

CVT Basics - Constant Variable Transmissions

One thing people regularly wonder about is how a CVT (Constant Variable Transmission) works. CVTs are used mostly in scooters, like the 50cc Aprilia SR50 DiTech this document describes, but some larger scooters also use CVTs, and they are even being used on some Audis now! If you've ever been confused about that strange little transmission in your scooter, this should help clear things up a bit.

CVTs are quite simple in design, but since every part must work in concert with all the others, it can be difficult to visualize their operation, and understand how each part fits into the whole. The drawings are not to scale, but are meant to just give you a better idea about what is going on.

This document was originally written by Scott (AKA [Scootnfast](#)) on the [ApriliaForum](#) website. I have done a bit of editing so that things make sense in a non-forum context, but all the photos and info are his, and have been reproduced with his permission.

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People ask a lot about different roller weights, clutch springs, contra springs variators and belts. This is an attempt to put the effect these have on your CVT in simple terms.

The truth of the matter is, a new variator, springs, or weights WILL NOT increase your vehicles over all power! The power your vehicle produces depends on the engine, not the transmission.

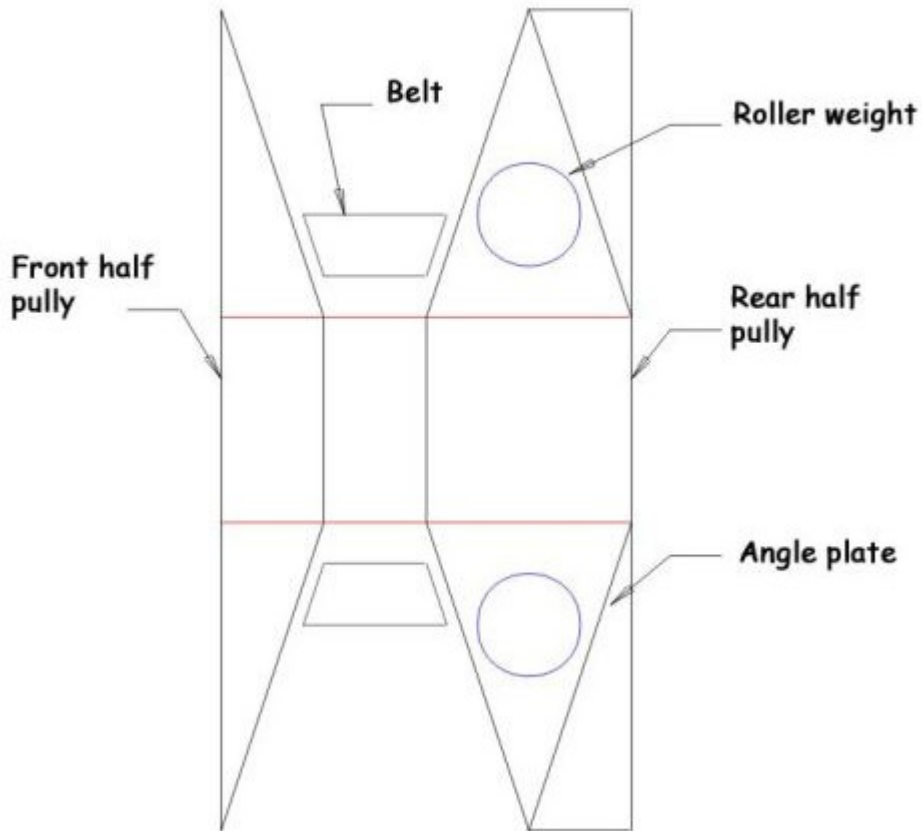
What it does do is adjust your rate of acceleration, and at what RPM your motor runs at while it is accelerating, and at what speed the motor is revving when you reach the highest gear ratio available.

Now having said both of those things, the key is to have your motor running at the RPM where it creates the most horsepower consistently while accelerating. This value will be different for different engines. For the Aprilia SR50 DiTech used in this explanation, The max power is created between 8000 - 8500 RPMs. If you are accelerating at 5000 RPM's or 9500 RPM's, this will decrease your acceleration because your horsepower is not at it's peak.

This goal is achieved through trial and error. Changing first your contra spring, and then trying different roller weights is how one might go about doing this.

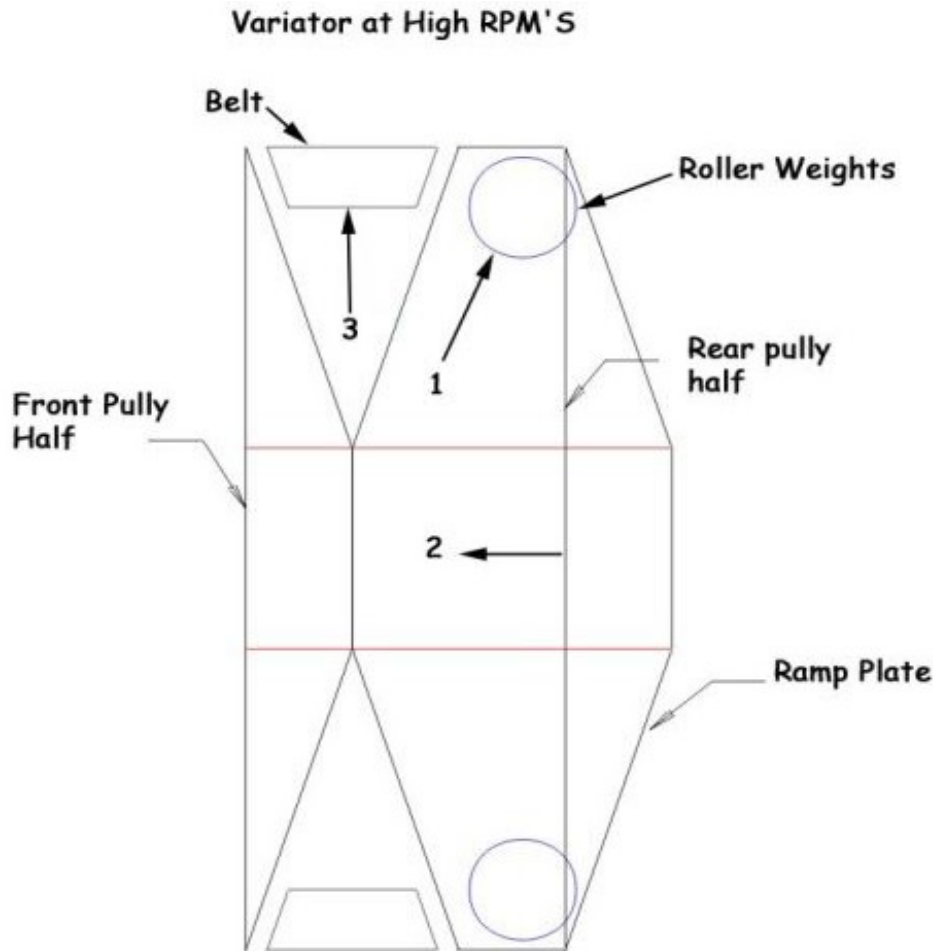
In order for you to understand which way you need to go with weights and springs, you must first understand how the entire drive train works.

Variator Assembly



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Lets start with the front pulley of the variator. This is where your roller weights and ramp plate are located. This image is a cross-section of the front pulley, showing the front half of the pulley, the belt, and the rollers sitting against the ramp plate. This is how the transmission looks when the engine is running at low RPMs.



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Now as the RPM's of the motor increase, the centrifugal force pushes the roller weights outward (number 1 in picture).

The roller weights push out and onto the angle plates surface. This causes the rear half of the pulley to move toward the front half of the pulley (number 2 in picture).

When the rear half of the pulley pushes to the front pulley, it forces the belt out to a higher gear ratio (number 3 in picture).

This is the basic operation of the front pulley. Faster engine speeds cause the belt to go outward.

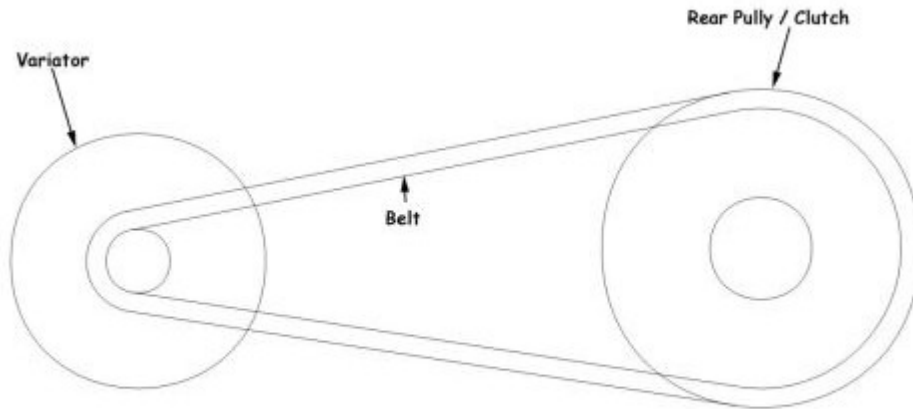
If you are thinking about getting a new variator, let me first start by telling you that it will probably not have any effect on your over all top speed. What it will do is give you a more steady acceleration. The distance that the rear half of the pulley can travel pretty much remains the same. Meaning that it will only push the belt out as far as the stock variator will which results in the same high gear ratio as the stock variator. The key difference between the stock and performance variators is the angle on which the roller weights travel and the angle on the angle plate in the rear of the variator. This will only help give you a smoother, more constant acceleration.

Now as for the different weights for the rollers. It is really rather simple. The heavier the weight, the more force will be applied to the angle plate forcing the rear pulley half forward faster. If the roller weights are too heavy, it will force the gear into too high of a gear too fast.

I like to use a 10 speed bicycle as a comparison. From a dead start, if you are in 10th gear, it is very difficult to get going. But if you are in first gear, it is very easy to get moving. the same principle applies here. You want the weights to keep you in first gear, and as the RPM's increase, it will gradually step the gears up until it reaches tenth gear.

If your roller weights are too light, then there will not be enough force to push the ramp plate out and the rear half forward. This will result in good acceleration, but a low top end. You will simply remain in a low gear for too long. As the engine speed finally gets moving enough to move the pulley forward and raise your gearing, you will be above the RPM of peak horsepower for the engine, and it will not have the power to get you moving.

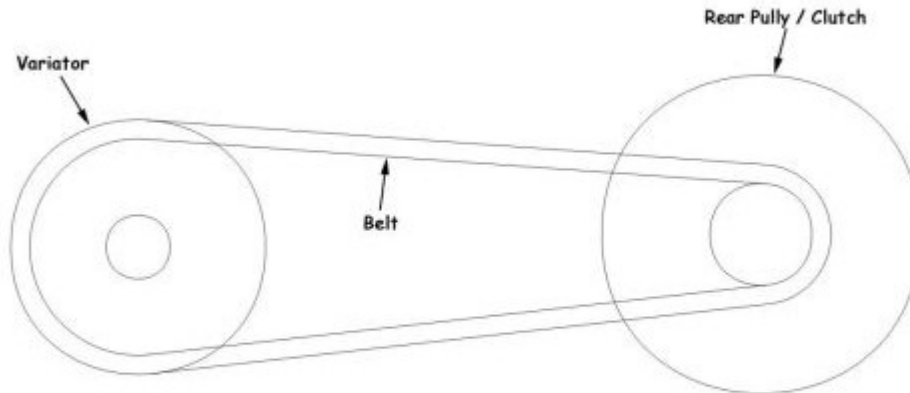
Engine at low RPM'S



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This image is a side view of what the ratio looks like in low gear. You will see that the front pulley is small, and the rear pulley is large. This is like first gear of the 10 speed bike.

Variator at High RPM'S

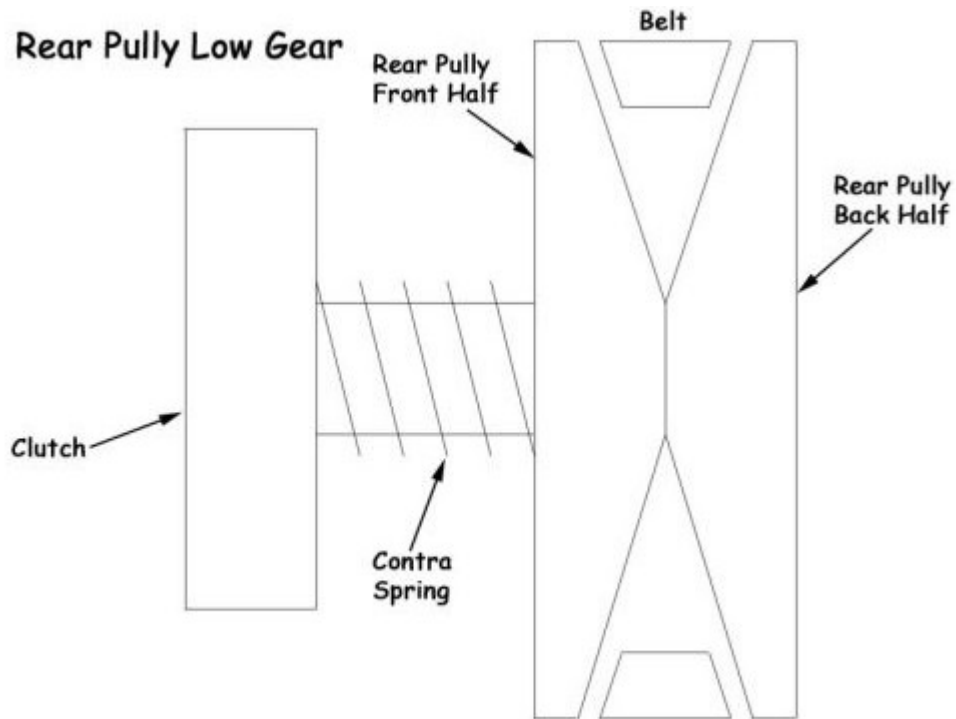


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This image is what the gear ratio looks like when the roller weights are pushed out and the rear half of the pulley is forward. The belt is pushed out to a higher ratio. This is like tenth gear on the bicycle.

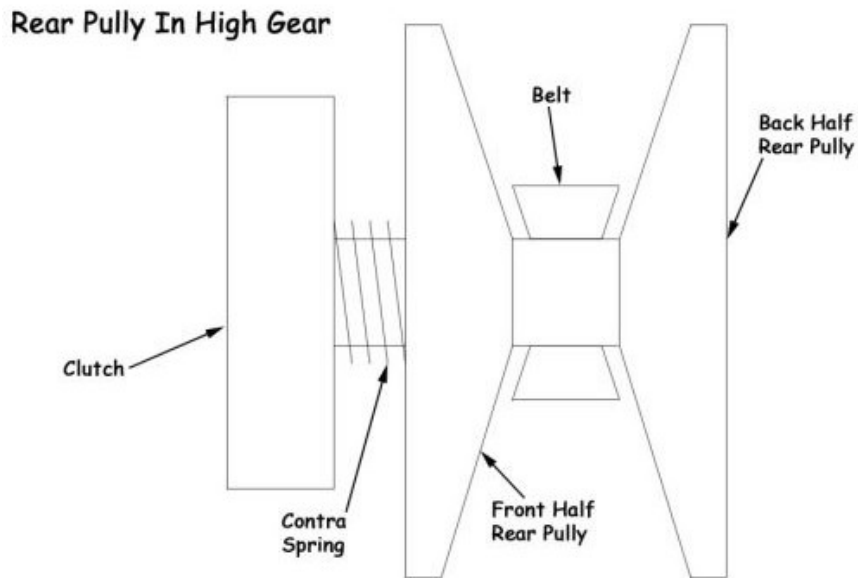
Now the other factor in this equation is the rear pulley. The rear pulley has a spring holding it together. This is your contra spring.

The front half of the pulley is also torque controlled. There are angled grooves that the pulley travels on. As torque is applied, this limits the belt from traveling in too quickly. Likewise, as you go up a hill and torque is applied to the pulley, it is supposed to force the pulley together giving you a lower gear ratio.



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This image is what the rear pulley looks like at low rpm's. The spring is forcing the two halves of the rear pulley together, holding belt outward, and keeping a low gearing. As torque is applied to the belt, the halves of the pulley begin to separate, pulling the belt inward, which raises your gearing. The stiffness of this spring determines how fast the pulley halves expand, and how strongly they return to their original shape when the torque is lowered again.



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This image is what the rear pulley looks like at high rpm's. Notice the spring has been compressed, and the belt has moved inward.

If your roller weights are giving you good acceleration, and a good top end, but when you approach a small hill the scooter slows drastically, this may be caused by having too light of a contra spring. The contra spring helps push the rear pulley back together when torque is applied to the rear pulley.

Say you are running good at say 50MPH, and you slow down to 35MPH. If you then try to accelerate, and you have hardly any acceleration, this can be caused by having too light of a contra spring. When you slow down, the spring is supposed to push the rear pulley together into a lower gear ratio. If the spring isn't strong enough, the pulley will remain in a high gear, and then when you try to accelerate, there isn't enough power to push you because you are in too high of a gear.

On the other hand, if your spring is too strong, then the roller weights may not be heavy enough to force the belt out all the way and into it's highest gear ratio, and you won't be able to reach your top speed.

If you go with a stiffer contra spring, you may need to go to a slightly heavier roller weight. Likewise, if you go to a softer spring, you may need to go to a lighter roller weight.

There is a very fine balance that you must achieve between the contra spring and your roller weights. This is only accomplished through trial and error.

If you are looking for different roller weights for your scooter, check with your dealer or do some web searching for your model of scooter.