

## Measuring Brake Rotors to Eliminate Pedal Pulsation

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### Run-out

Think of the ideal brake rotor surface as a series of rings, all having a common centerline, perpendicular from the plane formed by each ring. Think of the hub as having a centerline or axis, common

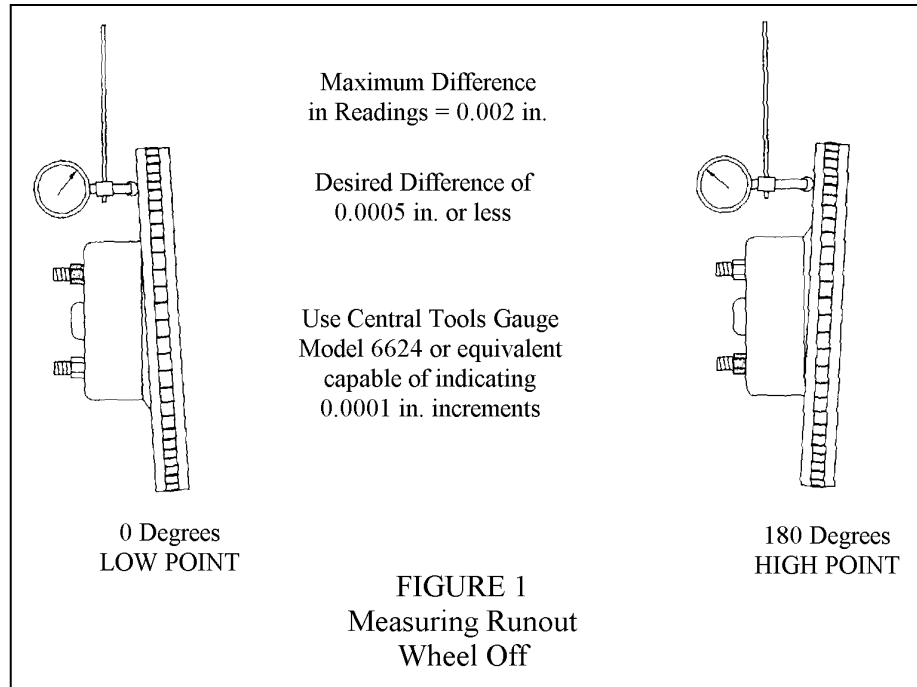
with the vehicles axle. Run out is created when the rotor surface's centerline is not parallel and concentric to the hub axis. In other words, looking from the side, the rotor is tilted from a line perpendicular to the hub axis. (See Figure 1)

By placing a dial indicator on the rotor surface, the dial indicator will trace one ring of the brake rotor surface as the rotor is rotated one revolution.

Run out is defined as the difference between the dial indicator reading at one point and another point on the ring 180 degrees of rotation away.

Maximum Run Out is defined as the highest run out found, most normally being the difference between the highest or lowest dial indicator reading and the corresponding reading 180 degrees of rotation away from the first point. Most manufacturers specify that run out should be measured along a ring that is mid-way across the rotor's braking surface. (See Figure 1)

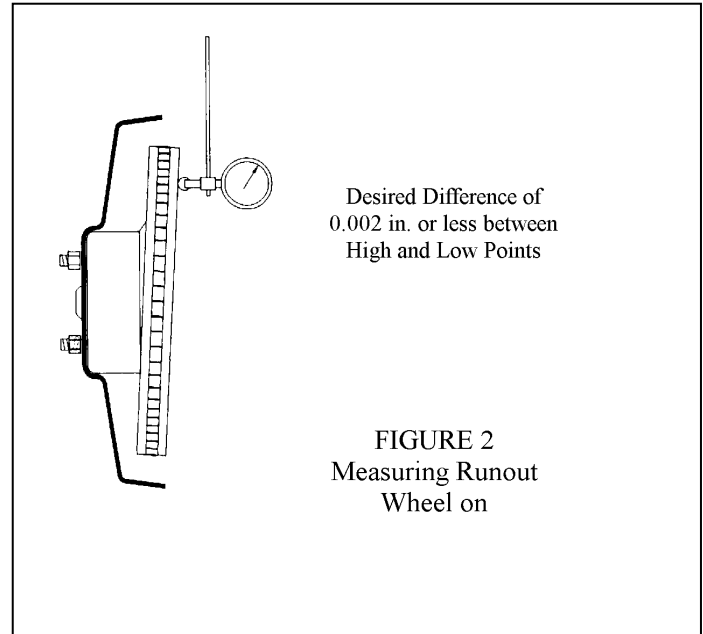
Typically run out is measured with the wheel off, on the outboard face of the rotor. RTI recommends that run out be measured additionally, after the wheel is installed by



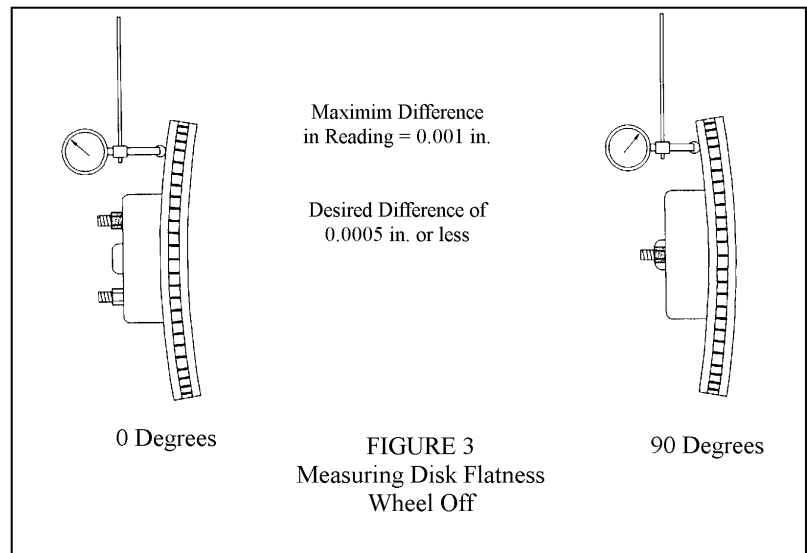
measuring the inboard face of the rotor. (See Figure 2) Excessive run out will lead to Disc Thickness Variation (DTV) over time.

### Disc Flatness

This term is misunderstood by many but is really quite simple. It is not to be confused with disc surface perpendicularity to the hub axis. Insufficient Disc Flatness will also lead to Disc Thickness Variation (DTV) over time. A brake rotor that is not flat is typically warped and deformed similar to a potato chip or like the brim of a hat with two sides curled up and the other two sides curled down. (See Figure 3)



Instead of the rotor being a series of perfect rings, it is a series of rings that become increasingly deformed as the rings become larger, again like the brim of a hat. A similar result would occur if the rings were twisted. In either case, Disc Flatness can be measured with the same dial indicator as used to check run out. Except, to check Disc Flatness, the rotor is rotated 90 degrees.



To insure the highest degree of precision, it may be advisable to check Disc Flatness nearer to the outside diameter of the rotor. (See Figure 3)

*Do not attempt to check Disc Flatness with the old fashioned method of a straight edge and feeler gauge since this method does not measure points along the same diameter and can produce errors or misleading information.*

Using the dial indicator measurement system is very precise and will always identify flatness problems that could lead to DTV over time.

## Dial Indicator Measurement

To measure both Maximum Run Out and Disc Flatness at the center of the braking surface, simply mount the dial indicator as shown in Figure 1. Find the highest point by rotating the rotor one full revolution, then record *that* dial indicator reading labeled Point 1. From that point, rotate the rotor 90 degrees and record the new dial indicator

reading labeled Point 2. Rotate the rotor another 90 degrees and record the reading labeled Point 3, and then again another 90 degrees labeled Point 4. The difference between Point 1 and 3 will be the Maximum Run Out. Disc Flatness will be the *highest* difference between: Points 1 and 2: Points 2 and 3: Points 3 and 4: *or* Points 1 and 4.

## Measuring DTV

Disc Thickness Variation is the cause of Pedal Pulsation. DTV is caused by excessive run out or insufficient flatness. Measuring DTV requires careful use of a precision micrometer. The disc's thickness should be measured at eight different points, 45 degrees of rotation from one another around a ring at the center of the braking surface. The thickness variation should be less than 0.0002".

