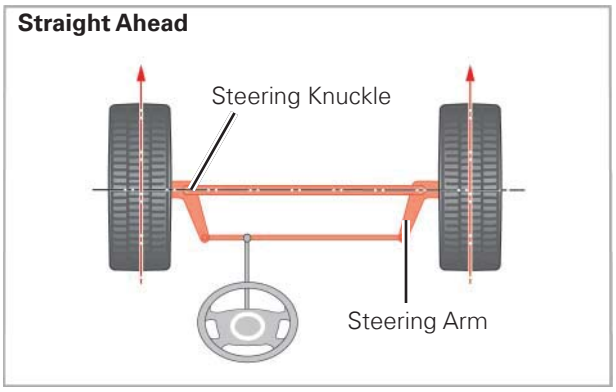
Toe-out on turns is determined by the Ackermann steering geometry

Ackermann Steering Geometry

The front axle, the steering arms and the steering rack with the tie rods form the Ackermann steering geometry.

The Ackermann steering geometry creates different steering angles when the vehicle is cornering.

The steering knuckle and steering arms are not positioned at a 90° angle to each other. This results in unequal travel at the ends of the two steering arms when the steering wheel is turned. As a result, the wheels are turned at different angles.



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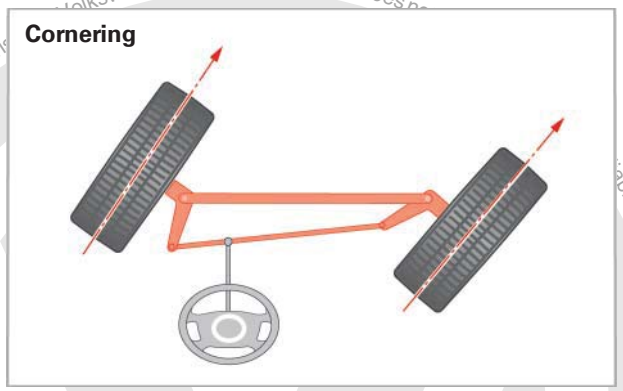

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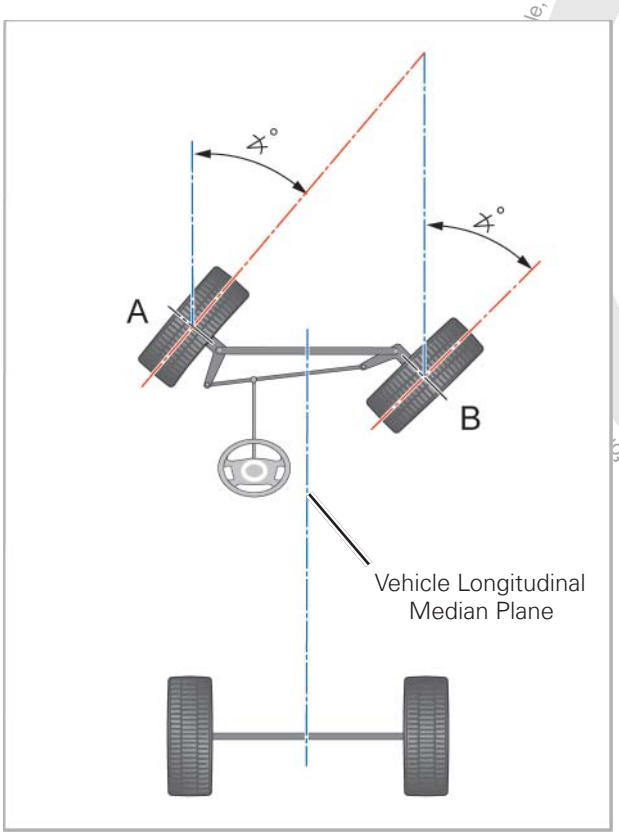


S448_026

Maximum steering angle

The maximum steering angle is the angle of the center plane of the inside wheel (B) and of the outside wheel (A) relative to the vehicle longitudinal median plane when the steering wheel is at full left or right lock.

The maximum steering angle should be the same on both sides, resulting in identical turning circles.

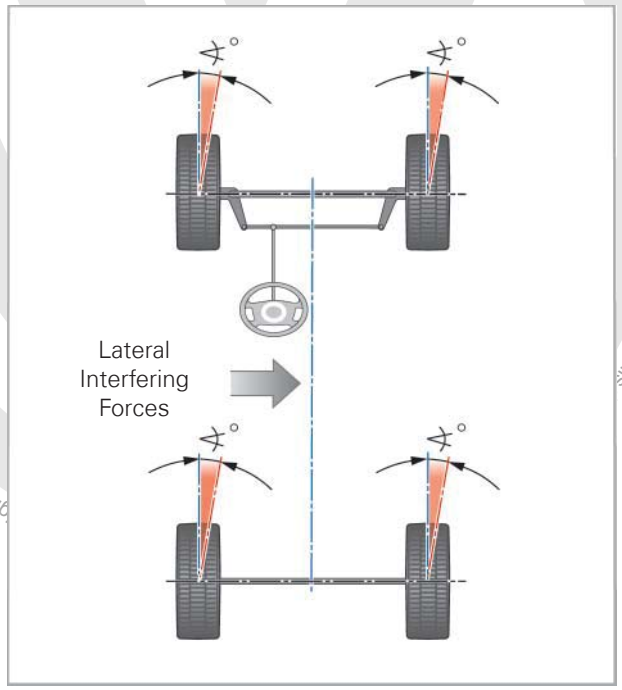
Slip Angle

The slip angle is the angle between the wheel plane and the direction of travel (direction that the wheel moves).

A slip angle is formed when a rolling vehicle is subjected to interfering lateral forces, for example, wind and centrifugal forces. The wheels change their direction of travel and run at a specific angle diagonally to the original direction of travel.

If the slip angle is the same at the front and rear, the handling will be neutral. If the slip angle is greater at the front, the vehicle will understeer. If the slip angle is greater at the rear, the vehicle will oversteer.

The slip angle depends on the wheel load, interference force, tire type, tire tread, tire inflation pressure and static friction.



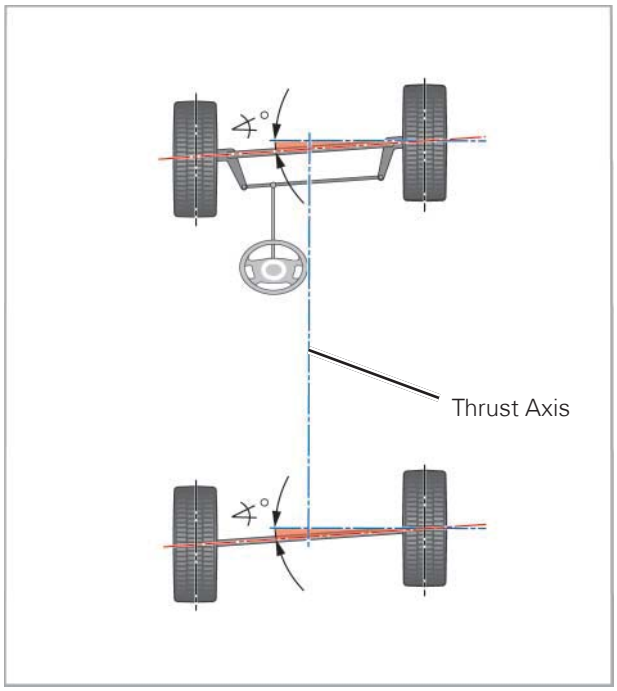
S448_027

Wheel set-back

The wheel set-back is the angle between a line connecting the wheel contact point and a line that runs at 90° to the thrust axis.

The wheel set-back can be positive or negative.

- Positive – right wheel is set to the front
- Negative – right wheel is set to the rear



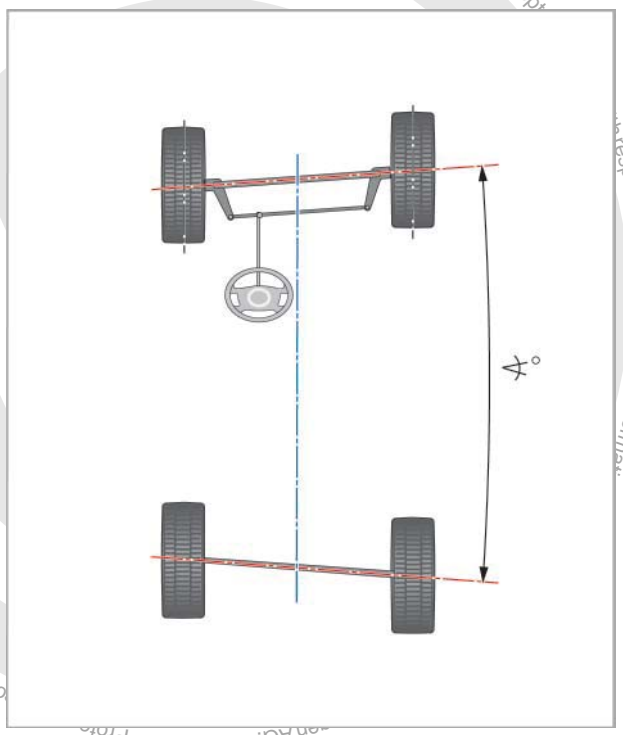
S448_028

Wheelbase Difference

The wheelbase difference is the angle between a line connecting the front wheel contact points and a line connecting the rear wheel contact points.

The wheelbase difference can be positive or negative.

- Positive – the wheelbase is longer on the right-hand side than on the left-hand side
- Negative – the wheelbase is shorter on the right-hand side than on the left-hand side



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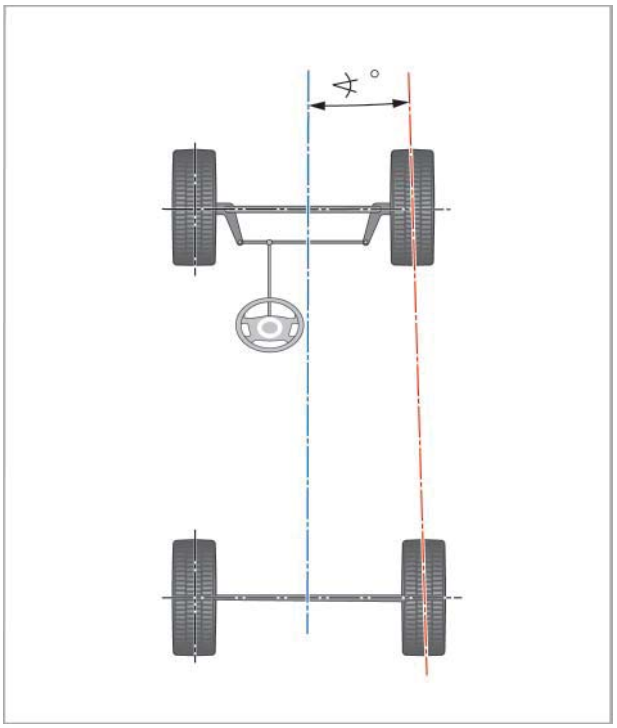
Lateral offset

The lateral offset is the angle between a line connecting the wheel contact points of the right-hand or left-hand front and rear wheels and the thrust axis.

The lateral offset can be used to diagnose possible body damage.

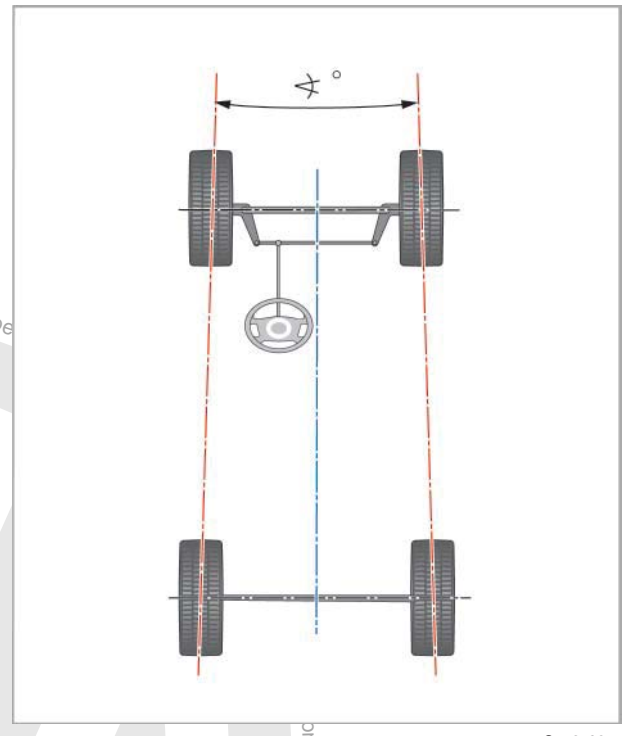


S448_030

Track Width Difference

The track width difference is the angle between a line connecting the wheel contact points of the left-hand front and rear wheels and a line connecting the wheel contact points of the right-hand front and rear wheels.

The track width is positive if the rear track width is larger than the front track width.

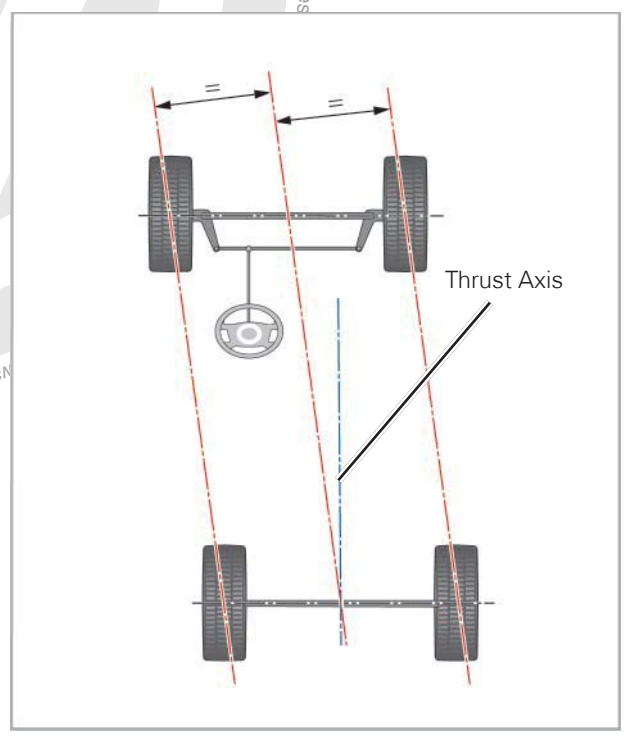


S448_031

Axle offset

The axle offset is considered to be positive if the rear axle is offset to the right of the front axle in relation to the thrust axis.

The axle offset can be used to diagnose possible body damage.



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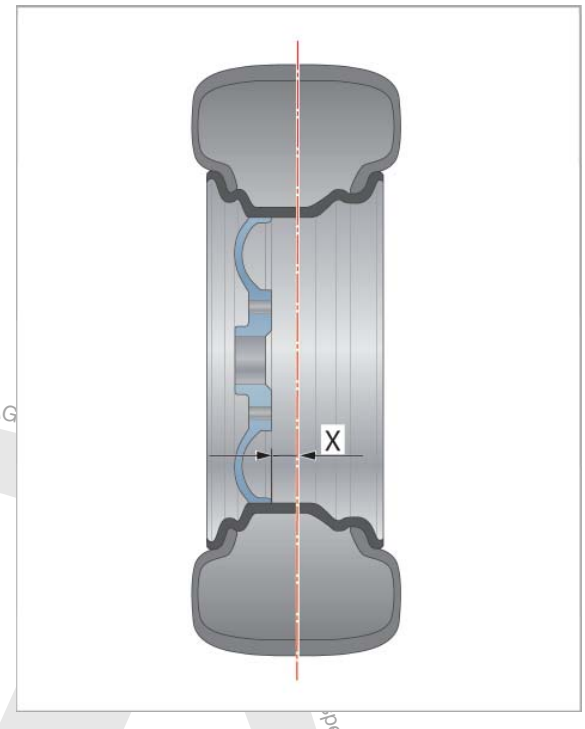
Wheel Offset

The wheel offset is the measurement from the centerline of the wheel to the hub mounting surface of the wheel ("x").

The wheel offset influences the track width and the scrub radius.



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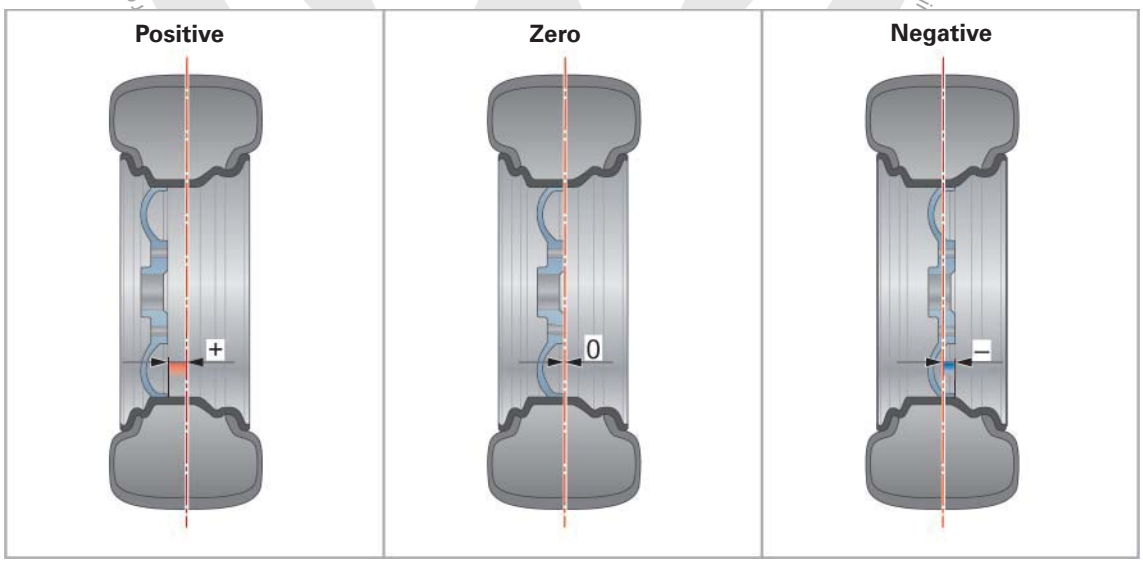
There are three variants of wheel offset:

- Zero – If the hub mounting surface is precisely on the centerline of the wheel
- Positive – If the hub mounting surface, relative to the centerline of the wheel, is offset to the outside of the wheel – reduction in track width
- Negative – If the hub mounting surface, relative to the centerline of the wheel, is offset to the inside of the wheel – increase in track width



S448_034

Wheel Alignment

Why do the Wheels Need to be Aligned?

Correct wheel alignment is necessary for optimum handling and minimum tire wear.

Incorrect adjustments such as the toe or camber, will affect the road safety of the vehicle.

Incorrect deviations in the wheel alignment can also occur following repairs when suspension parts are replaced.

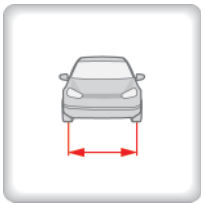
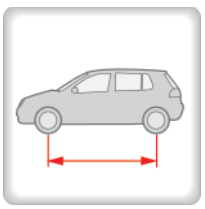
Incorrect alignment can lead to incorrect wheel positions, which can cause damage to the tires.

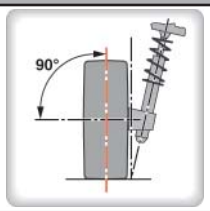
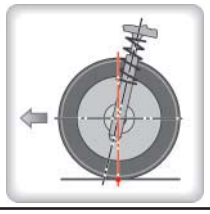
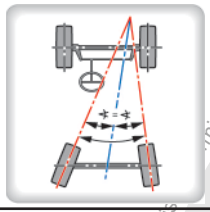
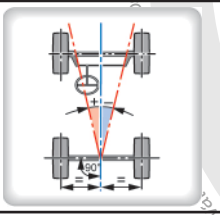
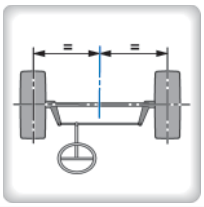
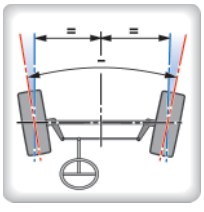
If handling problems or noticeable wear occur, wheel alignment can be used to diagnose the causes and determine what action needs to be taken to restore the correct suspension set-up.

Wheel alignment should only be performed by properly trained personnel.

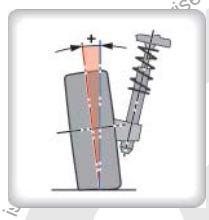
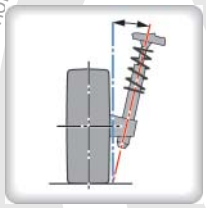
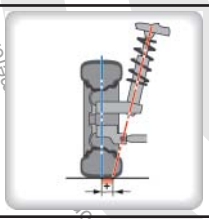
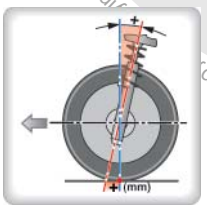
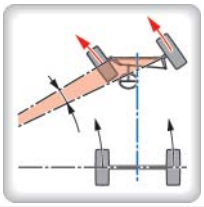
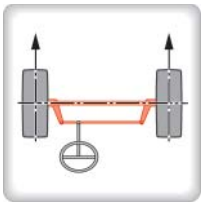
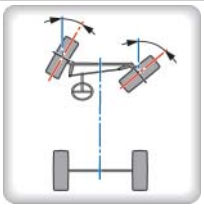
Suspension parameters – Effects of faults - Adjustment possibilities

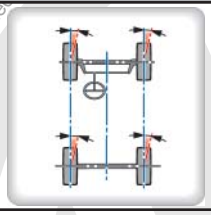
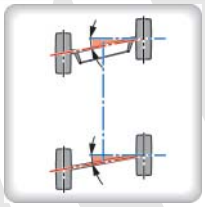
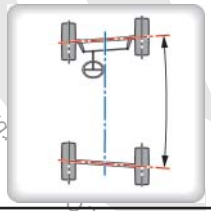
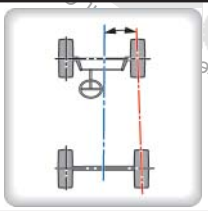
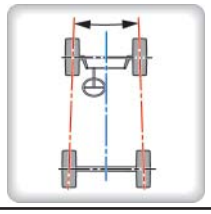
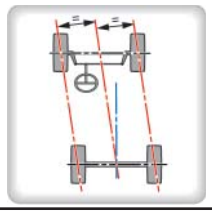
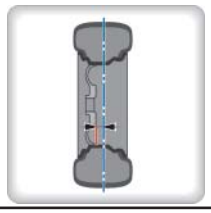
The suspension parameters are distinguished by non-adjustable original and reference design parameters and adjustable parameters. These will be explained separately in the following table.

Suspension parameter (basic terms)		Effect of fault - Adjustment possibility
Track width		Original and reference design parameter – faults have no effect. • Non-adjustable suspension parameter
Wheelbase		Original and reference design parameter – faults have no effect.Non-adjustable suspension parameter

Suspension Parameter (basic terms)		Effect of Fault - Adjustment Possibility
Wheel center plane		Original and reference design parameter – faults have no effect. • Non-adjustable suspension parameter
Wheel contact point		Original and reference design parameter – no fault effects. • Non-adjustable suspension parameter
Thrust axis		If this straight line deviates from the vehicle longitudinal median plane, a thrust axis deviation results and the vehicle will run to one side – this is known as "crabbing". • Adjustable suspension parameter
Vehicle longitudinal median plane		Original and reference design parameter – no fault effects. • Non-adjustable suspension parameter
Thrust axis deviation		If the thrust axis deviation is an angle other than zero, the vehicle will run to one side – this is known as "crabbing". • Adjustable suspension parameter
Straight ahead		In this wheel position, the front wheels are set at the same individual toe angle to the vehicle longitudinal median plane. The rear axle is aligned in this position
Toe		Too much negative toe (toe-out): Wear on inside of tire and poor straight running. Too much positive toe (toe-in): Wear on outside of tire and poor straight running. • Adjustable suspension parameter

Wheel Alignment

Suspension Parameter (basic terms)		Effect of Fault - Adjustment Possibility
Camber		Too much negative camber: Better directional stability in corners, but one-sided overloading and consequently greater wear on inside of tire. Too much positive camber: Poorer directional stability, increased wear on the outside of the tire. • Vehicle-dependent adjustable suspension parameter
Steering axis inclination (SAI)		Steering axis inclination too large: High steering and holding forces. Steering axis inclination too small: Poor steering wheel return, sensitive to tire faults, vehicle may pull to one side. Right/left steering axis inclination different: Vehicle tends to pull to side. • Non-adjustable suspension parameter
Scrub radius		The scrub radius is influenced by the camber, steering axis inclination and wheel offset and can only be changed by adjusting these parameters. • Non-adjustable suspension parameter
Caster		Too much positive caster: High steering and holding forces. Too much negative caster: Poor steering wheel return, sensitive to tire faults Right/left caster different: Vehicle tends to pull to side. The caster changes, for example, depending on the load in the luggage compartment. • Non-adjustable suspension parameter
Toe-out on turns		Original and reference design parameter – no fault effects. • Non-adjustable suspension parameter
Ackermann steering geometry		The front axle, the steering arms and the steering rack with the track rods form the Ackermann steering geometry. The Ackermann steering geometry creates the steering angles that are required when the vehicle is cornering. • Non-adjustable suspension parameter
Max. steering angle		If the maximum steering angle differs for left/right full lock, the turning circle will be different on the left and right. This is a design specification. • Adjustable suspension parameter

Suspension Parameter (basic terms)		Effect of fault - Adjustment Possibility
Slip angle		The slip angle results from the parameters of wheel load, lateral force, tire design, tire tread, tire inflation pressure and static friction coefficient. • Non-adjustable suspension parameter
Wheel setback		The wheel set-back is a measure of the angle of an axle. • Non-adjustable suspension parameter
Wheelbase difference		The wheelbase difference is a measure of the angle of the axles. • Non-adjustable suspension parameter
Lateral offset		Lateral offset can result from body damage. • Non-adjustable suspension parameter
Track width difference		A track width difference can result from body damage. • Non-adjustable suspension parameter
Axle offset		Axle offset can result from body damage. • Non-adjustable suspension parameter
Wheel offset		Original and reference design parameter. • Incorrect offset alters track width and other related suspension measurements

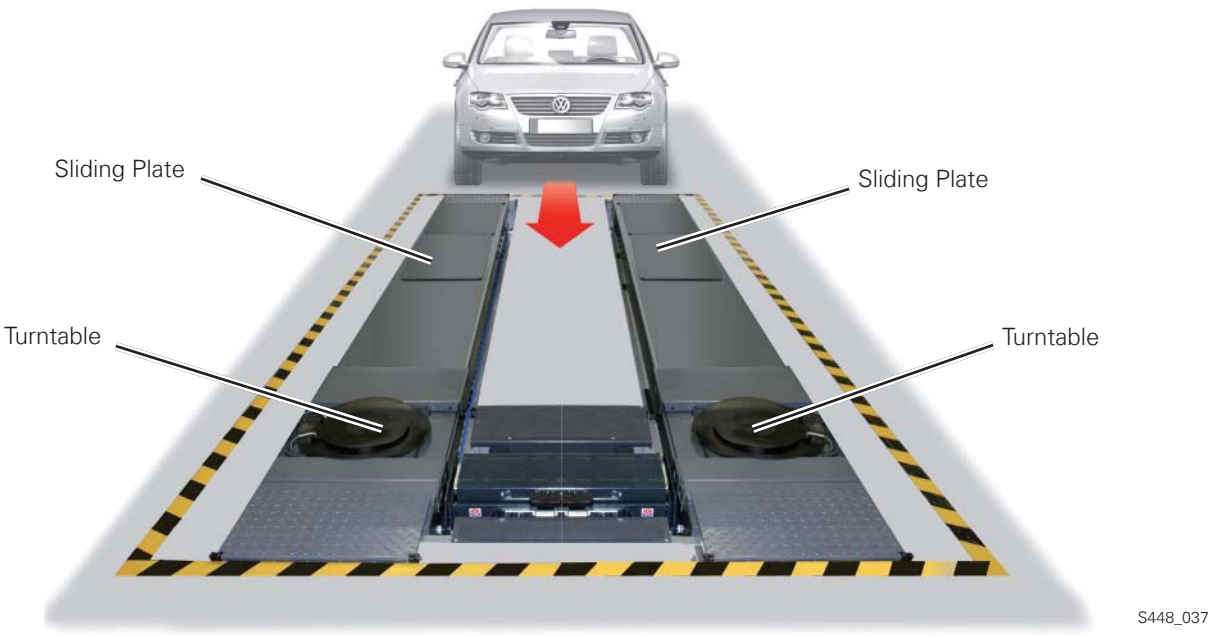
Wheel Alignment

Workshop Equipment for Wheel Alignment

Special components are used for wheel alignment. They will be described over the following pages.

Wheel alignment platform

Wheel alignment is performed using a special platform.



The alignment equipment must be able to produce repeatable measurements. In order to perform these:

- The wheel alignment platform must be clean and the turntables and sliding plates must move smoothly
- The turntables and sliding plates should be locked in place with pins or similar locking devices so that they cannot move while the vehicle is driven on or off of the platform
- All wheel contact points must be at the same height
- The maximum permitted height differences should be maintained both in the lowered position for the initial and final measurements and in the raised position for the adjustment work

Wheel Alignment System

For precise wheel alignment, an alignment system that meets Volkswagen's specifications must be used.

We cannot look at every alignment system in this SSP. The following pages describe wheel alignment using a computer-supported wheel alignment system as an example.

S448_044

Beissbarth Alignment Equipment

The system has the following main components:

- Computer with monitor and corresponding alignment software
- Input devices such as a keyboard and remote control
- Output unit such as a printer
- Sensors
- Clamps for sensors

Hunter Alignment Equipment

John Bean Alignment Equipment

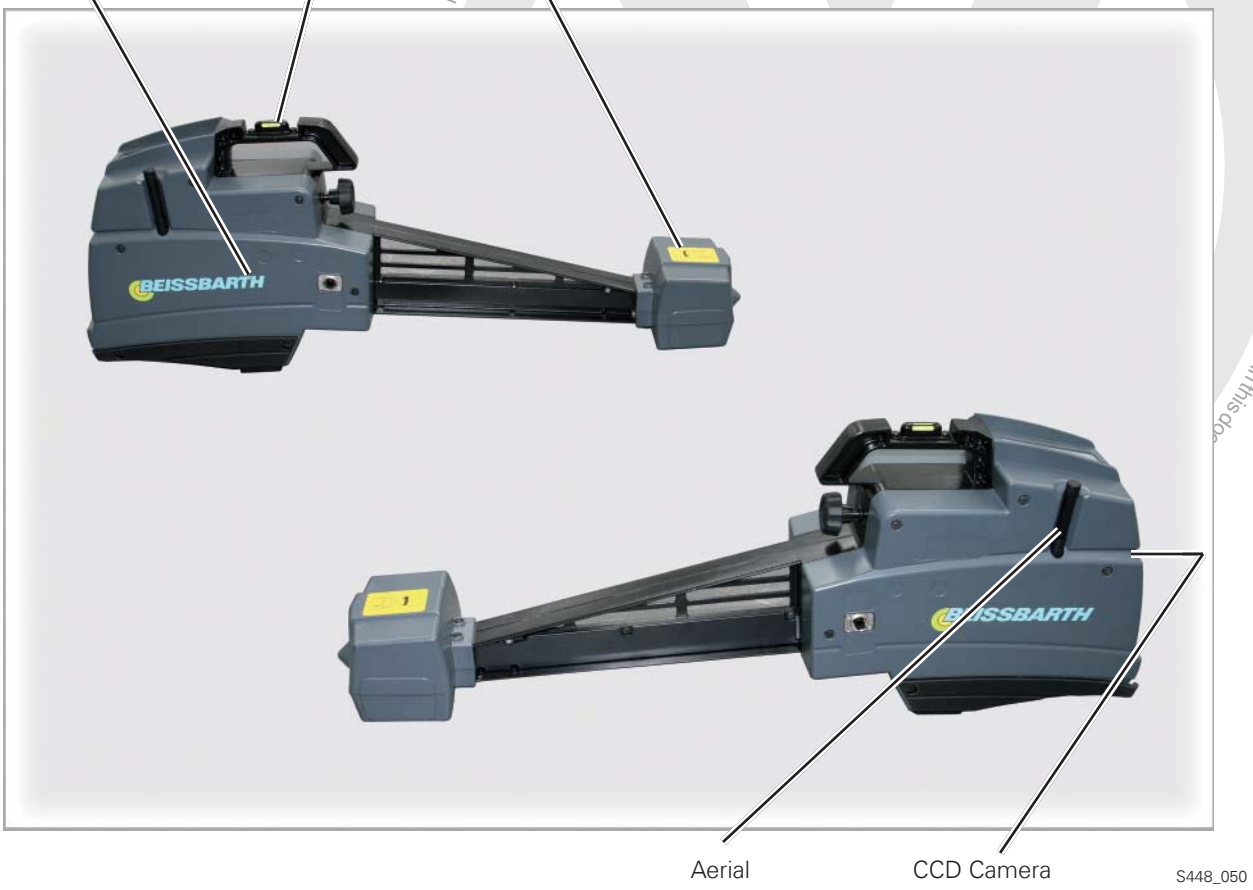
Wheel Alignment

Sensors

The sensors work on either rechargeable batteries or direct power. Each of the four sensors is equipped with two Charge Coupled Device (CCD) cameras that allow infrared measurements.

The measurement is made with an infrared light beam that is projected through a lens to a light mark. All measurements on the horizontal plane are carried out with two transceiver CCD cameras that communicate with each other.

The measurement data is transferred to the measuring box wirelessly.



The sensors form a closed measuring rectangle around the vehicle (see page 29).

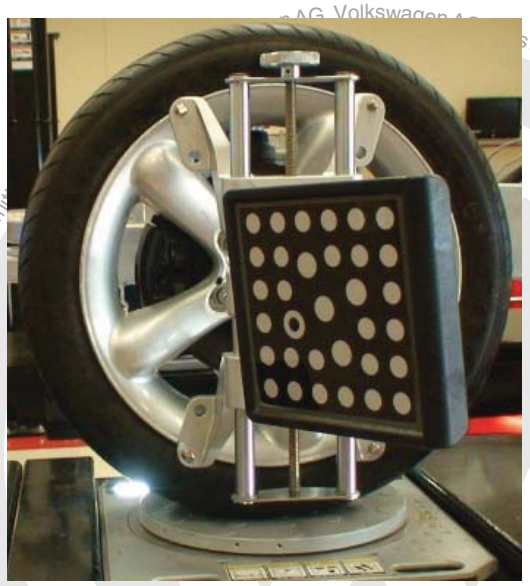
Measuring Unit Bracket

The measuring unit bracket is universally suitable for wheels from 10 inches to 23 inches. The brackets on the clamp simply fit onto the tire tread.

The accessories such as plastic sleeves prevent damage to painted wheels or alloy wheels.

S448_048

Beissbarth Equipment Example



John Bean Equipment Example

Hunter Equipment Example

Wheel Alignment

Brake pedal actuator

The brake pedal actuator prevents the wheels from rolling on the turntables when the steering wheel is turned. This is absolutely necessary to obtain precise caster, steering axis inclination and track difference angle measurements.

S448_114

Bases for Wheels

Turntable

The turntable can be ordered as an accessory for the wheel alignment computer.

It allows the steering to be turned.

S448_038

Sliding plate

The sliding plate can be ordered as an accessory for the wheel alignment computer.

The sliding plate allows wheel alignment to be performed on vehicles with different wheelbases without having to reposition the sliding plate.

S448_039

The turntables and the sliding plates should be unlocked after wheel rim run-out compensation.

Wheel Alignment

Wheel Alignment Software

Once the preparations have been completed and the alignment system has been set up, you can start the wheel alignment process.

The measurements are made in single steps with the aid of a dialog box on the computer screen.

The software has been specially developed for VW. It provides vehicle-specific measuring procedures and information. It provides information on the adjustment procedures and contains alignment data for vehicles throughout the Volkswagen Group.

Beissbarth Software Example

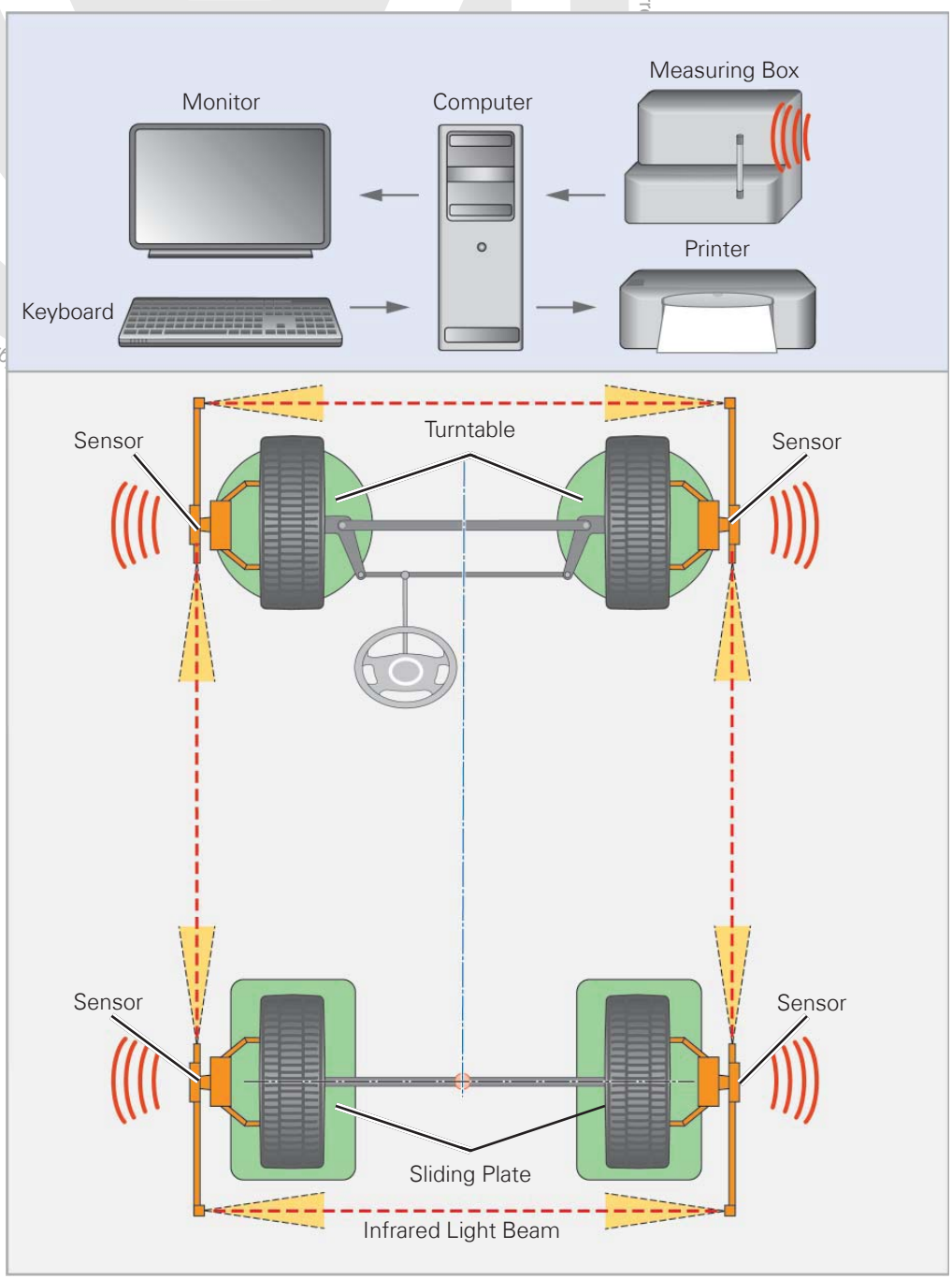
The screenshots are only examples.

Hunter Software Example

John Bean Software Example

Wheel Alignment System Set-Up

The illustration shows the communication paths of the wheel alignment system.



S448_047

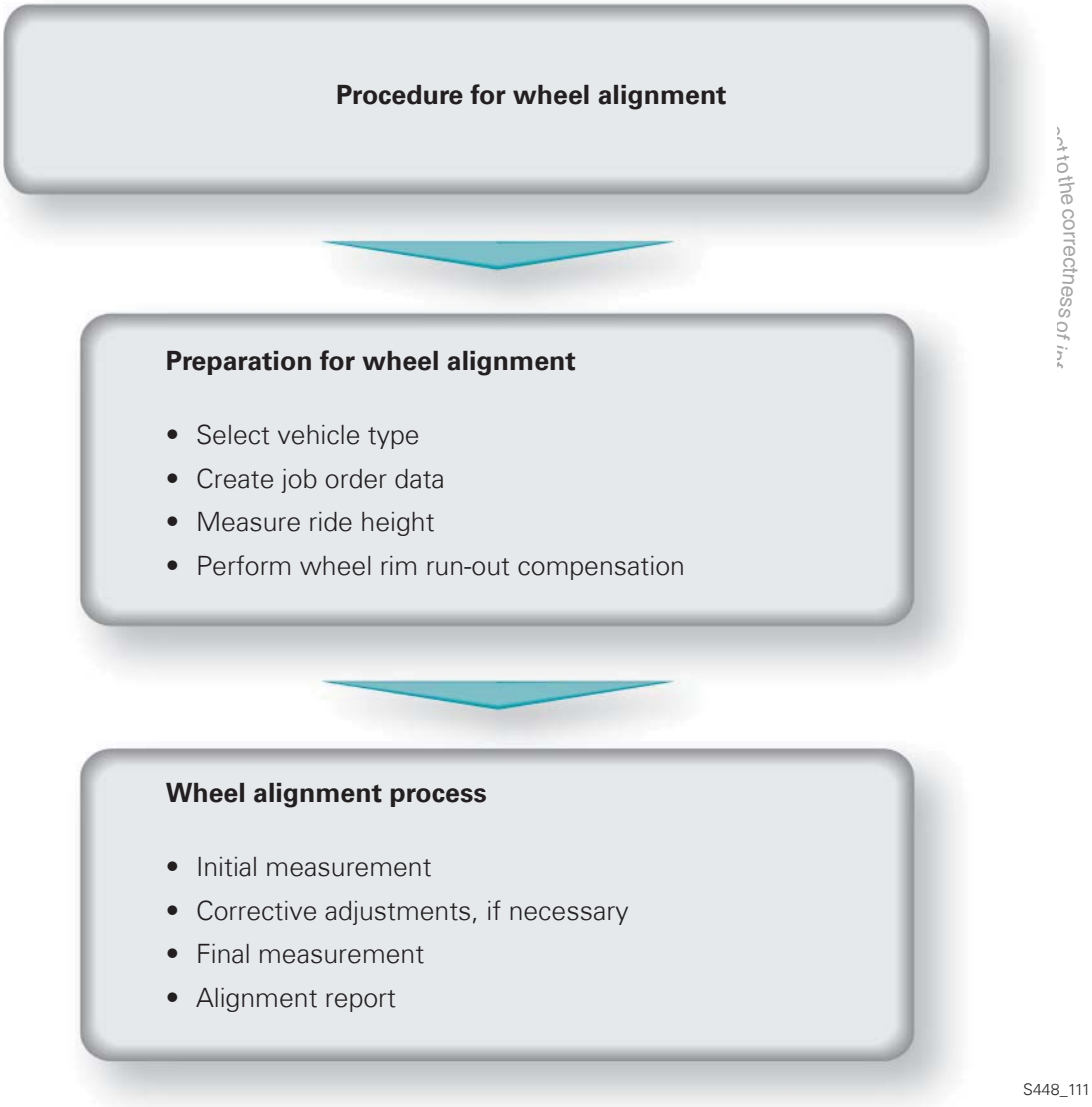
The infrared light beams emitted by the measuring system must not be broken during the measurement.

Wheel Alignment

Carrying Out the Wheel Alignment

The wheel alignment process compares the existing vehicle measurements to the specified vehicle measurements.

Adjustments can be made if the specifications vary too much.



In the following descriptions, wheel alignment will be explained using electronic alignment with a wheel alignment computer.

Preparations for Wheel Alignment

The following table provides an overview of the basic work steps to prepare for the wheel alignment.

Preparations for wheel alignment
Line up the turntables and sliding plates and adjust the lifting platform width for the track width and wheelbase of the vehicle.
Drive the vehicle onto the turntables and sliding plates. The wheels must be in the center of the turntables and plates.
Secure vehicle against rolling.
Test prerequisites: Please observe the vehicle-specific information in the wheel alignment software. • Check the general condition of the suspension and shock absorbers • Check that the wheel rims and tires are the same size • Check the suspension, wheel bearings, steering and steering linkage for impermissible play and damage • The tread depth of the tires on one axle may differ by a maximum of 2mm • The inflation pressure of the tires must comply with the specifications • The curb weight of the vehicle must be observed • The fuel tank must be full. Fill it up if necessary • The spare wheel and vehicle tool set must be in the correct area in the vehicle • The water reservoir for the windscreen and headlight washer system must be full • Make sure that none of the sliding plates or turntables are at their end position during the alignment process • Compensating weights can be used for missing liquids • The vehicle should be cool (e.g. Touareg/Phaeton with air suspension)
Attach the measuring unit brackets to the wheels. The following criteria should be observed: • Sleeves should be used if necessary • Secure attachment of the measuring unit bracket • Same attaching surface of measuring unit bracket • Good form fit and positive engagement

Wheel Alignment

Settings for Wheel Alignment

Ride Height

The ride height has a decisive influence on the results of the wheel alignment because the toe and camber readings will be different if the ride height differs due to the suspension geometry.

The ride height is determined by measuring vertically from the center of the wheel to the lower edge of the wheel arch.

It is also possible to measure the distance from the lower edge of the wheel arch to the rim flange and then add half of the wheel rim diameter (the wheel rim diameter must be measured).

This method is recommended because the center of the wheel could be obscured by parts of the measuring equipment such as the quick clamp units.

The ride height can be varied by changing the load, which also changes the readings for the suspension. The vehicle should have the correct curb weight before the wheel alignment is started.

You must make sure that the ride height is within the tolerance range specified by the manufacturer. If the tank is not completely filled with fuel, changes to the toe, camber and caster readings will result.

Wheel Rim Run-Out Compensation

Wheel rim run-out compensation must be performed. During the process of one revolution, the lateral runout and the clamping errors of the measuring unit bracket are measured. This will allow for compensation of the toe and camber readings.

The wheels must be lifted off the ground to perform the wheel rim run-out compensation. Loosen the securing screw on the sensor so that the rotational angle sender can measure the wheel position.

S448_052

Beissbarth Equipment Example

Hunter Equipment Example

The vehicle should be lowered onto the centers of the turntables and sliding plates.

Wheel Alignment

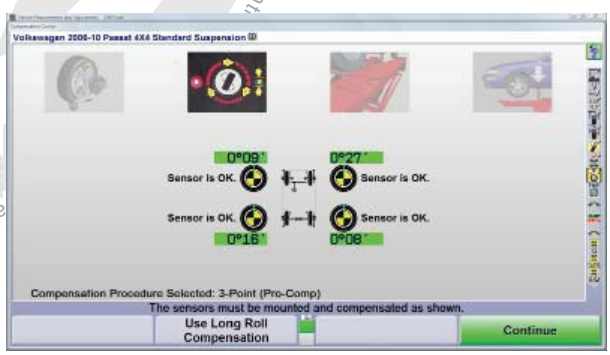
After the wheel rim run-out compensation has been started, the wheel should be turned one quarter of a revolution three times in the direction of travel in accordance with the user guide on the screen.

S448_053

Beissbarth Software Example

The following work is also necessary after the wheel rim run-out compensation and before the initial measurement

- Pull out the locking pins from the turntables under the wheels to prevent tension in the suspension
- Lower the vehicle
- Rock the vehicle at the front and rear axle so that the suspension settles in a stable central position
- Lock the brakes by installing the brake pedal actuator



Hunter Software Example

The screens shown over the following pages are purely examples.

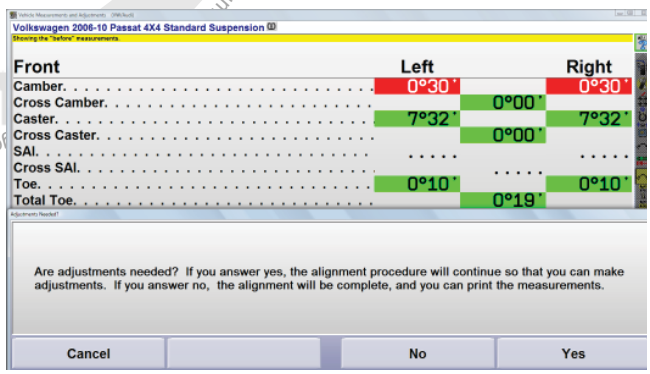
Initial Measurement

The initial measurement should be carried out with the following basic steps:

- Set wheels to straight-ahead
- Align spirit level on sensors
- Measure the rear axle values
- Perform steering routine by turning wheels to 20° on both sides in order to determine caster, steering axis inclination and toe-out on turns.
- Return steering wheel to straight ahead position.
- Measure toe and camber of front axle
- Perform steering routine for measuring maximum left/right steering angle
- Review specified/current readings and compare them. If all readings are within the permitted tolerances, an alignment report can be printed out immediately and the wheel alignment can be ended on this vehicle
- If the current readings are outside the tolerance range, adjustments are required. All values that can be adjusted on the vehicle are indicated by a tool icon during the adjustment work. Corresponding adjustment diagrams and information can be displayed on the screen for these readings at the touch of a button

S448_073

Beissbarth Software Example



Hunter Software Example

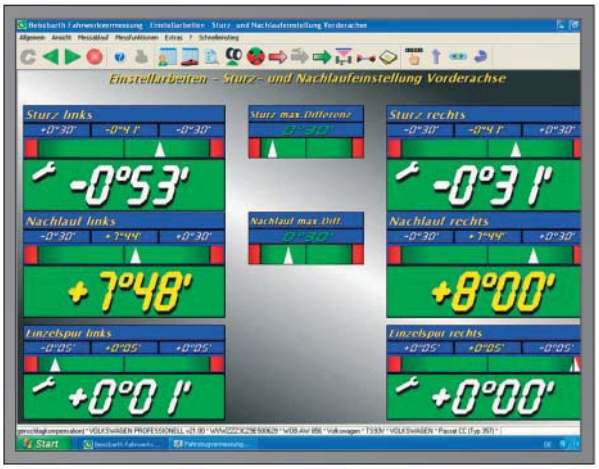
John Bean Software Example

Due to possible changes and updates, the instructions in ElsaWeb should be referenced during the preparation and performance of the wheel alignment.

Adjustment Work – Camber and Caster Setting on Front Axle

The following can be set:

- Left camber
- Left caster
- Left toe
- Right camber
- Right caster
- Right toe
- Camber difference
- Caster difference



S448_056

Beissbarth Software Example

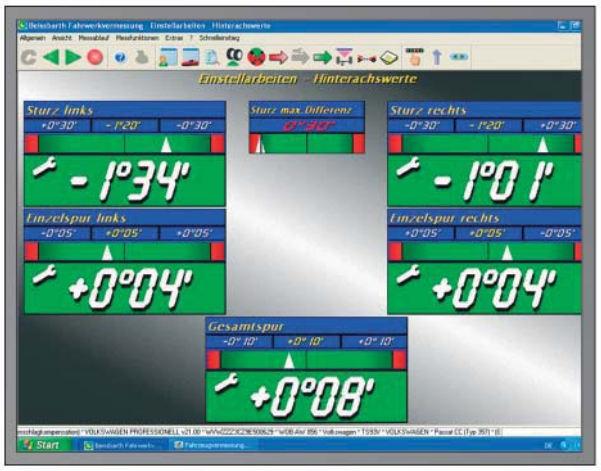
Hunter Software Example

Adjustment Work – Rear Axle Settings

The following can be set:

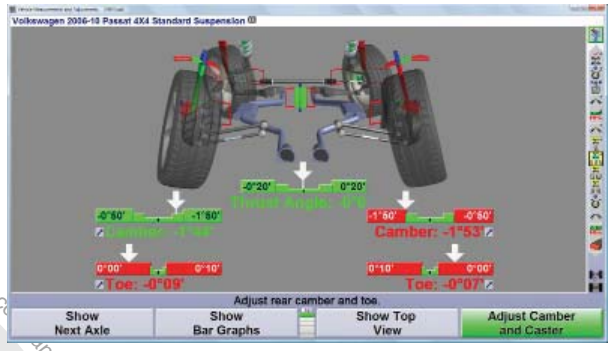
- Left camber
- Right camber
- Left toe
- Right toe
- Total toe
- Camber difference

On torsion beam axles installed on some Jettas, individual adjustments cannot be made. The readings can be averaged out by shifting the axle.

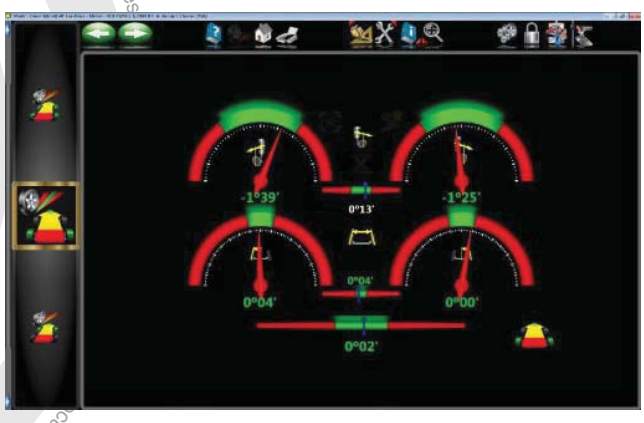


S448_057

Beissbarth Software Example



Hunter Software Example

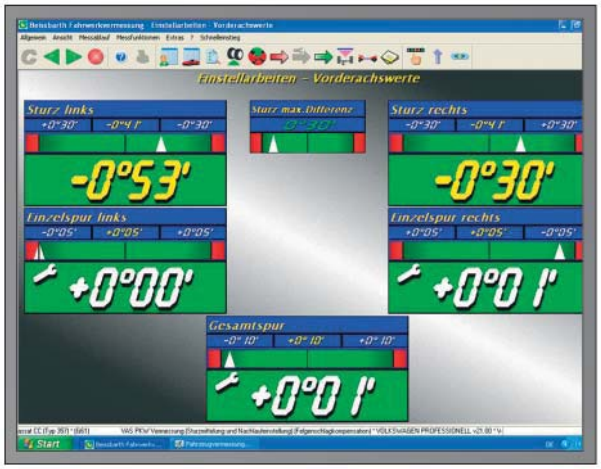


John Bean Software Example

Adjustment Work – Front Axle Settings

The following can be set:

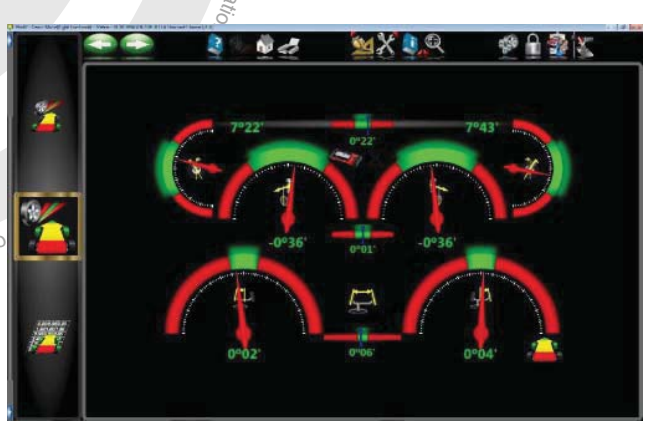
- Left camber
- Right camber
- Left toe
- Right toe
- Total toe



S448_059

Beissbarth Software Example

Hunter Software Example



John Bean Software Example

Final Measurement

The final measurement should be performed in the same way as the initial measurement.

The alignment report is displayed at the end of the final measurement.

If all readings from the final measurement are within the permitted tolerances, an alignment report can then be printed and the wheel alignment can be ended on this vehicle.

Before the final measurement, all loosened screw connections on the axles should be tightened to the specified torques.

S448_061

Alignment report

The customer and vehicle data is shown at the top of the alignment report.

In the lower section, you will see the specified data related to the readings from the initial and final measurement.

S448_072

Beissbarth Software Example

John Bean Software Example

Hunter Software Example

Using Wheel Alignment Stands

Driver Assistance Systems

Driver assistance systems provide physical and psychological support for the driver. As ever, the driver is solely responsible for his vehicle and its performance.

Adaptive Cruise Control – ACC

If the vehicle is equipped with the Adaptive Cruise Control (ACC) system, the radar sensors used by the system may need to be re-calibrated after wheel alignment.

This is absolutely necessary if the rear axle toe has been adjusted during the wheel alignment. You will need the setting device VAS 6430 to calibrate the radar sensor.

S448_115

Setting Device VAS 6430

Rear View Camera – Reversing Camera System

If a vehicle is equipped with the rear view system, the system's camera will need to be re-calibrated if the toe or camber settings of the rear axle have been adjusted during wheel alignment.

The calibration unit VAS 6350 is used to calibrate the rear view camera.

Adjusting the settings on the rear axle also changes the thrust axis of the vehicle. The optimum scanning area of the rear view camera depends on the thrust axis.

S448_116

Calibration Unit VAS 6350

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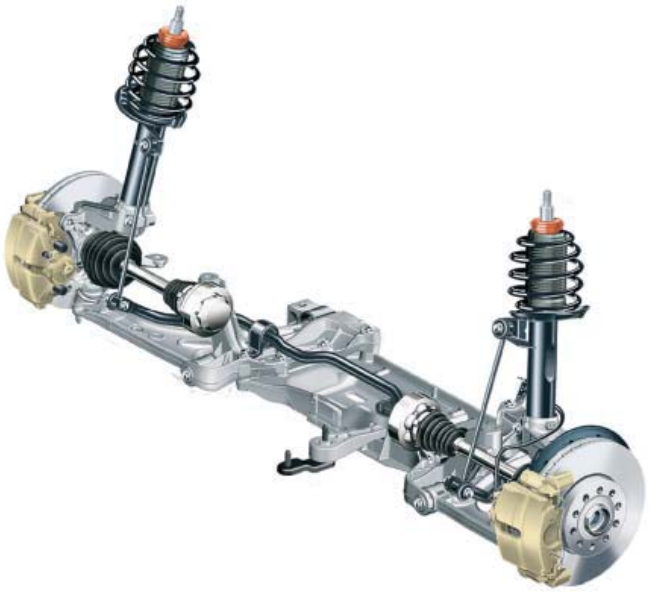
Axles

Types of Axle

The following are some examples of the types of axle used by Volkswagen.

McPherson Strut Front Suspension on the 2005 Jetta

- Toe adjustable
- Camber not adjustable, can be influenced by centering the axle



S448_006

Four-Link Rear Axle on 2005 Jetta

- Toe and camber separately adjustable

S448_007

Torsion-Beam Rear Axle on 2011 Jetta

- Cannot be adjusted
- Can only be centered

S448_070

Four-link 4Motion Rear Axle on Passat and Tiguan

- Toe and camber separately adjustable

S448_069

Axles

Steel-spring Suspension or Air Suspension on Touareg

The Touareg can be equipped either with a steel-spring suspension system or an air suspension system. The illustrations show the version with air suspension.

Front Axle

- Toe, camber and caster separately adjustable

S448_008

Rear Axle

- Toe and camber separately adjustable

S448_106

Steel-spring Suspension or Air Suspension on Phaeton

The Phaeton can be equipped either with a steel-spring suspension system or an air suspension system. The illustrations show the version with air suspension.

Front Axle

- Toe, camber and caster separately adjustable

S448_009

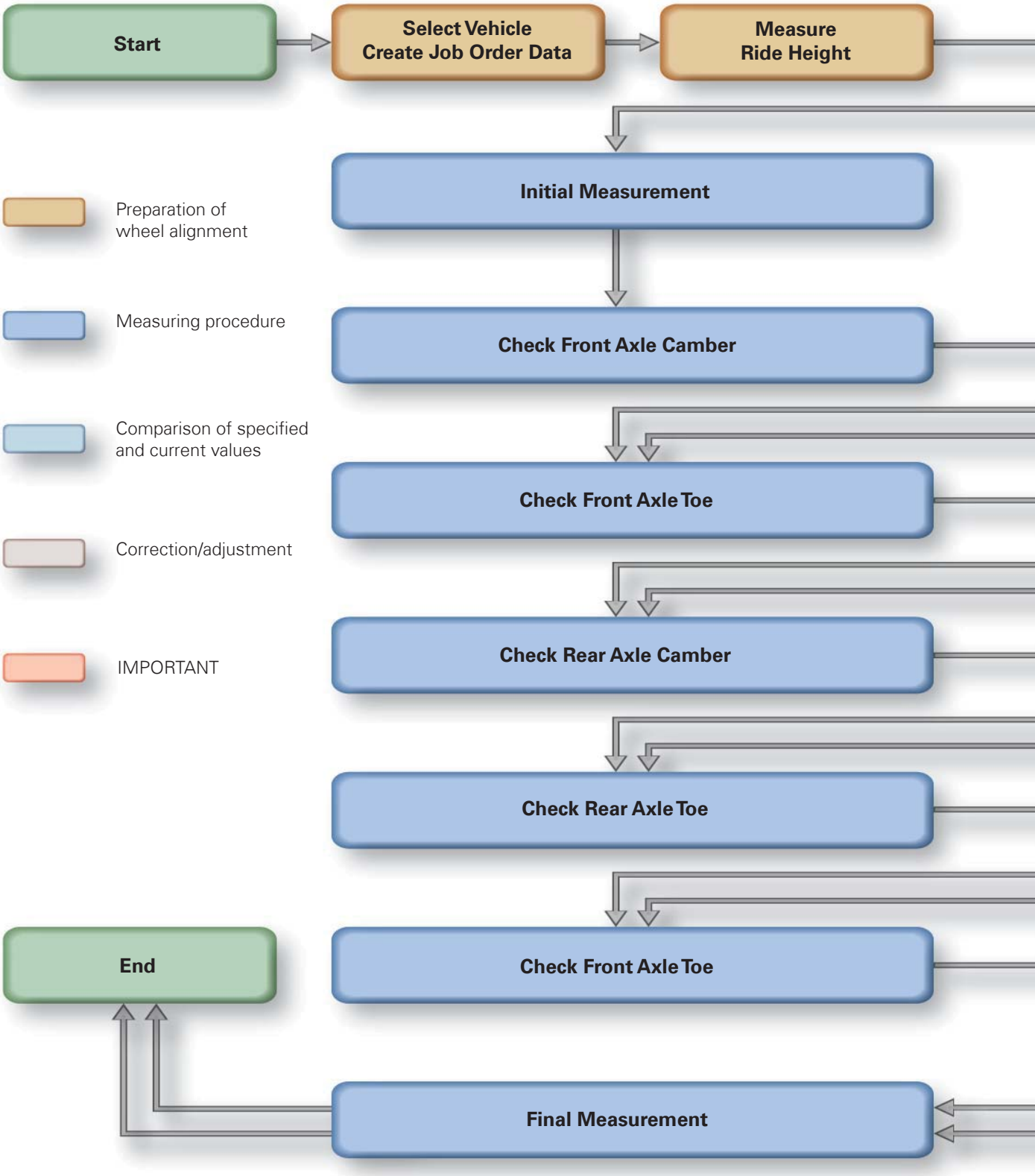
Rear Axle

- Toe and camber separately adjustable

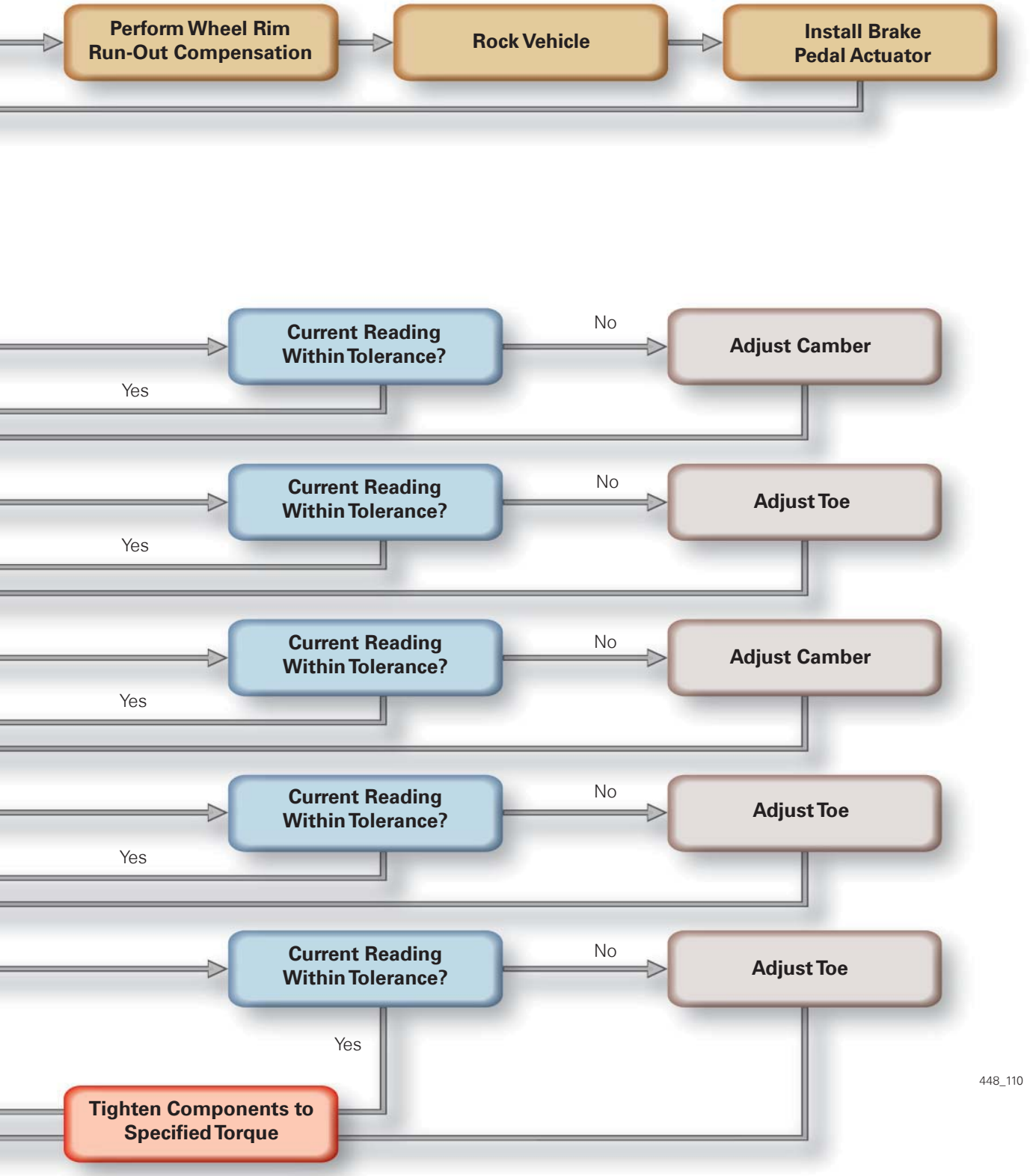
S448_107

Flowchart

Flowchart for Wheel Alignment (using example of 2009 Jetta)



Flowchart



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Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this Self-Study Program.

The Knowledge Assessment may or may not be required for Certification.

You can find this Knowledge Assessment at:

www.vwwebsource.com

For Assistance, please call:

Volkswagen Academy

Certification Program Headquarters

1-877-791-4838

(8:00 a.m. to 8:00 p.m. EST)

Or, E-mail:

concierge@volkswagenacademy.com

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Herndon, VA 20171
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Cautions & Warnings

Please read these WARNINGS and CAUTIONS before proceeding with maintenance and repair work. You must answer that you have read and you understand these WARNINGS and CAUTIONS before you will be allowed to view this information.

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized Volkswagen retailer or other qualified shop. We especially urge you to consult an authorized Volkswagen retailer before beginning repairs on any vehicle that may still be covered wholly or in part by any of the extensive warranties issued by Volkswagen.
- Disconnect the battery negative terminal (ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.
- Volkswagen is constantly improving its vehicles and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized Volkswagen retailer parts department for the latest information.
- Any time the battery has been disconnected on an automatic transmission vehicle, it will be necessary to reestablish Transmission Control Module (TCM) basic settings using the VAG 1551 Scan Tool (ST).
- Never work under a lifted vehicle unless it is solidly supported on stands designed for the purpose. Do not support a vehicle on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a vehicle that is supported solely by a jack. Never work under the vehicle while the engine is running.
- For vehicles equipped with an anti-theft radio, be sure of the correct radio activation code before disconnecting the battery or removing the radio. If the wrong code is entered when the power is restored, the radio may lock up and become inoperable, even if the correct code is used in a later attempt.
- If you are going to work under a vehicle on the ground, make sure that the ground is level. Block the wheels to keep the vehicle from rolling. Disconnect the battery negative terminal (ground strap) to prevent others from starting the vehicle while you are under it.
- Do not attempt to work on your vehicle if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medicine or any other substances that may impair you or keep you from being fully alert.
- Never run the engine unless the work area is well ventilated. Carbon monoxide (CO) kills.
- Always observe good workshop practices. Wear goggles when you operate machine tools or work with acid. Wear goggles, gloves and other protective clothing whenever the job requires working with harmful substances.
- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.
- Do not re-use any fasteners that are worn or deformed in normal use. Some fasteners are designed to be used only once and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual - replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.

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Cautions & Warnings

- Illuminate the work area adequately but safely. Use a portable safety light for working inside or under the vehicle. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

- Friction materials such as brake pads and clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing asbestos fibers and asbestos dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

- Finger rings should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.

- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly; do not attempt shortcuts. Use tools that are appropriate to the work and use only replacement parts meeting Volkswagen specifications. Makeshift tools, parts and procedures will not make good repairs.

- Catch draining fuel, oil or brake fluid in suitable containers. Do not use empty food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.

- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque listed.

- Keep sparks, lighted matches, and open flame away from the top of the battery. If escaping hydrogen gas is ignited, it will ignite gas trapped in the cells and cause the battery to explode.

- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond, or lake. Consult local ordinances that govern the disposal of wastes.

- The air-conditioning (A/C) system is filled with a chemical refrigerant that is hazardous. The A/C system should be serviced only by trained automotive service technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.

- Before doing any electrical welding on vehicles equipped with anti-lock brakes (ABS), disconnect the battery negative terminal (ground strap) and the ABS control module connector.

- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.

- When boost-charging the battery, first remove the fuses for the Engine Control Module (ECM), the Transmission Control Module (TCM), the ABS control module, and the trip computer. In cases where one or more of these components is not separately fused, disconnect the control module connector(s).

- Some of the vehicles covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys an airbag in the event of a frontal impact. The airbag is operated by an explosive device. Handled improperly or without adequate safeguards, it can be accidentally activated and cause serious personal injury. To guard against personal injury or airbag system failure, only trained Volkswagen Service technicians should test, disassemble or service the airbag system.

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Version 1.0

Cautions & Warnings

- Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.

- Never use a test light to conduct electrical tests of the airbag system. The system must only be tested by trained Volkswagen Service technicians using the VAG 1551 Scan Tool (ST) or an approved equivalent. The airbag unit must never be electrically tested while it is not installed in the vehicle.

- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.

- When driving or riding in an airbag-equipped vehicle, never hold test equipment in your hands or lap while the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.

I have read and I understand these Cautions and Warnings.

back  OK