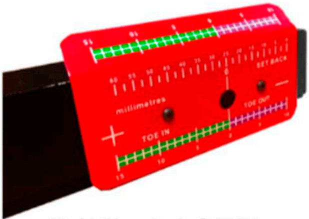
DUNLOP AG045L MANUAL

INKL. RATLÅS



INKL. LASER

INKL. VÆGHOLDER

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Content

Section 1 System Configuration Options

The Dunlop laser system is available in multiple configurations of two different alignment systems and we would very much like you to fully understand the differences. Both systems come in two sizes. A standard size for passenger cars, SUVs, light trucks, and vans, and a similar larger sized system for multi-axle heavy-duty trucks and buses. The larger heavy-duty systems also work well for light vehicles that have been fitted with oversize tires having a tire side-wall taller than 8" or 200mm.

Entry Level Alignment System

The entry-level 2-wheel only system is designed to measure total toe on a single axle without regard to the other vehicle axle (or axles). It cannot measure individual toe on each side. See toe description page 9.

This system uses one laser on one side, with a mirror on the opposing side. The mirror reflects the beam back to a total toe scale on the laser side. It is available as a standard size for passenger cars, SUVs, light trucks, and vans ***(See Figure 2)***. And a similar but larger sized system for multi-axle heavy-duty trucks and buses.

This system does an excellent job of accurately setting total toe, however, it is unable to measure or correct individual side-to-side toe without toe scales and lasers on each side as our 4-wheel system incorporates. It would also need a reference to the rear axle (or axles) as our 4-wheel system incorporates. See our TIP in section 8, page 18 of this manual to get the most out of your 2-wheel only system and improve your results.

NOTE: *Camber may be measured using your smart phone with a "level" app by holding the phone directly against the main horizontal sheet metal of the hanger structure (next to the vertical slot, just above the black adjustment knob), or with an optional gauge purchased separately from the Dunlop alignment system.*

Figure 2: 2-Wheel Standard Size System (Product name: 'Whippet')

Section 2 Wheel Alignment – A Quick Overview Of The Basics

Wheel alignment is part of standard vehicle maintenance. The procedure consists of adjusting the geometric angles of the vehicle's road wheels so that they travel in a straight and true manner. This reduces excessive and premature tire wear and provides the best handling characteristics for the vehicle.

Periodic inspection and adjustment of these angles is required. Normal wear and tear, and steering component replacement, will cause these geometric angles to move out of vehicle manufacturer tolerances.

Industry recommendations are to check wheel alignment annually. The Dunlop system provides a quick, easy, and accurate method of doing so.

There are a great deal of wheel alignment angles, and there is much to understand about wheel alignment. But don't get overwhelmed. Toe, Rear Axle Thrust Angle, and Camber are common angles that you will be concerned with for the average wheel alignment job. There is no better teacher than jumping right in and doing it. You will be surprised at how quickly you become proficient at it. Each alignment job will become easier as you grow in the understanding of alignment theory and the use of the equipment.

> ***NOTE:*** *Not all of the angles described have been provided with factory adjustments on every wheel on every vehicle. Some vehicles are provided with more factory provisions for adjustments than others. After-market adjustment kits available from many auto parts stores and online retailers are available to provide a means of adjustment in most situations requiring them. These would include angles such as camber, caster, and rear toe. In other cases, bent or damaged parts must be located and replaced.*

The Most Commonly Measured Front Wheel Angles

TOE when viewed from above the vehicle is the difference in the distance across the front edge of tires, compared to the back edge of the tires on an axle. This would be considered "total toe" ***(See Figure 4)***. Individual toe for one wheel may also be measured. Individual toe is viewed from above the vehicle. It is the difference in the distance from the vehicle center-line to the front edge of a tire, compared to the vehicle center-line to the back edge of the same tire ***(See Figure 5)***.

> ***NOTE:*** *Incorrect toe is the most common cause of excessive tire wear.*

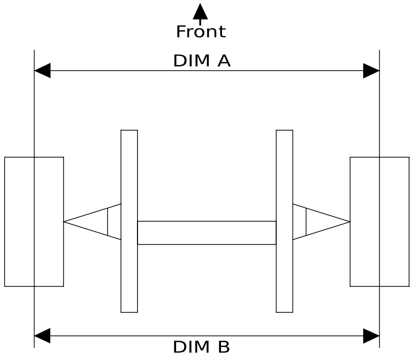


Figure 4: Total Toe Angle

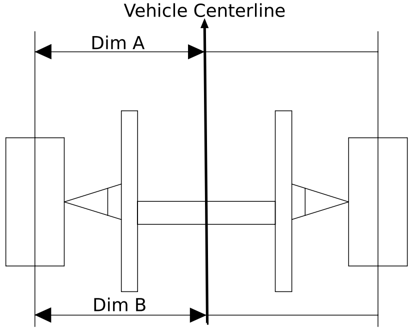


Figure 5: Individual Toe Angle

CAMBER when viewed from ahead or behind the vehicle is the angle formed when the top of the tire leans out away from the vehicle (positive) or in toward the vehicle (negative) ***(See Figure 6)***.

Front-wheel camber is a tire wear angle (camber wear occurs primarily during turning) and it can induce a pull, typically toward the side with more positive camber. A side to side difference of more than ½ degree will normally result in a pull. Some suspension designs are more sensitive to camber variance than others. Equal camber is generally ideal for most situations although it can be used to correct for drift caused by a high road crown or to act against a caster pull. This can be helpful when a vehicle does not have a provision for caster adjustment.

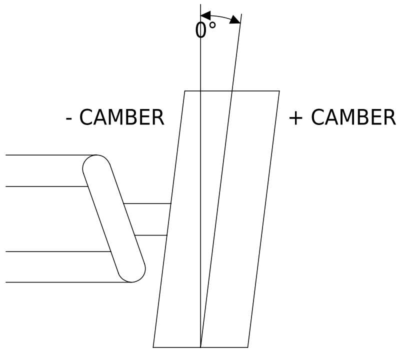


Figure 6: Camber Angle

Example: The left wheel has 3 degrees of positive caster. The right wheel has 3½ degrees of positive caster. Assuming that camber is equal, this will induce a pull left. A camber angle set to ½ degree higher on the right side than the left side could be used to neutralize the induced pull.

> ***NOTE:*** *Adjustment changes in camber will change toe, therefore any required camber changes should be made before final toe adjustments.*

> ***NOTE:*** *Camber may be measured using your smart phone with a "level" app by holding the phone directly against the main horizontal sheet metal of the hanger structure (next to the vertical slot, just above the black adjustment knob), or with an optional gauge purchased separately from the Dunlop alignment system.*

CASTER is the tilt of the steering axis of each front wheel as viewed from the side of the vehicle. If the upper ball joint or strut mounting plate is behind the lower ball joint or the steering axis otherwise tilts backward in this manner it is considered positive caster. The opposite is negative caster ***(See Figure 7)***.
Caster is not considered a tire wear angle, is non-adjustable on many modern vehicles, but it can induce a pull. The vehicle will tend to pull toward the side with the least amount of caster. Almost all road vehicles have been designed for positive caster. Very few vehicles have been produced with a negative caster design but it can be found on some earlier vehicle designs. More than ½ degree side to side variation can induce a pull depending on vehicle design. Most strut-type front suspension systems have a high SAI angle ***(see SAI description page 13)*** designed into the suspension. These vehicles are less prone to a caster-induced pull unless the side to side variance is significantly greater than ½ degree. A higher caster adds resistance to turning and reduces the tendency for a vehicle to wander. Too much caster can make slow speed turning too difficult. Manual steering vehicles generally have less caster than power steering vehicles for this reason.

Equal caster is generally ideal for most situations although it can be used to correct for drift caused by a high road crown or to act against a camber pull. This can be helpful in situations where it is easier to make a caster adjustment than a camber adjustment.

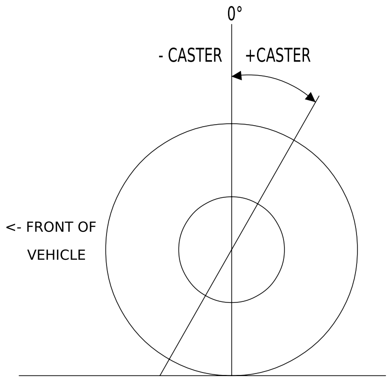


Figure 7: Caster Angle

Example: The left wheel has zero camber. The right wheel has ½ degree positive camber. Assuming caster is equal, this will induce a pull right. A caster angle could be set to ½ degree lower on the left side than the right side to neutralize the induced camber pull.

> ***NOTE:*** *Changes in the caster can affect camber and toe depending on design, therefore any required caster changes should be made before camber and final toe adjustments.*
>
> ***Caster readings*** *require an optional gauge purchased separately from the Dunlop alignment system.*

4-Wheel or Thrust Angle Alignment Adds:

Rear Axle Toe when viewed from above the vehicle is the difference in the distance across the front edge of tires, compared to the back edge of the tires on an axle. This would be considered "total toe" (See Figure 4, on page 9). Individual toe for one wheel may also be measured. Individual toe is viewed from above the vehicle. It is the difference in the distance from the vehicle center-line to the front edge of a tire, compared to the vehicle center-line to the back edge of the same tire ***(See Figure 5, on page 9)***.

> ***NOTE:*** *Incorrect toe is the most common cause of excessive tire wear. Incorrect rear toe can result in a thrust angle "push" where the rear of the vehicle is steering the back end one way or the other. This can occur when one side of a solid rear axle is ahead or behind the other side or when a fully adjustable independent type rear axle is mis-adjusted.*

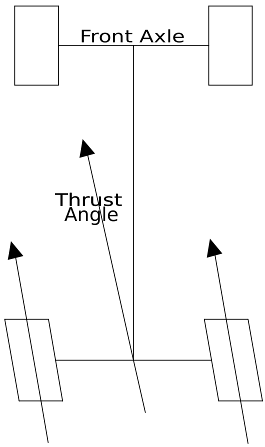
Rear Axle Camber when viewed from ahead or behind the vehicle is the angle formed when the top of the tire leans out away from the vehicle (positive) or in toward the vehicle (negative) ***(See Figure 6, on page 9)***. The rear axle camber is not a tire wear angle. Changes in camber can change toe depending on the rear suspension design, therefore any required camber changes should be made before final toe adjustments.

> ***NOTE:*** *Camber may be measured using your smart phone with a "level" app by holding the phone directly against the main horizontal sheet metal of the hanger structure (next to the vertical slot, just above the black adjustment knob), or with an optional gauge purchased separately from the Dunlop alignment system.*

Rear Axle Thrust Angle is the angle formed between the vehicle's geometric center-line and the direction in which the rear wheels are aimed *(See Figure 8, on page 12)*. Zero thrust angle is ideal. This is where the rear axle is exactly perpendicular to the vehicle center-line and both wheels are parallel to each other. However, due to manufacturing tolerances the ideal thrust angle of zero is seldom achieved during assembly on solid non-adjustable rear axle vehicles.

Vehicles with adjustable rear axles should be adjusted to the ideal thrust angle of zero during wheel alignment. Vehicles with non-adjustable rear axles should be measured, and then compensated for thrust angle during wheel alignment. This will maintain proper vehicle handling, maintain a properly centred steering wheel, and reduce potential tire wear issues. Most solid rear axle vehicles will have some thrust angle due to manufacturing tolerances.

A non-adjustable rear axle thrust angle beyond ½ degree typically requires further mechanical repair. Alignment alone cannot fully compensate in these cases. This measurement and compensation procedure requires the use of rear tracking lasers and flag scales, included with all 4-wheel versions of the Dunlop alignment system. The 2-wheel only version will not perform a thrust angle or four-wheel alignment.



Setback is the difference between the right side and left side wheelbase length *(See Figure 9)*. It is built into some vehicles by design, such as the Ford twin I-beam design found mainly on older, full-size pickup trucks and vans. Unless setback is excessive, it does not generally affect vehicle handling. Most vehicles using conventional suspension (non-twin I-beam) will allow up to ¼" (or 6mm) of setback. An out-of-spec setback dimension may occur from a difference between right and left caster or from suspension damage. Hitting a pothole or a curb for instance may push a wheel back. A rear axle thrust angle will also affect a setback reading.

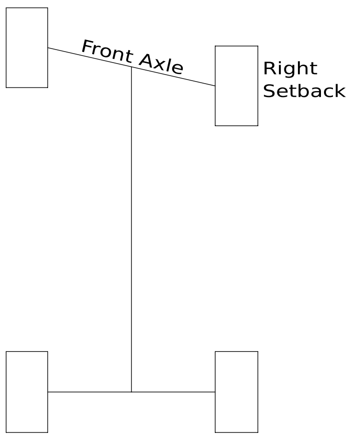


Figure 9: Setback

Ride Height Sagging springs or changes in spring height by installing lift kits, etc. will affect vehicle ride height. Depending on the design, changes in ride height can affect the camber angle which in turn affects the toe. This should be taken into consideration on vehicles using independent or twin I-beam suspensions. Solid axle vehicles are generally unaffected. If for example you are measuring a vehicle with four-wheel independent strut suspension, and you determine camber is negative and requires adjustment at all four wheels, the vehicle most likely has sagging worn-out springs. A quick check is to lift the body to normal ride height with a jack and see if the camber comes into specifications. If so, replace the springs and then align the vehicle.

Toe Out On Turns (sometimes referred to as the Ackermann Angle). This is designed into the steering knuckle arm where the outer tie rod attaches. This design allows changes in side-to-side 18.5°steering angles during turns. During turns it allows the inside wheel to turn a tighter circle than the outside 20°wheel. This reduces tire scuffing, squealing, and excessive tire wear ***(See Figure10)***.

Applicable on **steering axles only**. Checked manually this procedure requires the use of optional bearing type turntables with radius gauges.

With a tire turned out away from the vehicle to 20 degrees (this would be the inside wheel on a turn), the opposite side (outside wheel on a turn) should normally be about 1½ degrees lower, so about 18½ degrees. Verify by checking both sides as the difference in readings varies between designs but each vehicle should have the same reading side to side. This is normally only a problem if a collision bent a steering arm. A bent steering arm will result in toe type tire wear even though straight ahead total toe is correct because the problem only occurs during turns.

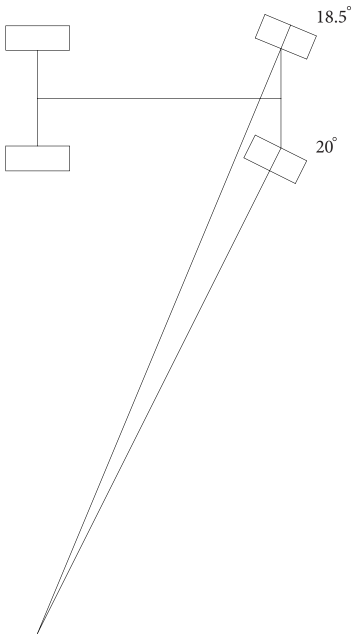


Figure 10: Toe Out On Turns

SAI - Steering Axis Inclination (sometimes referred to as KPI, or King Pin Inclination), is applicable on steering axles only. SAI is the tilt of the steering axis from vertical as viewed from ahead or behind the vehicle. It is the angle formed by drawing a line from the center of the lower ball joint up through the center of the upper ball joint or strut mount and compared to vertical *(See Figure 10)*. Think of it as spreading your legs apart while standing. This adds stability to the vehicle, especially while turning.

SAI readings are useful in diagnosing a mis-adjusted engine cradle assembly on front-wheel drive vehicles and for diagnosing collision damage. SAI readings require an optional gauge.

Included Angle is created by adding together the SAI and Camber angle measurements, applicable on steering axles only *(See Figure 11)*. This is useful for diagnosing bent or damaged steering components after a collision. Included angle readings require an optional SAI gauge.

Maximum Turn Angle is the lock to lock steering angle. This is when the steering wheel is turned all the way one direction until it stops, and then all the way the other direction until it stops. It is applicable on steering axles only. Useful to determine side-to-side difference from the true center of steering gear to check for bent, damaged, or miss-adjusted steering components. Requires the use of optional bearing type turntables with radius gauges.

Track Width compares the difference between the front and rear axle width. Built into some vehicles by the manufacturer in which case it is evenly split side to side. Seldom used during an alignment routine, but it can be useful in collision repair to determine if it is no longer evenly split side to side. Can be mechanically measured however the use of computerized equipment is the most common method of measurement today.

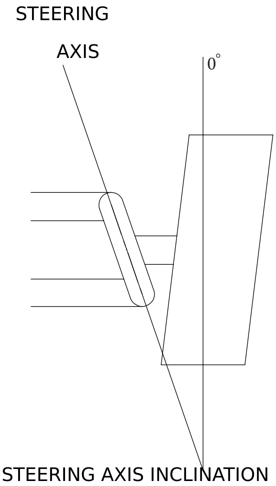


Figure 10: SAI

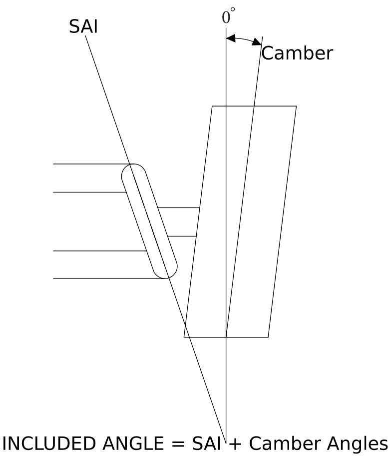
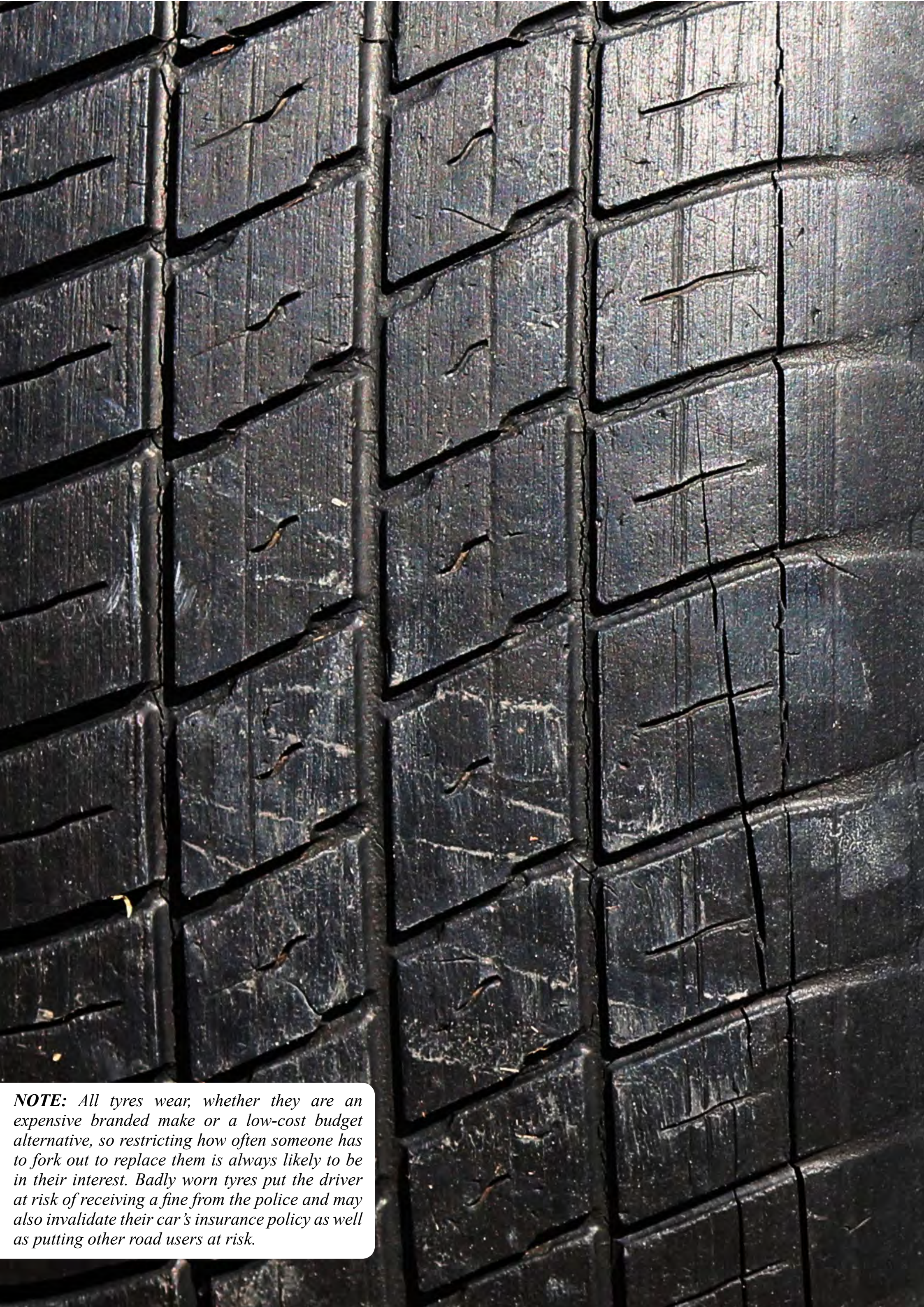


Figure 11: Included Angle



NOTE: *All tyres wear, whether they are an expensive branded make or a low-cost budget alternative, so restricting how often someone has to fork out to replace them is always likely to be in their interest. Badly worn tyres put the driver at risk of receiving a fine from the police and may also invalidate their car's insurance policy as well as putting other road users at risk.*

Section 3 Pre-Alignment Checks

Tire Inflation; Verify proper tire pressure, a soft tire affects alignment and can induce a vehicle pull just from the additional rolling resistance.

Ride Height If a specification is known the vehicle should be checked for proper ride height to determine spring condition (not all manufacturers publish a vehicle ride height specification).

Shocks and Struts play an important role in proper vehicle handling and tire life and are often overlooked. Shocks and struts maintain firm tire contact with the road surface. When worn they will allow the tire to bounce slightly on and off of the road surface. This results in a cupping type of wear pattern throughout the tires tread surface. Shocks and struts also act to dampen and absorb road impacts, protecting expensive front-end components from those road impacts. Worn shocks and struts allow road impacts to instead be absorbed by the vehicle's ball joints, tie rod ends, steering gear, bushings, and other expensive to replace items.

Shocks and struts should be visually inspected for leaks or damage. They should also be checked for proper rebound dampening by jouncing each end of the vehicle while monitoring the effectiveness of the shocks to stop vehicle movement quickly. A similar test can be performed on vehicles with stiff suspension by standing beside the vehicle and pushing on a solid area of the roof above the doors. The object is to get the vehicle rocking sideways and monitor how quickly the vehicle movement stops when you quit pushing on the vehicle. Purchase only high-quality replacement shocks and struts, they perform a very important job.

Inspect All Steering And Suspension Components for wear or damage. Replace questionable items before vehicle alignment. A small amount of movement at a tie rod end is greatly exaggerated at the edge of the tire. It is impossible to properly set and maintain a toe setting when excessive wear exists in components. An 1/8" (or 3.175mm) of incorrect toe is equivalent to dragging a tire sideways for twenty-eight feet (8.5 meters) per mile driven. This is based on an average diameter tire of 28.5" (or 724mm).

The best way to inspect **steering linkage** (tie rods and related) is with a helper performing a "loaded" test. With normal vehicle weight on the front tires while on a firm surface to resist turning (not on turntables), have the helper move the steering wheel back and forth a small distance beyond the point of when resistance is felt at the steering wheel. This should be done at a slow to medium speed as rapid movement will make the task more difficult. The "inspector" can watch and feel for movement at each joint in the steering assembly. On earlier vehicles using center-link style linkage with idler arms, be sure to watch for up and down movement in the idler arm where it attaches to the center-link. This will affect a change in the toe.

In **rack and pinion** systems pinch the rubber boots at the outer ends of the housing and feel for any movement in the inner socket joint inside where it attaches to the rack. This is a common point of wear and will affect a change in the toe.

Suspension components include control arms, radius arms (or strut rods), mounting bushings, ball joints, struts, and strut mounting systems. Many of these items must be "unloaded' from spring pressure while in their normal plane of geometry to properly check for excessive play. Due to many variances in vehicle design, it is best to reference inspection procedures for the specific vehicle being inspected.

Often a **rubber bushing** can be visually inspected. Inspect for heavy cracking on bushings and also whether or not the item supported by the bushing is still supported in the center of the bushing. As bushings wear they will often sag allowing the supported component to be out of its normally designed position. The normal direction of pressure applied against the bushing will indicate whether this pressure caused the sag over time or if possibly the bushing was meant to be other than centred. Additionally, bushings can be inspected where they contact the metal arms or rods that they support by looking for "large rubbed clean" areas indicating that uncontrolled movement is commonly occurring in this area.

Install Turntables or Slip-plates with care to avoid binding the suspension outside of its normal geometry. During alignment we are trying to replicate the vehicle's geometry as if it were driving down the road. Bearing style turntables can be damaged by driving onto or off of them without plate locking pins installed and the use of some type of ramp for a smooth roll onto or off of the table. Lifting the wheel by jacking under the lower control arm or axle is often the best method of turntable placement. Place the jack in a position to maintain as much as of the normal geometry of the control arm as possible.

Jounce The Vehicle by pushing down at the bumper areas. This will help settle out the suspension by putting it back into its normal geometry. This should be done anytime the vehicle is jacked up whether to install turntables or when required for making adjustments.

Section 6 Performing An Alignment With The Dunlop System

All wheels to be adjusted MUST be on turnplates or slip plates for proper adjustments to be made. It is best to use turntables for front axle adjustments and turntables work equally well for rear axle adjustments. Slip plates may be used for rear axle adjustments. Attempting adjustments without these will result in improper adjustments and improper readings after adjustments because the tires will stretch (as rubber does) rather than move fully into the position being measured. This applies to ANY brand of wheel alignment equipment.

Due to road forces while driving, the front wheels will automatically turn into the direction needed to become parallel with the rear wheels and match any thrust in the rear axle. All-wheel alignments, regardless of the equipment used, should be referenced in some manner off of the rear axle.

> ***NOTE:*** *See our TIP in section 8 on how to reference the other axle (or axles) when using the 2-wheel only laser alignment system. By referencing the rear axle the front wheels can be made parallel with the rear wheels thereby creating a centred steering wheel and a vehicle that handles properly with minimal tire wear.*

If a non-compensated thrust angle exists, a crooked steering wheel is a result even though the steering wheel was straight when the vehicle toe was set. If any rear wheel adjustments are to be made, they should always be made before the final alignment of the front steering axle.

> ***NOTE:*** *Adjustment changes in camber and caster will change toe, therefore any required camber or caster changes should be made before final toe adjustments.*

> ***CAUTION: The lasers used in this equipment are low-power lasers and meet safety standards, however, the lasers are very bright and one should never look directly into the lasers.***

NOTE: *If a car is driven when the wheels are incorrectly aligned, the driver is likely to notice that the quality of the ride is affected, the vehicle is liable to drift to the side of the road despite the drivers best efforts to maintain a straight course. Not only is this somewhat annoying, but having to continually alter the steering to compensate for the drift could be potentially dangerous.*

This 2-wheel only system is designed to measure total toe on a single axle without regard to the other vehicle axle (or axles). It cannot measure individual toe on each side. See toe description page 9. It uses a laser on one side, with a mirror on the opposing side, to reflect back to a total toe scale on the laser side.

This system does an excellent job of accurately setting total toe, but is unable to measure or correct individual side-to-side toe without a reference to the other axle (or axles).

Install the laser sensors as follows. When using the 2-wheel only system, whenever possible, the sensors should be placed on the vehicle with the toe scale and mirror ends pointing toward the front of the vehicle. This is regardless of which axle they are installed on. This allows the toe scales to be read in a normal manner. If vehicle clearance will not allow this on the rear axle, the sensors may be installed with the toe scale and mirror ends extending rearward away from the vehicle. In this case, the toe scale must be read in reverse. Indicated toe-in will actually be toe-out, and indicated toe-out will actually be toe-in, as the scale is being viewed in an opposite manner.

> ***NOTE:*** *This is different than when using the 4-wheel system on the rear axle where the scales always extend out away from the vehicle and are read in reverse of what is indicated for toe-in and toe-out.*

The laser sensor hangs from the top of the tires tread surface. When installing the laser sensor, adjust the position of the sensor so that the level vial has a centred bubble while at the same time positioning all three aluminium stand-off pins firmly against the wheel's edge. The sensor should be exactly parallel with the tire side-wall. The two lower aluminium stand-off pins are for toe while the single upper pin is for camber.

Although not normally required, it may be helpful on some tire and wheel assemblies to use a "bungee" type rubber strap to keep the sensor firmly in position. Be careful not to over-tighten and distort the sensor body, just light pressure is all that is needed.

A Tip To Achieve Better Results Using 2-Wheel Only System

When using the 2-wheel only laser alignment system here is a **TIP:** To reference the other axle (or axles) tie a string snugly around the entire vehicle across the mid-point of all tires. This should locate the string at approximately wheel hub height.

The string can be used as a visual guide to determine if the front and rear tires are roughly parallel to each other by carefully determining how evenly the string touches or spaces away from the tire side-walls. Turn the steering wheel back and forth to obtain even pressure and distance of the string from all tire side-walls. It will not be as accurate as the Dunlop 4-wheel laser system, but when done properly it will perform an adequate job.

If the rear axle is to be adjusted, start in the rear first, if not skip ahead to the next paragraph. Place the sensors in position on the rear tires over the top of the string, leaving the string in position. Read the toe scale and adjust for proper total toe setting while maintaining even side-wall pressure and distance on the string to keep all tires parallel. This completes the rear axle adjustment.

Place the sensors on the front axle, leaving the string in position. Sit in the vehicle and visually center the steering wheel. It is helpful to start the engine on power steering equipped vehicles during this process. Once centred verify equal steering wheel play side to side and shut off the vehicle. If you have the steering wheel lock tool and the steering wheel level indicator tool now is a good time to install them. The steering wheel locking tool is very helpful, but not absolutely required. However, without the steering wheel locking tool, the job will require more frequent re-centring of the wheel during and after toe adjustments.

Visually inspect how the string contacts the front tire side-walls. You will adjust the toe to specification while at the same time correcting and maintaining the front tires parallel to the rear tires using the string as a guide.

Vehicles with individual tie rods for each steerable wheel may require adjustment on one side more than the other. On single adjustable tie rod vehicles, you will adjust for total toe, and then if the vehicle has an adjustable drag-link use this to move the wheels into a parallel alignment with the rear axle while maintaining the steering wheel in the centred position.

After setting total toe on older single tie rod adjustment vehicles without an adjustable drag link, move the front wheels back and forth until even pressure and distance are applied to the string without regard to the steering wheel centring. Then remove the steering wheel and reinstall it in the centred position.

> ***NOTE:*** *this will only work on older vehicles (primarily vehicles manufactured before 1980) with non-indexed steering shafts where the steering wheel attaches. Modern vehicles have indexed steering shafts allowing steering wheel installation in one position only.*

> ***CAUTION: Never remove a steering wheel that incorporates an airbag deployment system without following the vehicle manufacturer's instructions to deactivate the system or serious personal injury could result.***

Section 6 Conversion Information

Degrees of Toe	Inches of Toe	Decimal Inch of Toe
2.00	1”	1.00
1.50	3/4”	0.75
1.00	1/2”	0.5
0.75	3/8”	0.375
0.50	1/4”	0.25
0.25	1/8”	0.125
0.13	1/16”	0.0625
0.01	5/1000”	0.005

NOTE: Degree conversion is based on a 28.5” diameter tire

Figure 12: Conversion Chart, Degrees to Inches