

Wheel sizing

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The **wheel size** for a motor vehicle or similar wheel has a number of parameters.

Contents

- 1 Bolt pattern
- 2 Bolt circle
- 3 Lug nuts or bolts
- 4 Offset
- 5 Wheel size
- 6 Centerbore
- 7 X-factor
- 8 Load capacity
- 9 Load capacity
- 10 See also
- 11 References
- 12 External links

Bolt pattern

The *bolt pattern* determines the number and position of the mounting holes to allow the wheel to be bolted to the hub. As the bolts are evenly spaced, the number of bolts determines the pattern. For example: smaller cars have three (Citroën 2CV, Renault 4, some Peugeot 106s and Citroën Saxos). Compact cars may have four bolts. Most United States passenger cars have five bolts. Pickup trucks, large SUVs, and armored vehicles may have as many as five, six, eight, or ten. It is not unheard of to find vehicles with even more, such as enormous coal mining transporters that may have twelve.

Bolt circle

The bolt circle is the notional circle determined by the positions of the bolts. The center of every bolt lies on the circumference of the bolt circle. The important measurement is the bolt circle diameter (BCD),^[1] also called the *pitch circle diameter* (PCD).^[2]

The BCD may be expressed in millimeters or inches, and is usually given with the number of bolts. For example, a 1974 MG B has a 4/4.5 inch (4/114.3 mm) wheel hub, meaning it has a 4-bolt pattern with a 4.5 inch (114.3 mm) bolt circle diameter.

The most common BCD values are 100 mm (≈3.94 inches) and 4.5 inches (114.3 mm). Many old British cars use 4 x 4"

Lug nuts or bolts

Wheels must be fitted with the correct type of lug nuts on wheel studs, or bolts. Lug nuts (aka wheel nuts in British English) are usually either flat, tapered (generally at 60 degrees and referred to as conical seat), or ball seats, meaning the mounting surfaces are flat, tapered, or spherical respectively. Most Mercedes have ball lug seats from the factory while most aftermarket wheels have a tapered lug design. Wrong lug nuts for the wheel will not properly center it and cause wobble. Some manufacturers (e.g. Toyota and Lexus) have used taper lug nuts for steel wheels and flat seated lug nuts for alloy wheels.

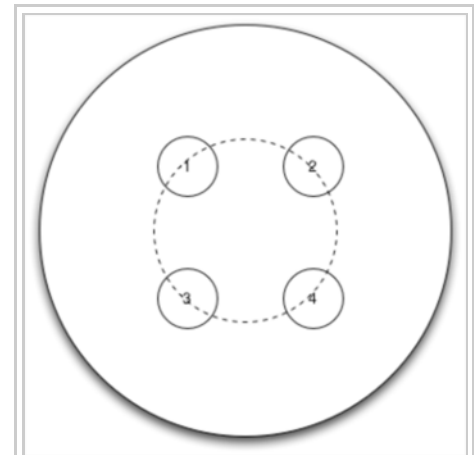
Some aftermarket wheels will only fit smaller lug nuts, or not allow an ordinary lug nut to be properly torqued down because a socket will not fit into the lug hole. Tuner lug nuts were created to solve this problem by utilizing a special key to allow removal and installation with standard lug wrench or socket. The design of tuner lug nuts can range from bit style to multisided or spline drive, and are sometimes lightweight for performance purposes.

A variation is the "locking wheel nut", which is almost universally used for alloy wheels in the United Kingdom. One standard lug nut on each wheel is replaced with a nut which requires a special and unique key (typically a computer-designed, rounded star shape) to fit and remove the nut. This helps to discourage theft of wheels. However, universal removal tools are available which grip the head of the locking nut using a hardened left-hand thread. The success of these depends on whether there is room to use it in the lug hole, and whether the manufacturer has incorporated a free-spinning outer casing to the lock. Keeping an appropriate tool to lock and unlock aftermarket nuts, and a spare set of nuts, with the spare tire in the boot of the car is recommended by manufacturers.

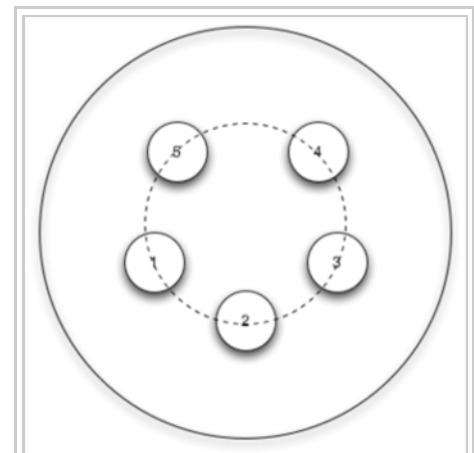
Offset

The *offset*, measured in millimeters, can be negative or positive, and is the distance from the hub-mounting surface to the rim's true centerline. A positive offset means the hub-mounting surface is closer to the outside edge of the wheel, i.e. the wheel wraps around the hub and brake hardware more deeply; a negative offset means the hub-mounting surface is closer to the inside edge of the wheel and wheel sticks outwards more than inwards.

When selecting aftermarket wheels, a wheel with too little positive offset will be closer to edge of the fender, and one with too much positive offset will tuck inside the fender and be closer to the suspension components. Wheel width, offset and tire size all determine the way a particular wheel/tire combination will work on a given car. Offset also affects the scrub radius of the steering and it is advisable to stay within the limits allowed by the vehicle manufacturer. Because wheel offset changes the lever-arm length between the center of the tire and the centerline of the steering knuckle, the way bumps, road imperfections and acceleration and braking forces are translated to steering torques (bump-steer, torque-steer, etc.) will change depending on wheel offset. Likewise, the wheel bearings will see increased thrust loads if the wheel centerline is moved away from the bearing centerline.



4 Hole Pattern



5 Hole Pattern

In other words, using the stock wheel offset number as the starting point, a lower off set number makes the wheel stick out more and a with higher number it sticks out less. (Lower is out more, higher is in more.)

Wheel size

The *wheel size* is the diameter of the wheel in inches where the beads of the tire sit on the wheel. This measurement does not include the rim flange. Modern road tires have several measurements associated with their size as specified by tire codes like 225/70R14. The first number in the code (e.g., "225") represents the nominal tire width in millimeters. This is followed by the aspect ratio (e.g., "70"), which is the height of the side wall expressed as a percentage of the nominal width. "R" stands for radial and relates to the tire construction. The final number in the code (e.g., "14") is the rim size measured in inches. The overall circumference of the tire will increase by increasing any of the tire's specifications. For example, increasing the width of the tire will also increase its circumference, because the side wall height is a proportional length. Increasing the aspect ratio will increase the height of the tire and hence the circumference.

Replacing the wheels on a car with larger ones, normally for a perceived improvement in appearance, also involves using tires with a reduced profile number (often as low as 35%) to keep the overall rolling radius within a few per cent of the original tire. If this is not done, gearing and speedometer accuracy are affected. All other things being equal, larger replacement wheels give a harsher ride because of the shorter and stiffer tire sidewall, in exchange for better handling and higher cornering limits due to the lower sidewall flex. In contrast, a car designed to have large wheels from the outset may have a more normal tire profile and gives a smoother ride due to the larger rolling radius of the tire.

Some wheels also have their diameter quoted in mm as opposed to inches ("metric" wheels). An example of a typical tyre size is 160/65r315, where '315' denotes the wheel diameter in mm.

Off-roading tires may use a different measurement scheme: outside diameter times(by) tread width, followed by rim size (all in inches) - for example 31x10.50R15. The size of the disc however is denoted like 8.5" X 20.0". This shall mean that the width (of thickness) of the wheel is 8.5 inches and the diameter is 20 inches.

A *dub* is a custom wheel that has a wheel size of 20 inches or greater; the term *dub* is a slang term for twenty. DUBS may have originated as an abbreviation for *double-deuces*, or 22 in wheels. DUB Magazine, an automotive enthusiasts magazine, takes its name from the term and covers material chiefly pertaining to urban vehicles and the people that own them.

Centerbore

The centerbore of a wheel is the size of the hole in the back of the wheel that centers it over the mounting hub of the car. Some factory wheels have a centerbore that matches exactly with the hub to reduce vibration by



Measuring an outside rim diameter to approximate wheel size



Asanti 28 inches wheel on a police Hummer H2 car

keeping the wheel centered. Wheels with the correct centerbore to the car they will be mounted on are known as hubcentric. Hubcentric wheels take the stress off the lug nuts, reducing the job of the lug nuts to center the wheel to the car. Wheels that are not hubcentric are known as lugcentric, as the job of centering is done by the lug nuts assuming they are properly torqued down.

Centerbore on aftermarket wheels must be equal to or greater than that of the hub, otherwise the wheel cannot be mounted on the car. Many aftermarket wheels come with "hubcentric rings" that lock or slide into the back of the wheel to adapt a wheel with a larger centerbore to a smaller hub.^[3] These adapters are usually made of plastic but also in aluminum. Plastic rings only provide initial centering, but are not strong enough to help support the wheel in case of high speed pot hole hit. Steel ring is strongest, and aluminum is medium

X-factor

Caliper Clearance (X-factor): The amount of clearance built into the wheel to allow for the vehicle's disc brake and caliper assembly.

Load capacity

Load capacity is the amount of weight a wheel will carry. This number will vary depending on the number of lugs, the PCD, the material used and the type of axle the wheel is used on. A wheel used on a free rolling trailer axle will carry more weight than that same wheel used on the drive or steering axle of a vehicle. All wheels will have the load capacity stamped on the back of the wheel.

Load capacity

GVWR is the Gross Vehicle Weight Rating. In the United States this information is required to be on the vehicle's door placard. The load capacity of the total number of wheels on the vehicle combined must meet or exceed the vehicle's GVWR.

See also

- Plus sizing
- Speedometer#Error - handy tire diameter formula, using tire code
- Tire code
- Uniform Tire Quality Grading (UTQG)

References

1. "Bolt Circle Diameter (B.C.D.)". *Sheldon Brown's Bicycle Glossary*. Retrieved 3 Dec 2010.
2. "P.C.D.". *Sheldon Brown's Bicycle Glossary*. Retrieved 3 Dec 2010.
3. "Hubcentric-rings.com". *Why hub centric rings?*. Retrieved 21 Mar 2011.

External links

- Bolt pattern guide by vehicle (<http://www.1010tires.com/Tools/Bolt-Pattern-Guide>)

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