Wheels

Selecting Rims or Wheels

When selecting rims or wheels, remember these five points:

1. Mount tires only on approved rim widths. See tire manufacturer data pages for the correct rim width range.
2. Always verify that the tire and rim diameter is the same. For example, a 16” tire must be mounted only on a 16” rim.
3. When changing tire sizes, verify that the rim/wheel carries adequate load and inflation pressure capacities. If the load and inflation pressure capacity are not identified on the rim/wheel (or are not identified for service conditions exceeding the rate capacities). Consult the rim/wheel manufacturer to determine the capacity.
4. Never use high-pressure compact spare wheel.
5. Be certain that the replacement rims have an offset that is as nearly equal as possible to the O.E. rims.

Custom Wheels

Custom wheels are extremely popular with consumers desiring to personalize their vehicles. They come in a huge assortment of sizes and styles, and are popular for trucks and SUV’s as well as passenger vehicles. Custom wheels are not only used to enhance the appearance of a vehicle, but, combined with high performance tires, can significantly alter the ride, handling, and overall performance.

All wheels do the same basic job of supporting the tire and attaching it to the suspension. In addition, virtually all-custom wheels are manufactured out of aluminum alloy. However, there are major differences between types and manufacturing techniques of wheels. These differences dictate both cost and performance.

Aluminum wheels are constructed in either one piece, two piece, or three piece designs. By far and away, the most popular is the one-piece design. It is either cast or forged into one unit. One-piece cast wheels are extremely popular in OE applications and tend to be very cost effective. However, each wheel must be made for a specific application.

Two piece wheels, as the name implies, consist of an inner and outer section that are bolted or welded together. By combining different halves, the offset and wheel width can be modified. Generally, the wheels that are bolted together are of higher quality and precision. They also tend to be lighter than the one piece.

Three-piece wheels consist of a center section that determines the bolt pattern, and two rim flange sections that determine the rim diameter, width, and offset. These three pieces are bolted together using high strength bolts and “O” ring seals. By using different combinations of the three pieces, the manufacturer can offer a variety of wheel sizes without stocking or building an entirely unique wheel for each application. Three-piece constructions tend to be reserved for the top-of-the-line wheels where lightweight and strength are a must. Another advantage to three-piece wheels is that a damaged component, such as a bent rim flange, can be replaced individually. Disadvantages are the relatively high cost, periodic checking of the bolt torque, and the possibility of seal leakage.
The price, strength, weight, and overall performance of the wheel are directly related to the manufacturing technique employed to make it. The most common and least expensive method of wheel manufacturing is gravity casting, where molten metal is simply poured into a mold and allowed to cool and harden. This system works well, but requires the wheel to be heavier and thicker to compensate for porosity in the metal.

There are pressurized casting methods, which place the molten metal under pressure or vacuum to “compress” the metal, reducing porosity and increasing strength. Obviously, this is more expensive than gravity casting, but produces a lighter, stronger wheel.

Forging is the most expensive and highest quality method of making a wheel. In this case, a solid piece of metal is heated and forged, or compressed, under millions of pounds of pressure. This method produces extremely strong, dense wheels, which can be made lighter because less material is needed for the required strength. A variation of forging called roll forging takes a rough cast rim and forges it into its final shape while rolling, netting the effect of strength with less material and lighter weight.

**Hub and Lug Centric Wheels**

To meet your high performance customer’s expectations, you’ll need to know as much as you can about custom wheels.

Wheels are manufactured to center on a vehicle in one of two ways:

1. **On the hub of the vehicle.**
2. **On the lug nuts.**

The hub hole of hub-centric wheels is made to perfectly match the diameter of a vehicle’s hub. For example, a hub hole that is 70mm in diameter will fit perfectly on a 70mm hub. Automakers use hub-centric wheels because they provide a more accurate fit. However, only the most expensive aftermarket wheels are hub-centric.

When replacing a wheel, you must select a replacement with a bolt pattern or circle that matches that of the vehicle. A bolt circle is the diameter of an imaginary circle drawn through the center of each lug nut hole. This is true of all lug patterns – 4, 5, 6 and 8.
To determine the diameter of the bolt circle for 4, 6 and 8 lug patterns, measure from the middle of two holes that are directly across from each other. Using the 4-lug pattern as an example, the bolt circle is 100mm in diameter. This is often referred to as a “4 x 100mm.”

Since no two lug holes appear directly across from each other in a 5-lug patterns, determine the bolt circle diameter by starting at the back of one hole and measuring to the center of a second hole that is on the opposing side.

**Wheel Effect on Braking**
Custom wheels can affect the braking performance of a vehicle as a result of the following four parameters:

1. **Size**
2. **Weight**
3. **Design or Ventilation**
4. **Materials**

The size of the wheel determines how much space there is between the wheel and the brake rotor. By moving up to a larger diameter wheel there will be more room for airflow around the brakes and therefore better cooling.

The weight of the wheel is an obvious issue. The heavier the wheel, the more mass the brakes have to slow down, therefore the more heat build up there will be. The mass is not only important in terms of the overall weight of the vehicle, the rotational inertia of the wheel goes up with more weight as well, causing even more work for the brakes.

The wheel design is critical for airflow around the brakes. A closed wheel design will keep the air from circulating around the brakes, decreasing brake cooling. Open designs will allow more airflow. However, all open designs are not the same when it comes to airflow around a rotating wheel. It is virtually impossible to know which one is better just by looking.

Materials such as aluminum transfer heat faster than steel, helping to keep the air around the brakes cooler. This is a relative small part of the equation, but it is a factor.

**Wheel Effect on Ride and Handling**
Wheels play a major role in the ride and handling of a vehicle. From a ride standpoint, the weight of the wheel has much to do with the ability of the suspension to control the tire/wheel motion over bumps. This is the “unsprung weight” issue that seems to come up frequently when talking about vehicle performance. Unsprung weight is the weight of the vehicle that is not supported by the suspension. This includes the wheel tire, and brake components. Since the suspension does not support this weight, it is not easily controlled when a bump or impact is incurred. The lighter the unsprung weight, the less affect it has on ride, and the easier it is for the shock and spring to work together to keep the tire in consistent contact with the road surface.

The handling of a vehicle is always improved with lighter weight. As in the case of ride, the lighter the unsprung weight, the more easily controlled is the motion of the tire/wheel, and the better the adhesion to the road surface.
Another factor in handling has to do with wheel strength and flex. A more rigid wheel will reduce wheel flex during cornering and improve tire performance. This is especially important with low aspect ratio, high performance tires that can generate high cornering forces.

Lastly, lower wheel weight with less flexing will have the affect of improving steering responsiveness.

**Rim Diameter and Width**

Before you mount the tire to the wheel, check the fit of the custom wheel to the vehicle. The diameter designation for both the tire and the rim MUST be the same. A 16” tire must be mounted only on 16” rim.

⚠️ **Warning:** Never mount a tire of one diameter on a wheel of a different diameter. Attempts to mount a tire of one diameter on a wheel of another diameter can lead to failure causing property damage, serious injury, or even death.

For example, while it is possible to pass a 16” diameter tire over the lip or flange of a 16.5” diameter rim, the tire cannot be inflated enough to position its beads against the rim flange. If an attempt is made to seat the tire bead by over-inflating, the bead will break with explosive force, possibly resulting in serious or fatal injury.

![Image: 5° Drop Center Rim and 15° Drop Center Rim](image)

*Note: Tires with beads of one taper must be mounted on rims of the same taper. The taper diagram above shows the difference between the two types of tapers.*

When selecting wheels, you must also pay attention to rim width. The tire manufacturer’s specifications will recommend a range of proper rim widths that will assist the tire/wheel assembly in meeting its performance potential. To achieve the best balance between ride, handling, and treadwear for highway vehicles, select a rim width in the middle of the manufacturers recommended range.

To improve cornering traction and steering response, choose a rim at a near the maximum recommended width. If the tread and the rim are two points, the shortest distance between them is a straight line. The wider the rim width, the straighter the tire sidewall, and the quicker the steering response. Conversely, using a rim width at the low end of the range will cause the tire to balloon or curve out, slowing steering response.
For light truck tires that will be used off-road, select a rim near the minimum recommended width, the tire sidewall will balloon or curve out, providing additional rim protection from rocks and other objects that could cause air loss or a blowout.

Wheel Offset
In addition to selecting wheels with the correct bolt circle and rim width, you must also choose a wheel with the correct offset. Offset is a measurement that most people in the tire business know something about, but many do not fully understand. Simply stated, offset is the measured difference between the wheel’s mounting face where it bolts up to the hub and the centerline of the rim.

In other words, when the mounting face directly aligns with the wheel’s centerline, the wheel has zero offsets. When the mounting face is toward the wheel’s streetside, the wheel has positive offset. Negative offset occurs when the mounting face is closer to the brake side of the wheel.

The offset of the rim is what locates the tire/wheel assembly in relation to the suspension. Front wheels usually have positive offset. Front-wheel drive vehicles have high positive offset wheels, which allow for proper clearance of the hub assembly within the wheel well.
On front-wheel or all wheel drive vehicles, it is important to keep the front axle offsets to the factory-designed specifications. Offsets that do not meet these specifications can increase steering effort, steering wheel kickback when accelerating around a turn and load on the wheel bearings. Using the proper positive or negative offset at the rear of the vehicle is important, but less so than using it at the front where the bearing load situation is critical.

Negative offset wheels also affect a vehicle’s handling. At the rear of the vehicle, they can increase its track, improving stability and handling. Excessive negative offset increases steering wheel kick-back and places additional stress on wheel bearings and the vehicle’s suspension.

Once you’ve selected the correct wheel and checked it for fit, you can mount the tire onto the wheel. Use the same procedures that you would for any non-custom wheel, being extra careful to protect the custom wheel, being extra careful to protect the custom wheel from direct contact with the mounting machine’s arms and mounting bar or tire tool. Proper mounting procedures are found in this guide in the “mounting and Match Mounting” section, the RMA “Demounting and Mounting Procedures for Automobile Tires” and “Demounting and Mounting Procedures for Truck Tires” wall charts.

**Measuring Wheel Back Spacing And Calculating Offset**

![Diagram of wheel back spacing](image)

Backspacing is the distance from the inside of the rim edge to the inside of the mounting face. When the offset measurement is not provided in the manufacturer’s product literature, use the following procedures to convert rear spacing to offset:

1. Measure the back spacing of the wheel, by lying it face down on a flat surface.
2. Then lay a straight edge across the inside edge of the wheel.
3. Measure backspacing from the wheel-mounting surface to the straight edge with a ruler, and record this distance.
4. Next, measure the overall wheel width and calculate the offset using the formula below.

**FORMULA:**

\[
\text{Back Spacing} - \left( \frac{\text{Overall Wheel Width}}{2} \right) = \text{Offset}
\]

**EXAMPLE:**

<table>
<thead>
<tr>
<th>Wheel</th>
<th>Back Spacing</th>
<th>Overall Width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>= 15&quot; x 6.5&quot;</td>
<td>= 4&quot;</td>
</tr>
<tr>
<td></td>
<td>= 7.5&quot;</td>
<td>= 7.5&quot;</td>
</tr>
</tbody>
</table>

\[
4" - \left( \frac{7.5"}{2} \right) = +0.25" \text{ Positive Offset}
\]
Calculating the Offset of a Mounted Tire and Wheel
To calculate the offset of a tire mounted on a wheel, follow these procedures:
1. Place the assembly face down on a flat surface.
2. Lay a straight edge across the inside sidewall of the tire.
3. Measure from the wheel-mounting surface to the straight edge.
4. Measure the tire’s actual mounted section width and use the following formula to calculate the offset

\[
\text{Offset} = \frac{\text{Sidewall to Mounting Surface} - \left( \frac{\text{Mounted Section Width}}{2} \right)}{2}
\]

EXAMPLE:
A customer wants to install 15" x 8.5" aftermarket wheels and 225/60R15 95V tires on a 1992 BMW 525i. Here are the steps you should follow:

1. Check the fit. To do this you'll need to determine the aftermarket wheel's offset. The back spacing measures 3.875", and the total wheel width measures 9.7".

\[
\frac{3.875"}{[\text{Back Space}] - \left( \frac{9.70" \text{ Total Wheel Width}}{2} \right)} = -.975" \quad \text{Negative Offset}
\]

2. Then measure the original 15" x 7" wheel and 205/65R15 94H O.E. tire to compare offsets. The measurement of the sidewall to the mounting surface equals 4.75". The mounted overall width equals 8.60".

\[
\frac{4.75" \text{ [Sidewall to Mounting Surface]}}{\left( \frac{8.60" \text{ Mounted Section Width}}{2} \right)} = +0.45" \quad \text{Positive Offset}
\]

In this example, .975" offset wheel is replacing an original + 1.45" offset wheel. The difference of 1.425" should alert you to the fact that the front wheel, wheel bearings and suspension will experience more sever service. The tire will be moved away from the car and toward the fenders, possibly causing interference.

When combined with the 1.5” additional wheel width, these offset differences indicate that the proposed tire and wheel combination may not be able to be used. One solution in this situation would be to install the 225/60R15 95V on the standard wheel or another aftermarket wheel that has an offset and back spacing closer to the original specifications.