

Vespa Gts 250

Variator Comparison

In the same way that the P-range and the T5 were originally mocked on their release - but later became the rally tool of choice for many scooterists - the GTS 250 is starting to follow suit. Whatever you think of the styling and engine configuration, this Vespa does ride wonderfully. That's not to say it can't be improved though...



PM Tuning use a Dyna Pro eddy current dyno to load the GTS for testing. Paul's test technique is very thorough and scientific.

On the limit

The 250cc fuel-injected Quasar (not Leader) engine is still fairly new and has not attracted a great deal in the way of tuning parts yet. Widely accepted as the best tuning product for the GTS is a flyscreen! If one is fitted the aerodynamics improve to such a degree that most riders pick up a few mph on top speed. This itself brings other problems because now the scooter can go fast enough to hit the engine rev limiter at around 9500rpm. At these revs the engine starts to stutter and simply won't go any faster. Depending on the state of the transmission components, this will happen at between 78mph and 82mph: though the highly delusional speedometer may well be showing 90mph...

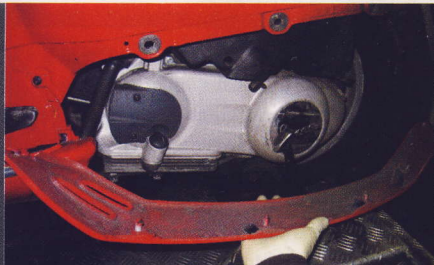
Potential solutions

If you want a scooter to go faster without increasing the rpm the traditional method is to raise the gearing. The problem for the Quasar engine is that there isn't a gear-up kit currently available, though PM Tuning are working on it. Your other options are to fit a taller rear tyre, or to change the behaviour of the variomatic transmission to increase its speed range. This can actually be achieved surprisingly easily with an aftermarket variator or even with a change of variator rollers.

Variator - wassatdoden?

The variator is the main actuator for gearing ratio changes on a variomatic engine. Your equivalent to first gear is when the belt sits low between the front pulley formed by the variator and its corresponding 'fixed half pulley'. In this position the belt is riding low at the crankshaft end, but high between the faces of the rear pulley, because they have been pushed together by a large spring (contrast spring). Low gearing is achieved by the fact that the crankshaft and front pulley must turn many times to achieve one rotation of the rear pulley.

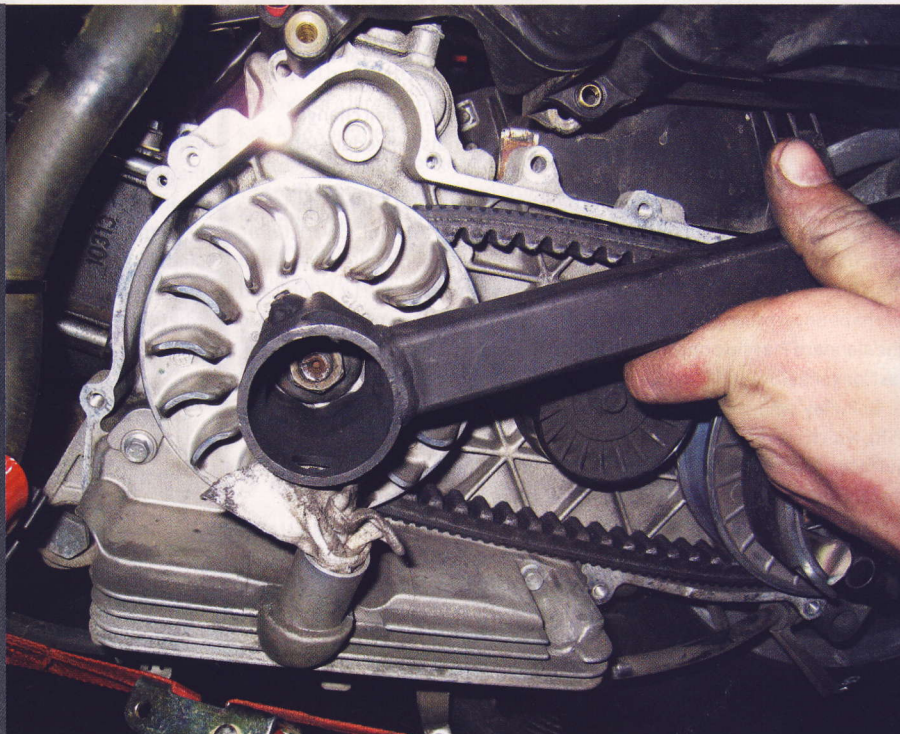
As the engine rpm increases, centrifugal weights (rollers) in the variator begin to fly outwards between specially machined ramps in the variator and a fixed plate. This has the effect of moving the variator closer to the fixed half pulley so the belt begins to ride higher at the crankshaft



Remove the lower side panel: one screw at the front and a nut at the back. Then remove the chrome cover to access the clutch nut.



The rectangular holes in the outer pulley are used for holding it steady while undoing the variator nut. Note the position of the two washers outside the pulley. There is also a thin shim washer beneath it.



Two pins in the Readspeak-produced holding tool lock the variator for tightening and loosening the nut.

end and lower at the wheel end.

Eventually – when the wheel speed rises and the standard variator is as close to the fixed pulley as it can get – one turn of the crankshaft will give you several turns of the rear pulley. This is your equivalent of fourth gear on a manual scooter gearbox, but it's not the end of the story. If you could push the variator even closer to the fixed pulley (or the design of its pulley face was different) then you could get the belt to ride even higher at the front and lower at the back. This would be the equivalent of adding a fifth gear to a manual box. Simple bolt-on aftermarket variators can do this: they can marginally increase the speed range so a machine like the GTS can go faster without hitting the rpm limiter.

Rpm control

Typically, there is more to a variator than simply adjusting the gearing. Its job is to use gearing to harmonise the engine revs against the wheel speed, so that while the scooter is accelerating it is always held at the rpm where it makes best power. This is achieved by a delicate balance between the centrifugal weights (rollers) in the variator and the rear pulley (contrast) spring.

If the weights are too heavy then the gearing will rise before the engine was spinning fast enough: a bit like someone who rides a manual scooter but always rides a gear too high. This kills acceleration.

If the weights are too light then the engine will over-rev during acceleration. This is like someone who misses the correct gearchange point on a manual gearbox and instead screams the engine to high revs before changing up. As with a manual box, the quickest way is to change the gear at the correct rpm. On a Vespa GTS peak power (at the crank, as claimed by Piaggio) is 22hp at 8500rpm, so for optimum acceleration the

variator needs to be held at 8500rpm across the whole speed range until it runs out of adjustment.

What's wrong with standard?

Setting up variomatic transmission is a bit of a black art, and when a manufacturer does it they have to consider more than just acceleration and top speed. Not everyone wants a race start each time they leave the traffic lights. Typically, they will design the ramps in the variator so that at lower speeds the engine rpm are also held lower, below peak power. This makes for a gentler acceleration, reduced engine wear and improved fuel economy at low speeds.

Some manufacturers have also been known to set the variator to drag the engine rpm down at a certain speed to help with drive-by noise or emissions testing. What this means is that – if you want more performance from a variomatic engine – then there are often fairly substantial gains to be had by fitting an aftermarket variator; particularly at the lower end of the speed range.

Variator fitting

Once you get the hang of it, fitting a variator to a GTS can take less than an hour, but you either need special tools to hold the clutch and front pulley, or access to an (air or electric) impact socket driver gun.

The first step is to remove the lower side panel, followed by the chrome clutch cover, which can be carefully levered out. To undo the clutch nut you either need to impact the 19mm nut off or use a special tool to hold it while it is undone. Jettin in USA have made a special one with pins that protrude through the casing (www.jettin.com). If desperate you can even lock the clutch by cable-tying the rear brake on or inserting an 8mm rod through the slots in the casing.

With the clutch nut and washer removed, now

undo the side casing bolts and three air-filter screws (one has a nut on the back that is accessed by removing the helmet bay).

After removing the transmission cover the next thing to tackle is the variator nut. This can safely be undone with an impact gun, but is best held with a special tool to be tightened to the correct torque figure when refitting. Genuine Piaggio tools are very expensive. Jerome from Readspeak made his own by welding two short lengths of Allen key to a box spanner, and then welding on a handle. The Allen key lugs locate in two rectangular slots in the outer pulley so it may be held firmly while the variator nut is tightened.



Ensure the belt sits deep into the rear pulley to be certain it is not trapped when rebuilding the variator. To do this pull the belt with your foot while also twisting the rear pulley halves to help them to separate.

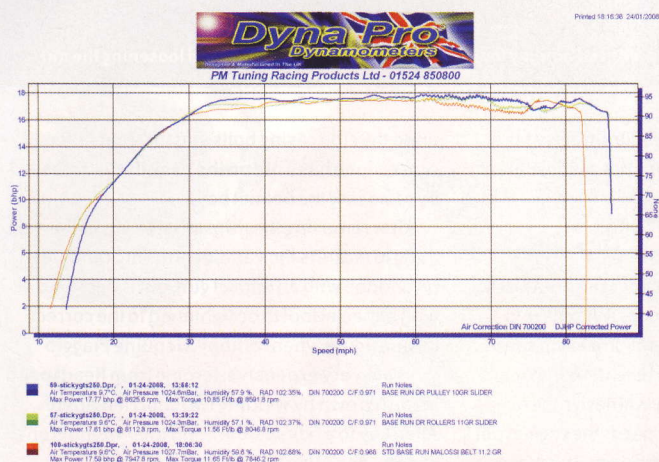
Dr Pulley slider weights

Generally, Piaggio are very good at setting up their automatic transmissions and the original variator performs quite well on the GTS. Gradually performance and top speed drop off before the 9000-mile belt change interval. A worn belt or rollers that have developed flats will reduce top speed and acceleration.

Dr Pulley are the Taiwanese brand of plastic specialists Union Materials Co. They have developed a 'tribological' (highly wear resistant, low friction) material aimed at increasing the lifespan of standard round rollers. We fitted their Round Rollers (RR) in the correct standard dimensions (21 x 17mm) and perhaps unsurprisingly there was no measurable performance difference to the standard Piaggio ones, though if what they say is true their rollers should last longer before suffering wear.

Dr Pulley's more interesting product are their patented Sliding Rollers (SR), which are odd-shaped centrifugal weights with various curved and flat surfaces. These are supposed to last even longer than their round rollers, but their odd shape actually increases variator movement at high speed, extending your gearing and offering a higher top speed.

The graph below shows that they do actually work, and add around 3mph to top speed before you hit the rpm limiter. Replacing the 11g round rollers (red curve) with 11g Sliding Rollers (green curve) gave a very small power increase, but we found that swapping to lighter 10g Sliding Rollers (blue curve) allowed the engine to rev a little harder and gave a worthwhile improvement.



PROS

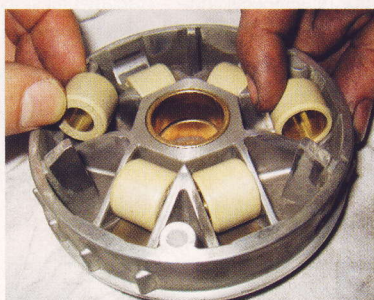
- Easy to fit during a service
- Do what they say on the tin – increase top speed potential
- Work with stock variator or aftermarket ones

CONS

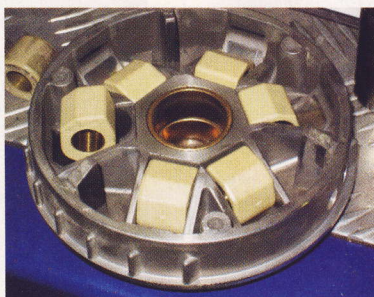
- More expensive compared to normal round rollers
- Need to be carefully aligned when fitted for correct performance, but quite easy for them to slip during assembly.

AVAILABILITY: SIP Scooter Shop

PRICE: Dr Pulley Sliding Rollers (SR) €14.20



Some round rollers are 'handed' for correct fitment. Follow the supplied instructions.

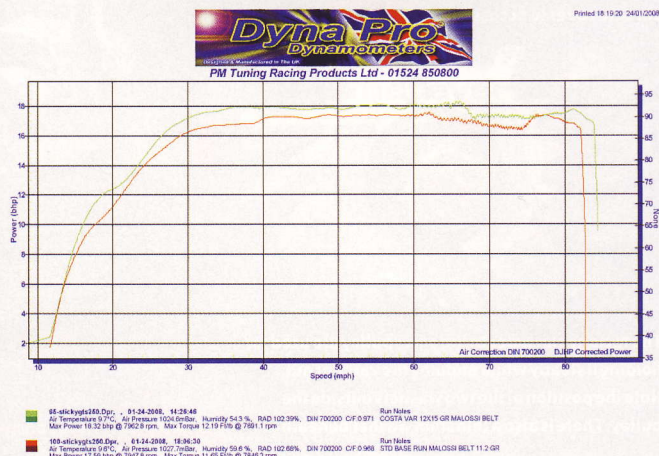


It is vital that the odd-shaped Dr Pulley sliders are fitted in the correct orientation for proper operation.

J Costa

Spanish firm J Costa have built their variator from solid aluminium billet making it a hefty beast that weighs 300g more than the Polini or Malossi variators. It works in a slightly different manner from conventional roller variators in that the centrifugal weights are actually bullet-shaped sliders that push on the pressed steel outer bell as they slide outwards. This one was fitted with 12 15g weights.

On the dyno the J Costa variator allows the engine to rev to 9000rpm off the mark for a good take-off, and it remains stable all the way up to 70mph. At just below 70mph the variator drags the engine rpm down to below 8,000, which is why there is only a small improvement on the standard variator at this point.



PROS

- Nicely made unit
- Gives a good improvement straight out of the box
- Adds a couple of mph top speed

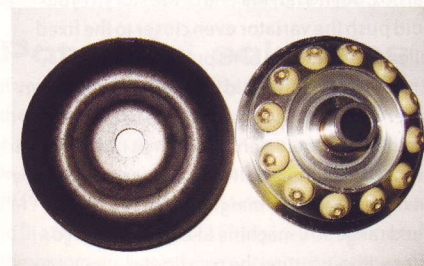
CONS

- Heavy
- Replacement weights not easily available
- Expensive

AVAILABILITY:

Birchwood Development Services Ltd, 63 Violet Close, Birchwood, Warrington, WA3 7NW
(www.jcostacompetition.com)

PRICE: from €200



The Dr Pulley variator has an unusual layout and uses bullet-shaped weights

Polini

Polini have previously listed two different variators for the 250cc Quasar engine. The first with part number 241.621 is actually for the Leader 200 engine. It does fit the Quasar 250 engine, but it has been superseded by 241.645. One of the problems with the 241.621 version is that it is supplied with a mix of roller weights: red and yellow (12.8g and 14.8g). Mixing rollers (as long as they are alternately positioned) does work if you are trying to find a compromise between the two weights, but in the long run it is the heavier ones that take the most abuse and thus wear out quicker.

The new 241.645 is identifiable by the chrome back-plate and by the fact that all six rollers supplied are the same 11.8gr weight. The Polini variator is very nicely made; with a design that incorporates two oil-seals so the bush can run in grease rather than dry like all the other types.

We encountered a problem with the use of the Malossi belt and the supplied configuration for the Polini variator. The instructions suggested the removal of the standard 1mm shim washer between the fixed outer pulley and the centre bush of the variator. When we tried this smoke started to pour out of the back of the engine at top speed – which has risen to a very respectable 88mph. The problem proved to be that the variator was lifting



75-stick engine Dyno - 01/24/2008, 18:14:11
Air Temperature 10.2°C, Air Pressure 1022.2mbars, Humidity 55.3%, RAD 102.21%, DIN 700000 C/F 0.071 POLINI VAR POSH 645 ROLLERS 13.5 GR MALLOSSI BELT 1.50 SHIM
Max Power 18.5 bhp @ 6052.0 rpm, Max Torque 11.27 F1b @ 6022 rpm

the belt so high in the front pulley that the outside of the belt was rubbing on the casing. The Malossi belt is 14.2mm tall, whereas I doubt this would be a problem with the 12.7mm tall original belt. Equally, you could always use a die grinder to relieve the parts of the casing that the belt was touching on.

We had to continue to use the Malossi belt for the remaining tests for them to be comparable, so we instead came up with another configuration that optimised operation. With both the standard 1mm shim and an additional 0.5mm shim used to space the fixed pulley out the belt would not ride so high and rub. For this to work we had to fit heavier 13g rollers. The end result was the best of the lot with the Polini variator holding the rpm at a very stable 8500-9000rpm across the whole speed range. Top speed was up 3mph, and power was up by 2hp across much of the speed range.

PROS

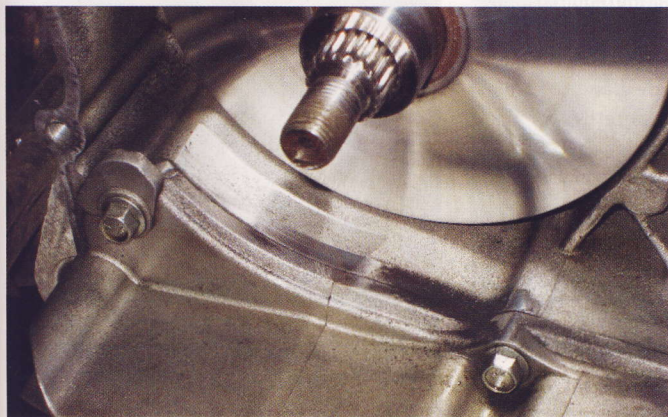
- Best Performance overall
- Best value for money
- Very stable rpm
- Increased top speed
- Quality construction

CONS

- Rubbing problems when used with the Malossi belt
- High revving variator will use more fuel

AVAILABILITY: PM Tuning
(www.pmtuning.com)
PRICE: £82.60

The Polini variator for the GT200 model comes with mixed weight rollers that should be distributed as shown. The correct one for the GTS250 comes with six rollers that are all the same weight.



The witness marks at the bottom of the transmission case show where the Malossi belt rubbed when used with the Polini variator. Most people on the GTS forum find that the standard Piaggio belt lasts longer than the Malossi one.

Malossi

The Malossi kit is the only one supplied with a new contrast (torque) spring. This must be fitted between the clutch and rear pulley, which requires the removal of a large centre nut. Special spanners are available to tackle this job. Also supplied in the kit are 14g and 15g rollers, but we found that neither of these was light enough to fully optimise the variator's performance. With 13g rollers the variator added an extra 1-1.5hp above 60mph and went to 86mph before hitting the limiter. With 12.5g rollers it gained power across the whole speed range, but was worse than the 13g rollers above 60mph. The optimum would probably be something between the two.

PROS

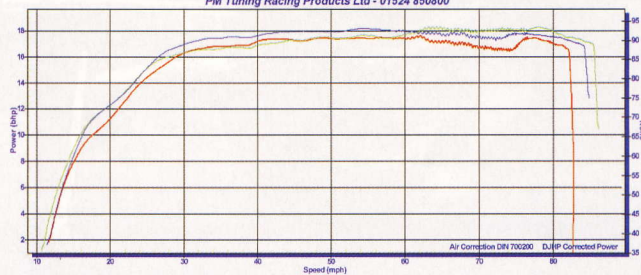
- Improves on the standard variator over entire speed range

CONS

- Replacement torque spring complicates fitting process
- Needed different rollers to optimise performance

AVAILABILITY: Any VE-UK dealer
(www.ve-uk.com)

PRICE: £111.75

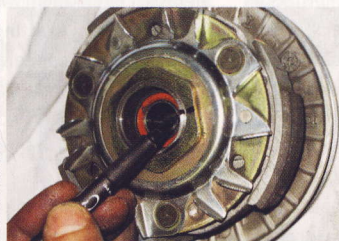


75-stick engine Dyno - 01/24/2008, 17:37:32
Air Temperature 9.0°C, Air Pressure 1022.2mbars, Humidity 55.3%, RAD 102.56%, DIN 700000 C/F 0.069 MALLOSSI VAR KIT INC TO SPRING 12.5 GR MALLOSSI BELT
Max Power 18.2 bhp @ 6052.0 rpm, Max Torque 10.87 F1b @ 6052.4 rpm

88-stick engine Dyno - 01/24/2008, 17:52:22
Air Temperature 10.2°C, Air Pressure 1022.2mbars, Humidity 55.3%, RAD 102.37%, DIN 700000 C/F 0.07 MALLOSSI VAR KIT INC TO SPRING 13.0 GR MALLOSSI BELT
Max Power 18.3 bhp @ 6052.0 rpm, Max Torque 10.85 F1b @ 6052.2 rpm

100-stick engine Dyno - 01/24/2008, 18:06:38
Air Temperature 9.0°C, Air Pressure 1022.2mbars, Humidity 55.3%, RAD 102.66%, DIN 700000 C/F 0.068 13.0 GR MALLOSSI BELT 11.2 GR
Max Power 17.50 bhp @ 7947.8 rpm, Max Torque 11.65 F1b @ 7940.2 rpm

The Malossi kit includes two sets of rollers and a contrast spring.



If you are going to change the contrast spring without using a torque wrench then it is wise to mark the position of the clutch nut so it can be retightened to its original position.

Sticky

Thanks to Paul at PM Tuning for the dyno time, Readspeer for other help with the article, and Dr Pulley, J Costa and VE-UK for supply of test components. For more info see the GTS Owners' Club site (<http://gtsownersclub.s4.bizhat.com>).