

Wheel Off-set

Along with the rim *diameter* and the rim *width*, the “*off-set*” of a wheel is *most important*.

When people talk about wheels, for both caravans and their tow-vehicles, the first point is usually are they steel or “mag” (magnesium light alloy)? The next most common items are the *diameter* and *width*.

Then comes “what will they fit”? How many stud holes are there? What diameter studs are the holes designed for? What PCD (pitch circle diameter) are they spaced on? There have been many reports of studs breaking - even *all* at once seemingly - and wheel nuts coming loose, even to the extent of coming completely un-done, with the horrible dilemma of a wheel falling off (and even over-taking the tow-vehicle)!

Camp-fires and forums have been flooded with opinions and theories as to *why* these events happen, and *how* to stop them from happening. Whether or not to lubricate the stud threads, and what torque to apply to the wheel nuts are two of the more contentious issues. One thing is certain... tighten the wheel nuts *exactly* how the manufacturer of the hub assembly advises.

The correct tightening *sequence* is vital; you *never* just tighten the nuts in a circular fashion in one “go”, but rather use a 4, 5 or 6-point “star” sequence, and use 2 or 3 *stages* to tighten them, e.g. Tighten all nuts in the star sequence to say 40 Nm (Newton-metres), and then repeat the sequence to say 80 Nm. Then use the same sequence to tighten the nuts to the torque specified by the hub manufacturer.

The correct wheel nut torque is so *critical*, that it should be prominently stated on the caravan or camper-trailer, as part of the vehicle manufacturer’s duty-of-care responsibilities.

One thing is definite: *Never* use an air (rattle) gun to tighten wheel nuts. Unless you have an extremely precise “calibrated arm” - as some old-timers claim to have developed - always use a *torque-wrench* to ensure the nuts are *accurately* tightened.

While it is most advisable to frequently physically check the security of the wheel nuts, a simple and quick way is to use a pencil, and mark one face of each nut, and draw an alignment mark on the wheel, so that any rotary movement of a nut can be easily noticed.

Other “what does it fit?” items of concern are:

- 1: Does the centre hole in the wheel perfectly match the diameter and contour of the spigot on the hub? If not, the wheel mounting surface may not make solid contact with the flange of the hub.
- 2: Is the PCD of the wheel holes *exactly* the same of the PCD of the hub studs? There are some *metric* and *imperial* wheels where the two PCD's are *nearly* the same, but not *quite*. This will cause the studs to bend as the nuts are tightened, and possibly fail.
- 3: Are the *flare angles* on the stud holes in the wheel, and on the wheels nuts, *exactly* the same? If not, the small contact area will eventually deform, causing the nuts to loosen.
- 4: Is the radial clearance between the studs and the stud holes the small design amount? If there is excessive clearance, the nuts may bottom-out on the hub flange, rather than secure the wheels as intended.

The often ignored, or misunderstood, dimension of a wheel is the “*Off-set*”. As shown in the diagram, the “off-set” is the lateral distance that the mounting face is displaced from the centre-line of the wheel.

Like the *camber* of a wheel (on an independent-suspension system) where the *amount* and the *direction* must be specified, *off-set* also has two properties... the distance (mm or inches), and the lateral *direction*. The distance is designated as either “positive” or “negative”. “Positive off-set” is when the mounting face is *out-board* of the wheel centre-line.

If the off-set is *reduced*, the “track” of the vehicle is *increased*.

Like advising the correct torque for wheel nuts, all caravan or camper-trailer manufacturers also need to advise what the off-set of the wheels on their vehicle is.

If wheels are replaced on any vehicle - caravan or tow-vehicle - with a *different* off-set to the OEM (original equipment manufacturer) wheels, the wheels will then be secured in a different lateral (sideways) position to the vehicle body. Vehicle regulations require that, for *all* combinations of steering, suspension, cornering and braking movements, there must *always* be sufficient clearance between the wheels/tyres and the vehicle structure/body. Just checking the static clearance around the tyres is *not* enough... you have to consider what will happen when you hit a bad bump, and there is a lot of body-roll when cornering. There have been many cases where the sidewalls of tyres have been cut, due to contact with sharp metal, leading to a sudden blow-out. This dangerous problem can happen regardless of whether the off-set is increased, or decreased.

An additional hazard can easily arise when the off-set is *decreased*... in other words, the track (the lateral distance between the centres of the tread of the two tyres on an axle) is *increased*. Axles are subjected to the *combination* of shear, bending and torsional forces, along with sudden shock impacts from road bumps. Combined forces are much more complex than just a single force. When a wheel is moved *outwards*, the stresses on the axle increase considerably, such that it may fail due to fatigue. Vehicle registration authorities usually limit the increase in a vehicle’s track to 25 mm (1”), or less if there is a possibility of “rubber contacting metal”.

The off-set of wheels should have the off-set stamped or embossed in the wheels, for example +25 or -10. If not, you can measure the off-set by laying the wheel on the ground, with the mounting side upwards. Using a straight-edge and a ruler, you take two vertical measurements to determine (a) the height of the centre-line of the wheel (the height of the top of the wheel/tyre above the ground, divided by 2), and the distance from the top of the wheel/tyre down to the mounting surface of the wheel. The difference between the two measurements is the *amount* of off-set; if the off-set is *greater* than the distance to the wheel centre-line, it is *positive*... and vice-versa.

The same problem of cutting the side-walls of tyres can easily occur if *wider* tyres are fitted. *All* combinations of wheels and tyres *must* be in accordance with those stated in the Manual of the Australian *Tyre & Rim Association*. All tyre dealers should have a copy of this Manual. Apart from possibly causing serious handling and stability problems by using mis-matched tyres and wheels, it is an offence to alter any components on *any* vehicle such that the legal compliance - both VSS-approved, or self-complianced - of the vehicle is invalidated.

The rims of road wheels must have circumferential “beads”, or raised rings, to help keep the tyre secured on the rim, should there be a blow-out. The “J” or “JJ” marking on wheels indicates if one or two beads are incorporated. On steel wheels, the recessed beads can be felt, but on cast alloy wheels, this is not possible.

The final word on wheels: *Always* ensure that *all* wheels on your vehicles have genuine Approval markings on them. There have been cases of cheap non-compliant wheels being sold in Australia. Some even had air leaking through the steel... yes, the *steel*!





