

6/2/1F- Gearing For 4x4/Trail Performance

There are four major considerations: terrain type, transmission type (automatic or manual) and ratios, drivetrain strength, and torque-to-weight ratio. There is also tire size to consider. A tire upgrade is one of the first and most important modifications made to a 4x4 that hits the trail. A gear ratio that matches the tire size is vital.

Since four-wheeling may involve a lot of very slow work, the gearing is often lower than you might see anywhere else. Also, the extra low ratios are often necessary to compensate for the very tall tires fitted to many modified 4x4s. The axle ratio is also chosen to complement the entire gearing package, which includes the transmission, transfer case and any splitters or crawlers that are fitted. The combination of these ratios is commonly called the "crawl ratio."

Crawl ratio has become a catchphrase, and like many trendy things, people can carry it too far in the quest to be "cool." With the gearing choices available today, owners of 4x4s use crawl ratios as low as 200:1, and even lower. Those ultra low gears are only useful to rigs with very small engines, very great weight or a very specific purpose such as competition rock crawling. Depending on how the gearing is achieved, it may completely eliminate the ability to use momentum.

How do you calculate crawl ratio? Just multiply all the gear ratios together. A vehicle with a 4:1 transmission first gear, 2.72:1 low range and 4.10 gears would have a crawl ratio of 44.6:1 ($4.0 \times 2.72 \times 4.10 = 44.608$). This final ratio offers the maximum torque multiplication for hard pulls or climbs.

Automatics are a bit more tricky to calculate. Do you count the converter ratio, or not? In this instance, yes. On average, they have a 2:1 ratio, which you would multiply by the "hard" ratio for the first gear planetary set. If you had a 2.41 mechanical ratio, you would multiply by 2 to get the approximate ratio. The key fact is that this ratio changes with engine speed. Your converter may have a 2:1 ratio at 800 rpm but by 1200 rpm it's only 1.3:1 and by 1500 rpms, is very near to 1:1.

What's the ideal crawl ratio? This takes us back to the four considerations discussed above. Starting with terrain, rockcrawlers need the lowest ratio and mudrunners need the highest. Most other situations fit midway between, but biased more towards the mudrunner spectrum.

Rockcrawlers need to be able to drive at a slow, comfortable speed, usually in the low single digits, and to have the torque multiplication to climb very steep stuff at an engine rpm that leaves the flexibility to slow down and speed up. Serious rockcrawlers are often around 100:1 ratio (torque converter included on automatics). Low powered rigs are sometimes much lower.

At the other end of the spectrum are the mudrunners, and the all-arounders. Mudrunners are often at around 50-60:1 and all-arounders from 40-50:1. The mudrunners need the taller gearing to spin up the tires in the clinging mud. All-arounders are often dual purpose machines that spend a fair bit of time on the street and the gearing reflects this. One way to have the best of both worlds is a splitter or extra low transfer case gearing.