



Universal Joint Alignment Procedure For Passenger Cars

Achieving front and rear ujoint alignment angles within the acceptable operating angle range is necessary to avoid driveline vibration and to allow the ujoints to last a long time.

Universal joints in most passenger cars have a minimum and maximum operating angle. The front ujoint when compared to the transmission output shaft and driveshaft should have an operating angle no less than $\frac{1}{2}^{\circ}$ and no more than $3\text{-}1/2^{\circ}$. The rear ujoint, when compared to the pinion and drive shaft, should have an operating angle of no less than $\frac{1}{2}^{\circ}$ and no more than $3\text{-}1/2^{\circ}$. The reason that at least $\frac{1}{2}^{\circ}$ of operating angle is required is because the ujoints will not last without at least some angle or movement. The lack of this movement will cause too much wear on the needle bearings leading to bearing damage (called "brinelling").

It is possible to have an operating angle that is greater than $3\text{-}1/2^{\circ}$ and still not have a vibration that you can feel but ujoint life will be shortened. It is difficult to determine exactly how much the ujoint life will be shortened - it will depend on how far past $3\text{-}1/2^{\circ}$ you are. At optimum operating angles, ujoints can last more than 100,000 miles so even if their life were shortened by $\frac{1}{2}$, you would still be happy as most of the muscle cars and trucks we are talking about only accumulate 3000 miles +/- per year. For example, $\frac{1}{2}$ the life of a ujoint would be 50,000 miles divided by 3000 miles driven per year = 16.666 years! Not bad for a \$20.00 ujoint. I have seen ujoints operating at more than $3\text{-}1/2^{\circ}$ that have not had any problems but these were in daily grocery getters or rock climbing Jeeps. Our muscle cars have driveshafts that turn faster and are subjected to much more power so keeping as close as possible to optimum operating angles is advisable.

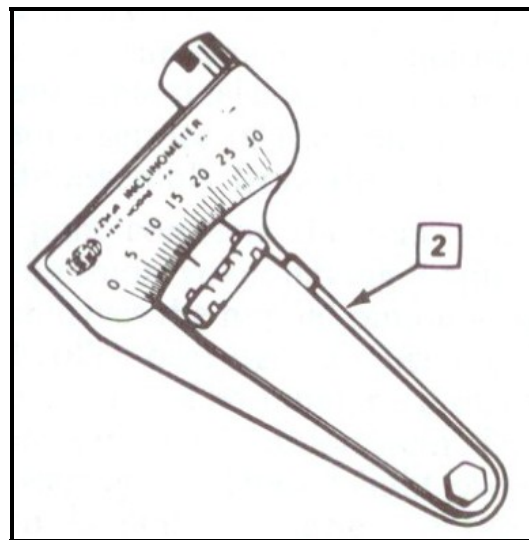
Front and rear ujoints should not be allowed to have operating angles of more than $\frac{1}{2}^{\circ}$ apart from each other. An example would be the front joint being 2° down while the rear ujoint is $2\text{-}1/2^{\circ}$ up. A greater angle than this will cause some harmonic vibration.

U-joints do not turn at an even speed. The greater the angle, the greater the speed or velocity changes as the driveshaft turns. In other words, as the ujoint travels around to the outside of its angle it slows down. When traveling through the inside of the angle it speeds up. The greater the operating angle is, the greater the speed difference is. Having the opposite ujoint at the same, *but opposite*, operating angle cancels out this speed difference and keeps harmonics to a minimum. If your operating angles are more than $\frac{1}{2}^{\circ}$ apart from each other, these velocity induced harmonics will resonate through the driveline. This is why you see constant velocity (CV) joints used in newer cars. CV joints are found in front wheel drive cars and they are common in BMW and Mercedes Benz driveshafts. CV joints are more expensive to replace but they do not live by the same rules as a u joint.

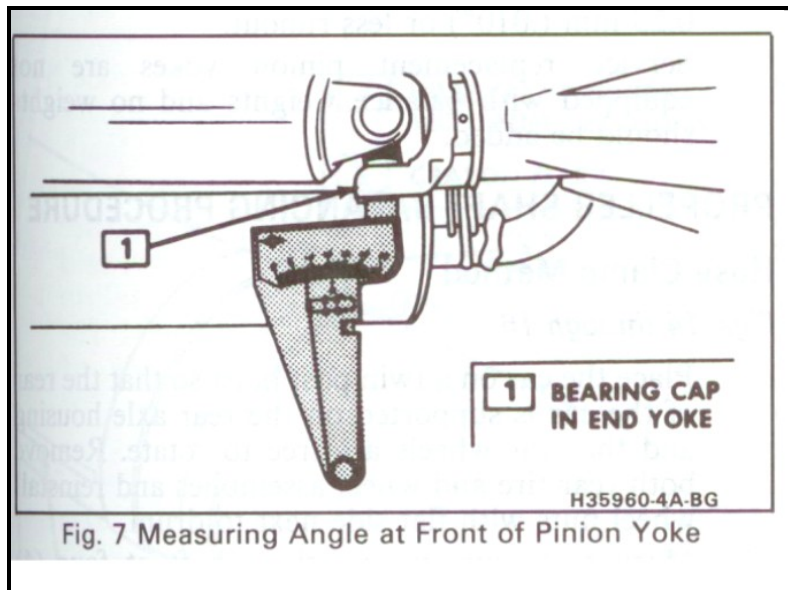
To measure your ujoint angles you will need an angle gauge (**Fig. 1**) or an inclinometer (**Fig. 2**). The best place to obtain accurate measurements is from the top of the u joint cap. When taking measurements from the caps it is necessary to temporarily remove the retaining clips (if equipped) temporarily from the yolk. By placing a short socket from your tool box (**Fig. 1**) on the end of the cap, you will be able to maintain the correct level without allowing interference from the surrounding material of the yolk.



(Fig. 1)



(Fig. 2)

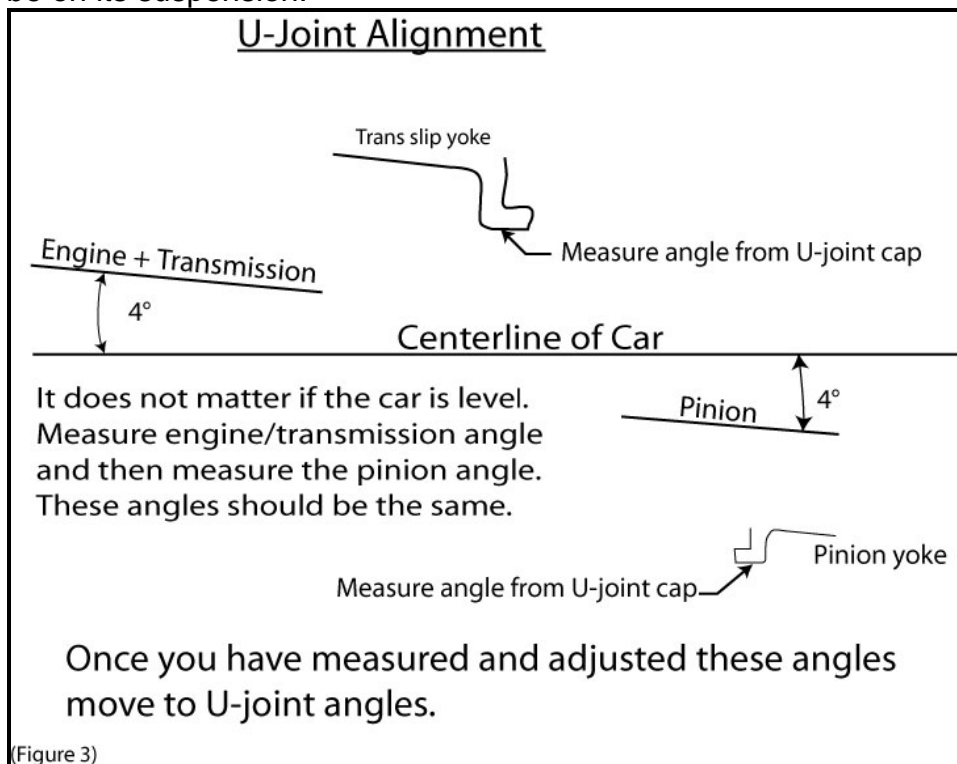


This is how a GM dealer uses an inclinometer to measure drive line angles.

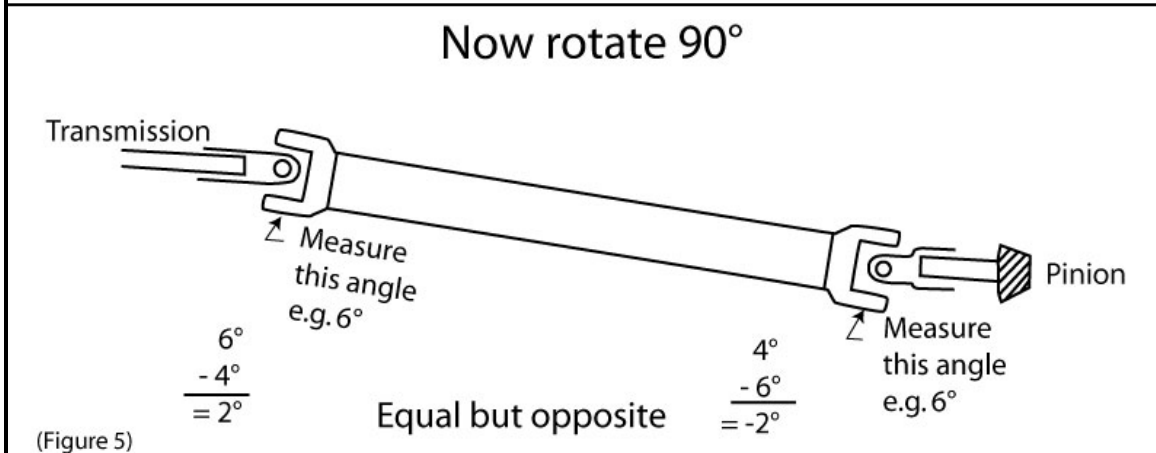
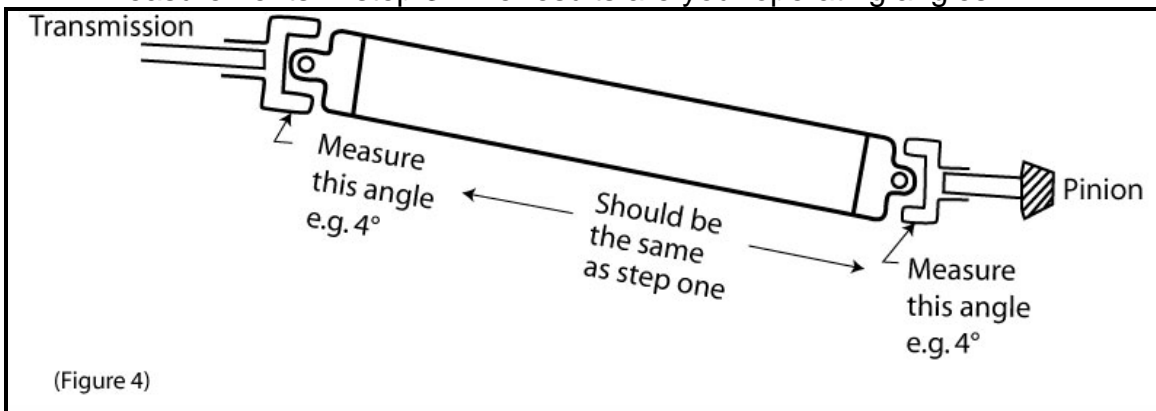
How to Measure U-joint Angles

1. Establishing starting angles.

Measure the transmission and pinion angles as shown below (Fig. 3). Note that the car does not need to be level; however the car's weight must be on its suspension.

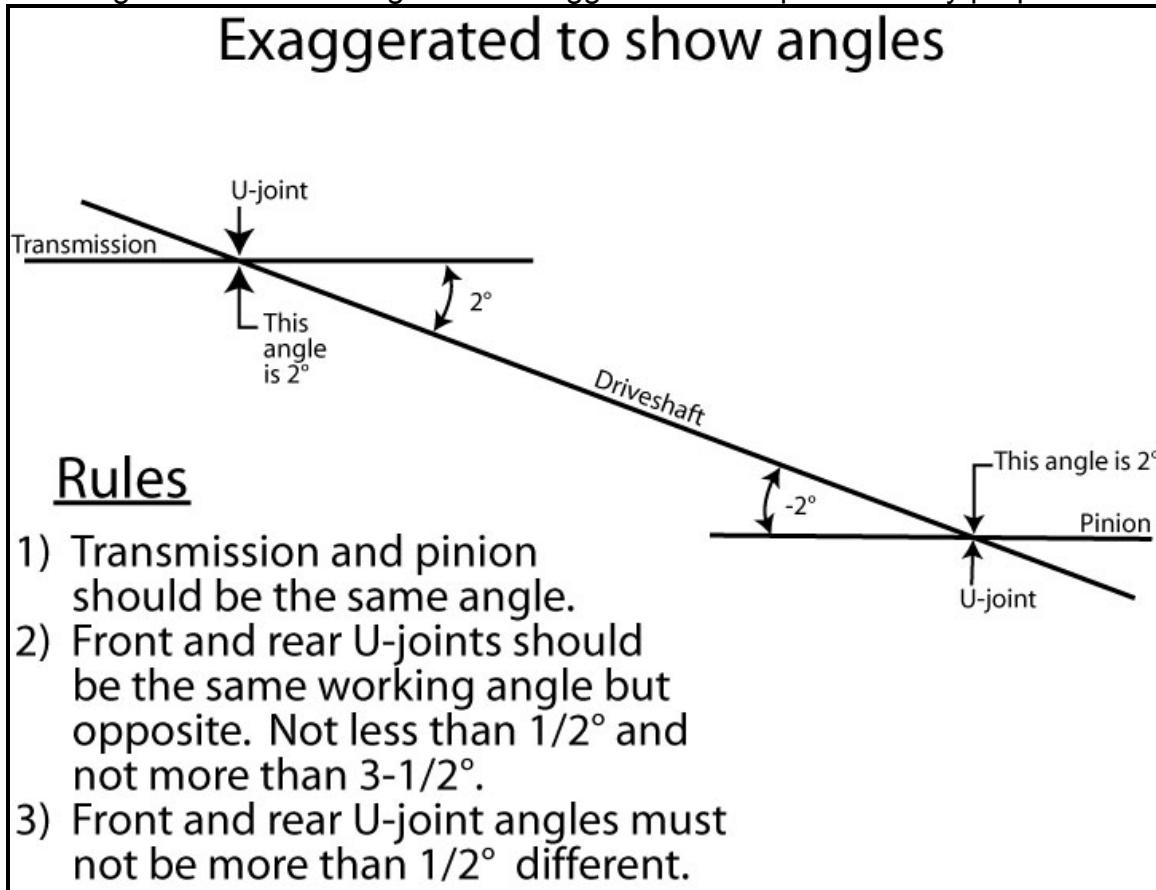


2. If the angles are not the same, make adjustments by raising or lowering the transmission and/or turning the rear end (if adjustable) to get the angles the same. If you have modified your car's suspension and you have leaf springs, you may need to use shims to change the pinion angle. Shims are available at most spring shops.
3. Measure each ujoint separately. First rotate the driveshaft so that the slip yolk and pinion yokes are at the 12:00 and 6:00 positions (**Fig. 4**). These angles should be equal to each other.
4. Rotate the driveshaft 90°, or ¼ turn, so that the driveshaft yokes are at the 12:00 and 6:00 positions (**Fig. 5**) and then measure the angles.
5. Subtract the first measurements obtained in step 4 from the measurements in step 3. The results are your operating angles.



In this example we have +2 degrees on the front and -2 degrees on the back. Don't let the plus and minus thing confuse you. These plus and minus values are applied to the measurements because they are opposite. You can call it what you want as long as they (the angles) are opposite. In this example, the correct operating angles exist, equal but opposite, or -2 and +2.

The diagram below shows gives an exaggerated example for clarity purposes.



Rules:

1. Transmission and pinion angle should be the same angle.
2. Front and rear u-joints should be the same working angle as each other, but opposite. Not less than $1/2^\circ$ but not more than $3 1/2^\circ$.
3. Front and rear u-joint angles must not be more than $1/2^\circ$ different.

If you require any more assistance on this subject or have any questions, please give us a call.

Special Note: The specifications above are for street driven vehicles driven at reasonable maximum speeds (70 - 75 MPH). If you intend to drive at higher speeds, use performance rear axle ratios, or use a combination of low rear end ratios and small tire diameters that will cause drive shaft rotational speeds to go beyond stock drive shaft critical speed limits, your drive shaft tubing size and materials used may need to be upgraded and universal joint operating angle limits will narrow proportionately.

Example. A 1969 Camaro with 235/60/15 (26.1" tall) tires and a 3.42 rear gears traveling at 70 MPH will have a drive shaft rotational speed of 3084 RPM. At 100 MPH the drive shaft will be turning at 4406 RPM. Critical speed for a factory 3" steel driveshaft that is 50 " long is 5790 RPM. 85% of critical speed is the maximum speed you should turn a driveshaft. 85% of 5790 = 5340. You can see that 4406 RPM is well within the limits for this driveshaft. If you change the rear end gears to 4.11, the 100 MPH driveshaft speed increases to 5295 RPM which is bordering on maximum critical speed. Having a driveshaft operating at 50 to 60% of critical speed will run smoother with less vibration than one operating at it's maximum.

Universal joint working angles between .5 degree and 3.5 degrees are fine for a stock application however as driveshaft speeds increase the maximum operating angles of 3.5 degrees can be significantly less. Example: at 3500 driveshaft RPM the maximum operating angle of a car u-joint is about 3.5 degrees. This MAXIMUM angle is acceptable for most stock applications. If driveshaft RPM increase to say 4000 RPM the MAXIMUM u-joint operating angle changes to 2.75 degrees. At 5000 driveshaft RPM this changes to 2.2 degrees. As driveshaft speeds increase, tubing size and u-joint operating angles must be adjusted to suit your vehicle requirements.

As an additional note, I do not subscribe to the practice of adjusting pinion angles to compensate for spring wrap or torque twist. If you have enough power to twist the axle housing far enough to change driveline angles to the extent they are going to cause problems then you have a RACE CAR! Race cars have different rules than street cars. Street cars spend the majority of their time on the street and the angles should be set up for the street. If you have a race car, you probably know all this stuff (or at least you should know it) and you will adjust angles for optimum performance at the track. Just remember - as in life, everything is a compromise!

GMJim