XT225.COM Rider's TECH TIPS

Bulletin 030
Sprocket Gearing

July 2009

By The Muniac

Choosing the right sprockets for a dirty job:

INTRODUCTION:

This tech bulletin explains how your bike's drive train functions and discusses the pros and cons of lower sprocket gearing for trail riding. Simply stated the engine develops torque which is imparted to the rear wheel through the drive train to move the bike. What's important is to understand that an engine's ability to develop torque varies with its speed or RPM. Thus torque isn't constant over its usable RPM range. At idle or low RPM an engine has minimum torque making it easy to stall. The usable torque required to move your bike forward begins as throttle is applied (See Figure 1). The factors that influence a given engine's speed/ torque relationship are complex. Bore, stroke, fuel delivery, valves, cam, 2 cycle, 4 cycle, compression ratio, cylinder count and ignition are the most common factors. Every engine is different owing to so many design parameters. Some, like the XT225 engine, develop good torque at lower RPM. Other engines do not. As a general rule all engines tend to produce more torque at greater RPM. It is this fundamental characteristic of engines that requires the clutch/transmission type drive train we all know well.

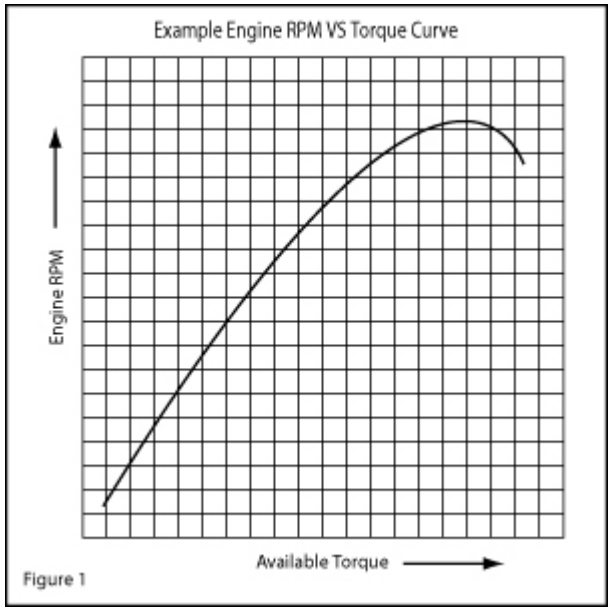

Figure 1

DRIVE TRAIN FUNDAMENTALS:

The first component in our drive train after the engine is the clutch. It's purpose is to mechanically engage and disengage the engine's output shaft from the transmission. It also must do this gradually to allow power to be metered accurately under operator control. On a bike the clutch control is through a hand lever. As the hand lever is released disc plates are compressed together allowing the engine's torque (or power) to be smoothly coupled through to the transmission. As the clutch is being engaged heat is developed and the discs

or plates wear. The more time a clutch spends slipping the shorter its life expectancy will be. When the lever is fully released a rigid mechanical connection is made allowing full power to pass through. "Fanning" (or slipping) the clutch is a common torque adaptation technique but won't be covered here. Fanning will shorten the life of your clutch.

Archimedes said, "Give me a lever, a fulcrum and a place to stand and I'll move the world." It is through this lever concept that we come to understand the mechanical advantage our bike's transmission provides. The magic of a lever allows us to move 1000 Lbs with just 10 Lbs or force. Can openers and wrenches are levers we all are familiar with. But there are trade offs. With levers the trade off is having to swing it through a large distance to move something a small distance. With a transmission the trade off is RPM and speed. Let's see how this all comes together.

Owing to an engines unique torque band (lower torque at lower speed), a transmission is required to couple its output shaft to the rear wheel. The gears or speeds become a set of rotational levers that allow a specific torque band to be adapted to a wide range of variable driving conditions. Gear ratios are selected by the manufacturer to satisfy certain performance criteria. Trail bikes are geared differently than touring bikes for example. In general, lower gears allow greater amounts of rear wheel torque but at the expensive of speed. Higher gears allow great amounts of speed but at the expense of torque. The transmission allows us to select the proper mix of speed and torque to accomplish our riding goal. One other thing the transmission does is to allow us to keep our engine in its best torque band. This is why you down shift (select a lower gear) on steep hills. Without the ability to select lower gearing your engine would fall out of its torque band and stall or lug. Lugging an engine happens when you exceed its available torque at a given lower RPM. Lugging isn't good for an engine and should be avoided by selecting a lower gear. Summarizing, lower gears mean more low speed torque with higher engine revs. Higher gears mean more speed with less torque at lower engine revs. This over simplifies things a little but is adequate here to develop our topic.

The last component in the drive train is your chain and sprockets. They couple the transmission's output shaft to the rear wheel. The chain and sprockets allow continuous power to be transmitted to the rear wheel while allowing it to move vertically in the swing arm. The chain also allows this power to be carried rearward through a distance. This last component also provides an extra fixed gearing as it were and can be used to establish a different operating point for the bike. Depending on the type of riding we do it may be beneficial to select different sprockets than those found on a stock bike. For example, the stock XT225 has a 15 tooth front sprocket and a 45 tooth rear sprocket. Dividing 15 into 45 gives us three turns of the front sprocket for each turn of the rear sprocket or a 3:1

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ratio. Engineers decided this ratio was the best overall compromise to allow the XT225 to handle most riding situations. Compromise is the operative word and needs further exploration.

COMPROMISE AND TRADE OFFS:

Whatever performance mods or sprocket changes you choose for your bike remember the rule is they come with trade offs and compromises. The key to making the correct choice(s) is in understanding where the trade offs are and what compromises you'll be making for a given riding style. Changing sprockets and the operating point or range of the bike is no exception to this rule.

This tech bulletin deals with selecting the sprocket sizes that enhance performance in slower technical riding situations. All of the lower gearing choices will sacrifice top end speed and fuel economy. But if you spend most of your time on technical trails and little of it on the road then these disadvantages won't dominate your riding experience. In fact, they may not be disadvantages at all. Figure 2 at right shows the more common sprocket choices for lower gearing. The first entry is stock XT225 sprockets and is our reference point. As you move down the table you will sacrifice top end and lower fuel economy. The best choice for you depends on what and how you ride the trails. If you are just getting into technical riding choose something close to stock for starters. As skill level improves you can re-evaluate your choice and adjust as required. The important advantages of lower gearing are more torque, less clutch wear, better throttle response at low end, increased engine braking, better speed recovery, less jump in gear positions, more throttle punch and more precise slow speed line attack. If you ride technical trails you will encounter all the aforementioned items sooner or later. Being setup ahead of time makes the riding experience safer and more enjoyable.

Common Low Gearing Sprockets

LOWER GEARING ↓

RATIO	FRONT SPROCKET TEETH	REAR SPROCKET TEETH	COMMENTS
3.00:1	15	45	Stock XT225 sprockets. Provides average good performance over usable speed range of bike.
3.21:1	14*	45	Easiest way to get lower gearing than stock. May not be low enough for some riding situations.
3.33:1	15	50	Good low gearing choice for most technical riding situations. Requires longer chain.
3.57:1	14*	50	Good lower gearing choice for most technical riding situations. Requires longer chain.
3.87:1	15	58	Provides lowest gearing and still allows road speeds of 55 MPH. Requires longer chain.

NOTES:

* Using 14 tooth sprocket will accelerate wear. 15 tooth will last longer. Some 14 tooth after market sprockets have poor mounts.

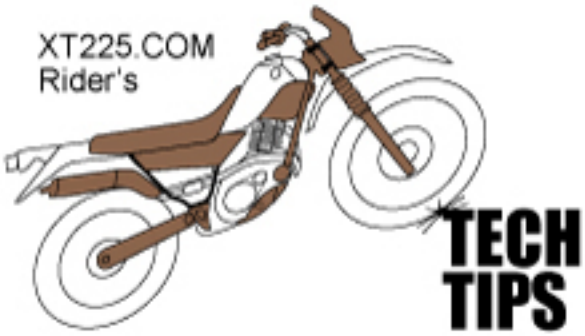
Aluminum sprockets not recommended due to poor service life.

DID-428 chain (130 links) good choice for use with 50 and 58 rear sprockets.

Lower gearing choices reduce gas mileage.

Figure 2

OPERATING POINT:



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What happens when the gearing is lowered, through alternate sprocket selection, is the entire operating point of the bike shifts downward. The most obvious change is a given engine RPM produces less speed and more torque. Starting becomes easier and puts less stress on the clutch. Ratio jumps in between shifts become smaller and more low end gears can be used. This allows fine tuning your attack gear because you have more gears that work. The engine works more in its higher torque band making throttle response better. Bursts of acceleration become stronger too. Especially at or from the low end. Narrowing the ratio jump between gears means increasing their sense of overlap. This means the top end of first gear is closer to the bottom end of second gear. Depending on shifting technique you can make them overlap. When smooth torque is required through successive shifts this is huge by getting you out of one gear and into the next quickly while maintaining "drive". Lowering the operating point also increases compression braking from the engine. Finally, if you spend most of your time on the trails traveling between 0-30 MPH lower gearing means bringing more of the transmission down into this range.

TRAILS AND LOW GEARING:

Let's go through some trail specifics where low gearing is really helpful.

1) In tight technical sections you may find it necessary to thread the needle so to speak. Here a slow crawl with good punch really helps. This allows you time to guide the front wheel and execute with precision. Should you need to lighten the front wheel it can be done with a quick throttle stab. Once completed the bike settles down quickly.

2) Hill climbing is another area where lower gearing pays off. On straight shots you'll need to achieve entrance speed to make it to the top. Lower gearing will get you to 30 MPH quicker in less space for example. On technical climbs or those with limited sight distance, you may find yourself rolling throttle off for a brief period to deal with something that came on quickly. You may roll off throttle to change your line mid stream. A lower gear will allow a better recovery to speed when you resume climbing at a normal rate. Also 2nd gear's low end overlaps 1st more with geared down sprockets. That means you have the best of both worlds as in torque and climbing speed. If you stall on a hill, stop or need to get started for some reason you'll find a low 1st gear comes in handy. A low 1st gear eases wear and tear on the clutch on steep starts because you can reach full engagement sooner.

3) Using compression braking saves wear and tear on the rear brake when coming down hills. Lower sprocket gearing significantly increases compression braking in the lower transmission gears and in many cases is all the braking you'll need. On very steep hills you can add in pulses of the back brake to arrest speed as required.

4) In some situations you may find yourself walking next to your bike while throttling it through something that is best negotiated without the added weight of a rider. A lower 1st gear makes this an easier task because the bike is less likely to zoom away from you. The same applies to someone else boosting you through a section that requires the booster to stay with the bike.

5) Paddling is another area where a slower controlled approach makes the job easier. This is especially true if you drop down in the seat on a steep hill climb and need to keep your momentum up. You can provide support with your feet and drive the bike at a slower speed that allows your feet to keep paddling. The gearing range of the bike needs to be low enough to generate enough torque against the hill to avoid a stall out as slower speeds.

Stalling on a steep hill like this requires considerable torque to get restarted. Stalling may be accidental or planned. Either way, lower gearing helps here to get restarted and is easier on the clutch.

Figure 3

6) High elevations is another area that lower gearing is helpful. Bikes tend to run rich which causes the engine to stumble at higher RPM. You can ease the stumbling by short shifting the bike and loading the engine a little more at lower RPM than usual. Torque still remains to climb reasonably well. This isn't a substitute for lost power at elevation but it does help. Sometimes that small improvement is just enough to get you to the top.

7) Creeping on bench cuts is often necessary if the cut is narrow and the edge is steep. Add to that junk in the trail, steep inclines and/or rocks. You may not want to just blast through a trail like this owing to the danger. A geared down bike crawls with much more control as you slide your foot along the uphill side for extra balance. All of your speed adjustments can be done with the throttle in precise increments and avoids having to fan the clutch. It's just one less thing to worry about in a tight spot when concentration is required elsewhere.

8) Rock gardens occur frequently on trails or when trails overlap stream beds. Blasting through on a bike with 9" of suspension travel (like the XT225) isn't

always practical or indicated. Low end torque and grunt allows working a bike through with precision. At slower speeds you can enhance the limited suspension travel with your knees. The punch of lower gears helps span holes between the rocks without building too much speed up for the next section. A bike can be accelerated and decelerated quickly all at low speed as required to get up and over rocks and holes.

9) Short distance run ups refer to getting up, through or over something that requires speed with a limited run up distance. The challenge is to get the bike to the entrance speed in the limited distance available. Lower gearing allows quicker acceleration and perhaps one shift if required. Many of these situations can be ridden between 5 and 10 MPH for example.

SUMMARY:

Presented above are some of the more common situations that are aided by lower gearing. Finding the correct ratio is strictly an empirical process that you must experiment with. Every rider is different and feels the bike in their own unique ways. There are no absolutes that apply to all riders on all trails. There are no perfect bike setups that allow a bike to be all things to all trails. The goal here is to provide some food for thought and a framework for experimenting to find the best gearing for you on the trails you enjoy riding. Remember that making improvements in one area sacrifices performance in another. Lowering the gearing of your bike will limit its top end and reduce fuel economy. Leaving the bike with stock gearing might make it more difficult to maneuver it safely through a technical trail situation. Stock gearing may increase a bike's tendancy to stall on steep slower climbs. The idea is to find an acceptable compromise that works best for you. Tuning your bike isn't a paper exercise. It's done incrementally on the trails as an educated guess in the direction of an improvement. With knowledge you can get things setup properly without too much wasted time, money and effort fooling around. The XT225 has great low end torque owing to its engine design. This feature really shines with lower sprocket gearing. I run 15:58 on my XT and have done so for over 5,000 miles. I swear by this setup and have found it the best for me. Almost all of my riding is on slower technical trails. With 15:58 I can still do 55 MPH which is fine for the small amount of road riding I do. Your situation may be different. The most important aspect is to enjoy your riding experience and maintain acceptable safety limits. Gear you bike to solve the riding prolems you encounter. If you ride technical terrain, back woods trails or back country you should seriously consider a lower than stock gearing option. I hope this tech bulletin helps you make the correct choice and improves the riding experience.

THE END

Credits (all photos, graphs & charts):

Courtesy Muniac @ XT225.com