Gearing Shifter Karts

SHIFTER KART FINAL DRIVE RATIOS

The importance of altering final drive ratios is appreciated in all forms of motor sport, whether it be for changing track conditions, head or tail winds, or from improved engine power etc. However with shifter karts, what at first seems a fairly simple operation of adding or subtracting one tooth to the axle sprocket for lower or higher ratios is just not good enough, particularly with the increasing competitiveness of our sport.

The first consideration is that we need a range of ratios not only to cover all the different race circuits, but also to allow us to fine tune for each particular circuit. A problem arises here because of the low numbers of teeth in the sprockets used, it is not easy to make smooth close steps in the ratios. To enable us to calculate good ratio changes and a suitable range of ratios we must look at the whole transmission picture. Engine R.P.M., engine primary ratio, gearbox ratios and the tyre diameter are all required. The following formula gives us results in miles per hour, which is more tangible than the decimal ratio of the final drive.

M.P.H. = [Eng.R.P.M. x Tyre Diam. x 3.1416 x Prim. Rat. x Gear Rat. x Fin. Drive Rat.] / 1056

note the **Tyre Diameter is Measured in Inches.**

Gearbox Ratio ....
Your selected ratio. = [No. of teeth on input shaft] / [No. of teeth on output shaft] i.e. 6th. has 22/22 = 1

Primary Drive Ratio = [No. of teeth in crankshaft gear] / [No. of teeth in gearbox input] (ie Clutch Drum)

Final Drive Ratio = [No. of teeth in engine sprocket] / [No. of teeth on back axle sprocket]

Before laying out a list of ratios we should consider why 0.5" pitch (428) chain is used almost universally as opposed to 0.625" pitch (520, 530). As an example the diameter of a 0.625" pitch 20 tooth sprocket with its chain is equivalent to 26 teeth in 0.5" pitch. Using our M.P.H. formula, let us say our engine is doing 12000 R.P.M., tyres are 10.75 inches in diameter, we have a primary ratio of 21/70 = 0.300, in 6th. gear 21/21 = 1.000, and for our final drive ratio we will also have a 1/1 ratio. Therefore in 0.625 pitch it will be a 20/20 and in 0.5 pitch it will be 26/26 making our answer the same for both,

M.P.H. = [12000 x 10.75 x 3.1416 x 0.300 x 1 x 1] / 1056

M.P.H. = 115.13

Now change one tooth on the back axle sprocket making our final drive ratio 20/19 (1.0526) and 26/25 (1.0400), therefore we have in 0.625 pitch 115.13 x 1.0526 = 121.19 M.P.H. and in 0.5 pitch 115.13 x 1.04 = 119.74 M.P.H. The difference of 1.45 M.P.H. may not seem much but in relation to the change from 115 M.P.H. we have alterations in speed of 6.06 M.P.H. and 4.61 M.P.H. Therefore, the 0.625 layout has jumped an extra 31%, and as we are looking for close ratio changes this is reason enough for the use of 0.5 pitch. Even changing the engine sprocket as well as the axle sprocket, good ratios are still very hard to calculate, and compromises have to be made. If you have had problems with 0.5 pitch watch out for misalignment, correct chain tension, lubrication and axle movement. There are many very quick 250cc International karts using 0.5 pitch with no problems apart from routine chain replacement.

Now we can calculate our ratio list. We will assume that we are already using different axle and engine sprockets. As an example we have 16 and 17 tooth on the engine and 19, 20 and 21 tooth axle sprockets. Take each engine sprocket and divide it in turn by each axle sprocket. This gives us 6 different ratios, sort them into order, lowest to highest, then against each ratio calculate M.P.H. For simplicity we will use our earlier example just changing final drive ratios.

Sprockets	**Ratio**	**M.P.H.**	**Difference**
16/21	.76190	87.72	
16/20	.80000	92.10	4.38
17/21	.80952	93.20	1.10
16/19	.84211	96.95	3.75
17/20	.85000	97.86	0.91
17/19	.89474	103.01	5.15

The difference between each ratio is far from being equal, so much so that two of the ratios are almost the same as others in the range being only 1 M.P.H. different. The ratios that are left have a difference of between 4 and 5 M.P.H. this is too great a variation for road racing especially for the smaller capacity classes, and the narrow power bands used. How can we improve this? First, let us get rid of those two ratios we do not really need, by looking at the ratios, we could remove the 20 tooth axle sprocket and even up the difference, giving us a new list :-

Sprockets	**Ratio**	**M.P.H.**	**Difference**
16/21	.76190	87.72	
17/21	.80952	93.20	5.48
16/19	.84211	96.95	4.66
17/19	.89474	103.01	5.15

Now we require ratios as near as possible in the middle of each of our existing ratios i.e.

[.80952 - .76190] / 2 + .76190 = .78571

[.84211 - .80952] / 2 + .80952 = .825815

[.89474 - .84211] / 2 + .8421 = .868425

Find out which sprockets are available for both engine and axle, or if you are going to have sprockets made, the smallest to largest numbers of teeth which can be fitted in each case. Take each available axle sprockets number of teeth and multiply it by the new ratio. We are looking for a whole number if possible as this is going to be the number of teeth in our engine sprocket. Do not waste time calculating to find you cannot fit a 50 tooth engine sprocket. Do not expect to solve the ratio exactly, the chances of that are very small.

e.g. :- .78571 x 23 = 18.07133 (as 18)

18/23 = .78261 90.10 M.P.H.

.825815 x 23 = 18.99375 (as 19)

19/23 = .8261 95.1 M.P.H.

.868425 x 23 = 19.97378 (as 20)

20/23 = .86956 100.11 M.P.H.

Using this selection of sprockets we require one extra axle sprocket 23 tooth, and three extra engine sprockets 18, 19 and 20 tooth. Now rewrite the list with the new ratios.

Sprockets	**Ratio**	**M.P.H.**	**Difference**
16/21	.76190	87.72	
18/23	.78261	90.10	2.38
17/21	.80952	93.20	3.10
19/23	.82610	95.11	1.91
16/19	.84210	96.95	1.84
20/23	.86956	100.11	3.16
17/19	.89474	103.01	2.90

We have seven different ratios with reasonably equal spread covering a 15 M.P.H. range. In addition we also have another eight ratios that we could use, and if you keep the 20 tooth axle sprocket another 5, making 20 ratios altogether. Our only interest in these is as a back-up for our calculated list. We have already seen that some of the ratios come very close to each other, so they could be used as spares. In this instance it is a good idea to keep note of all the ratios in addition to the calculated list.

Having selected our sprockets and ratios which we are going to use, it may be necessary to have two chains of different lengths, each one suitable for specific ratios as there may not be enough adjustment to cater for all conditions. Using our example again, add the numbers of teeth on both sprockets together for each ratio, as similar total numbers of teeth require similar chain length.

Chain A		**Chain B**	
Ratio	**Total No. of Teeth**	**Ratio**	**Total No. of Teeth**
16/21	37	18/23	41
17/21	38	19/23	42
16/19	35	20/23	43
17/19	36		

Add this to your ratio information and we are ready to go. One final point, each individual has different requirements. Drivers could demand finer ratio changes over a narrow M.P.H. range or quite the reverse. Nobody is suggesting that dozens of sprockets are required. The whole idea of the calculations is to eliminate much of the trial and error and tell us exactly what we need. The formula itself is the key to many questions, with a little juggling it can be changed to provide several different answers, for instance, if your tyre diameter changes a new ratio can be calculated to give exactly the same M.P.H. result. It is interesting to note that a change in tyre diameter of 0.100" is equivalent to more than 1 M.P.H. (in our example) or 50% of our calculated ratio changes. For the ultimate in tuning, gearbox modifications, with closer or wider spread ratios, can be calculated.

Always remember that you cannot create Horse Power with gearing alterations however you can apply your Horse Power in the best possible way with just a little thought.