

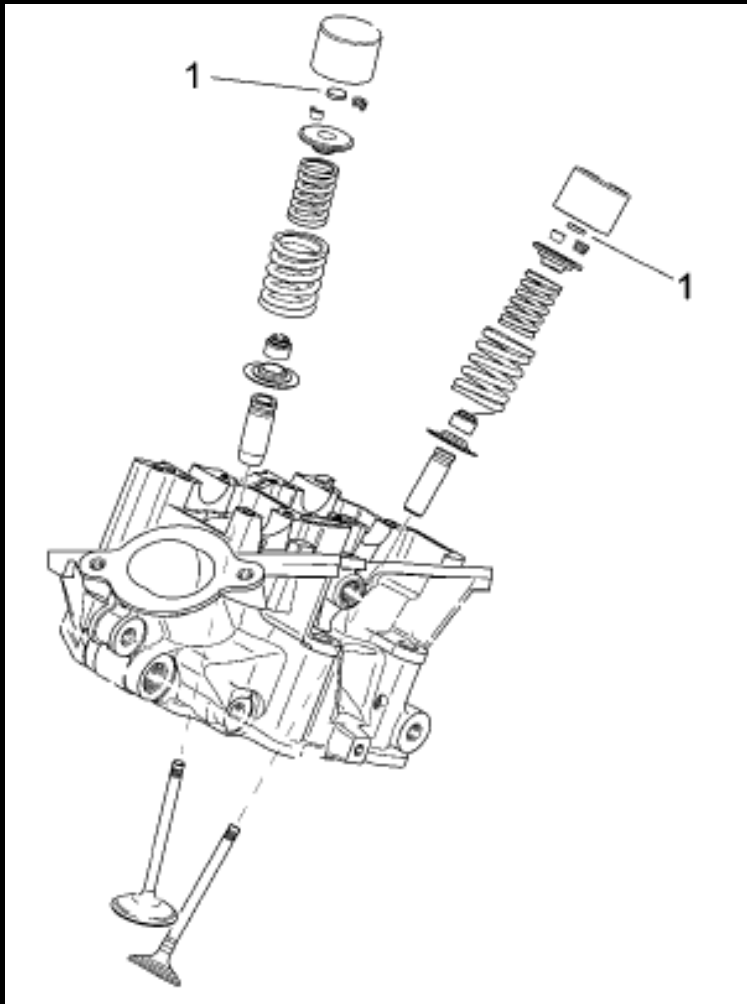
## *Servicing Your Aprilia Falco Valves*

### *Background*

The Falco utilizes four valves per cylinder head (two exhaust, two intake), driven by two overhead cams per cylinder head (one intake and one exhaust), and of course there are two cylinder heads. The cams are gear and chain driven off the crankshaft, with a system of guides and a self-adjusting tensioner to keep the chain from jumping. Over each valve stem is a small cylindrical shim, 10 mm in diameter and about 2mm thick. The entire keeper and spring is covered by an inverted bucket, providing a smooth and hardened surface for the cam lobes to push against. In this system, the valve shim sees little wear, and service intervals are high. There are also no rocker arms (or followers) so reliable operation at 10,500 rpm is possible. The downside is that servicing the shim requires removal of the camshafts.

In order to allow for thermal expansion of the valve stem, and wear of the valve seat, there must be some cold clearance between the valve stem/bucket and camshaft base radius. With zero clearance, the valve will not fully close and seal the combustion chamber. Also, the valve cooling comes from the time that the valve is sitting closed in the valve seat. A valve that isn't in the seat long enough will overheat, particularly on the exhaust side. Too much clearance is not as bad, but will create excessive noise. This is why US spec machines often have tighter clearances than European spec. Also, the more the clearance, the later on the lobe the valve opens, so duration is reduced and performance at higher RPM will suffer.

As the valve and seat wears in, the clearance will become smaller. A valve clearance that increases would generally indicate cam lobe wear. According to Aprilia, you should examine your valve clearances at the initial break-in service, and again every 9,350 miles. If you find a valve near a clearance limit, you may want to decrease the service interval unless you routinely reset the clearances of all your valves (easy on screw type adjusters, time consuming and possibly expensive on shim type).



*Drawing of one cylinder head. Two of four valves shown. Shims are labeled "1" in the diagram. Unlike shim-on-bucket designs, there is no way to extract the shims without removing the camshafts.*

Click [here](#) to continue to the [Valve Clearance Checking](#) page...

Click [here](#) to go back to the Falco home page.

## *Servicing Your Aprilia Falco Valves (continued)*

Click [here](#) to go to the beginning of this article.

### *Checking the Clearances*

**Remove the airbox.** In order to access the valves, you need to lift the tank and remove the airbox. See the [airbox](#) page for some tips on this. In my case, I had removed the tank anyways, and I really appreciated not having it in my way while I worked. To remove the tank, it's helpful to have a second quick disconnect (dry break) to use to drain the tank, because there is no petcock on the high pressure fuel outlet. You can unplug the sender at the harness under the seat. At any rate, it's probably not *necessary* to remove the tank to service your valves.

**Remove the valve covers.** It goes without saying that you want to be clean at this point, so wipe down any dirt from around the frame rails and underside of the tank. Anything that can fall in the motor while you work needs to be moved. There is nothing really in the way of removing the rear valve cover. The five screws come off and it's free. The front valve cover takes a bit of blind work to get at the screws, and you'll probably have to loosen the throttle body boot clamps and pop the throttle body off to get removal clearance. You don't need to totally remove the throttle body--just unseat it a bit to raise the throttle cables. On the rear cover, remove the reuseable rubber gasket with the cover. On the front, my gasket was tacked in place near the throttle body with a blob of silastic. This turned out to be very helpful, so I recommend you leave the gasket on the cylinder head if the factory has tacked yours down too.



*Remove five perimeter bolts to remove the valve covers. Rear cover shown here. Front will probably require that the throttle body boots be loosened too.*

**Find Top Dead Center.** At this point, the cams are now exposed (enough). When you are measuring the clearance on a valve, you want the cam lobe to be rotated completely off the bucket. In principle, you can measure clearances anytime the cam lobe you are working on is not in the 90 degree rotation that faces the valve. At TDC, you can measure all four valves at once. On most bikes, it's easiest to just remove the access plug and rotate the crankshaft with a socket until the cylinder you are working on is at top dead center. On the Falco, this requires a 14 mm allen key which I didn't have. I chose to just bump the bike over with the starter. Be careful with this route--you don't want to start the bike and the Falco won't bump over with the kill switch active. Any

way you choose to turn the bike over, it's nearly impossible to stop the motor at TDC with the spark plugs installed. You need to release the compression. I removed a plug and reinstalled it into the plug cap with a ground lead attached between the battery ground and the plug ground. The Falco ignition is probably not CDI, so this step may not be necessary, but I wanted to be sure there was a spark gap to load the coil just in case. On the Falco, the two cam lobes are facing away from each other at TDC. If you look at the cam drive gears, each is marked twice: once with an intake mark (IN) and once with an exhaust mark (EX). This is because the cam gears are one common part and are used on both cams. When viewing the exhaust cam (the cam closest to the header pipe), only pay attention to the EX mark. When viewing the intake cam (the cam closest to the throttle bodies), only pay attention to the IN mark. At top dead center, the EX on the exhaust cam faces and aligns with the IN mark on the intake cam. You can measure the clearances without these being perfectly aligned. The other hitch is that on the rear head, there is a balance shaft drive gear blocking the exhaust timing marks. Just bring the intake mark horizontal and facing the exhaust cam and you'll have TDC.

*A view of the cam timing marks on the rear head. This head is NOT at TDC. Notice that the balance shaft drive gear blocks the marks on the exhaust cam. To find TDC, this motor would need to be bumped around until the IN mark comes around to horizontal (facing the other cam).*



**Measure the clearances.** Slip a feeler gauge between the cam and the bucket. The range of acceptable clearances is small, so you'll probably just be able to do a go-no-go type of test. The there is a little drag on the feeler, you've got the right size. If it slides in easily, you probably have a clearance a half size looser. Of course, if the gauge doesn't fit at all, you've got less clearance than the gauge. Try to determine and record the valve clearance for each valve to the nearest half feeler size.



*Measuring the clearance on a rear exhaust valve. This engine is not at TDC, so in order to measure the intake side it will have to be bumped over. There are another set of valves to measure that are not visible here. Use the access slots in the cam hold-down to feel those clearances. Both lobes on a cam are in the same position.*

## 2000-1/2 Aprilia Falco Valve Clearance Specs and Measurements

<i>Valve Type</i>	<i>Valve Location</i>	<i>Acceptable Clearance</i>	<i>Front Cylinder Measurement (my bike)</i>	<i>Rear Cylinder Measurement (my bike)</i>
Intake	Gear side	0.005-0.007 in	<b>0.0045</b>	0.0060
	Opposite Gear		0.0050	0.0055
Exhaust	Gear side	0.009-0.011 in	0.0090	0.0100
	Opposite Gear		0.0100	0.0095

You can see from the table that I had an intake valve on the front cylinder was too tight. While it wasn't an exhaust valve, it could still be subjected to overheating. Also, I have no history so I don't know if it will continue to move before my next service interval. That shim will need to be swapped. If your valve clearances are in tolerance, congratulations. Button the bike up and check them again in 9,300 miles.

Click [here](#) to continue to the [Valve Clearance Adjustment](#) page.

Click [here](#) to go back to the Falco page.

## *Servicing Your Aprilia Falco Valves (continued)*

Click [here](#) to go to the beginning of this article.

### *Removing The Shims*

If you were unlucky enough to find a valve or two out of adjustment, you'll have to swap shims. Sometimes you can swap shims within your bike to bring all the valves back into spec. For instance, if you have a tight intake valve, you may be able to swap shims with a looser valve to make them both acceptable. If you can't do this, or don't want to be taking out more cams than necessary, you'll need to measure up your shims and head to the dealer. At any rate, you'll need to know what your current valve clearance is, so don't start tearing out the cams until you've recorded it. Once you've recorded the clearances, you can begin taking out the cams.

**Make sure you are at TDC.** While its possible to measure clearances without bringing a cylinder to TDC, you can't remove the cams if either of the cams are pressing down on the valves. Also, in case you lose your cam alignment marks, you have a prayer of realignment if the crankshaft is in the TDC position. If you can't see the timing marks on the front cylinder, you can unbolt the upper nylon chain guide and bump the engine with it off. Just stuff a rag into the cases when you are unbolting it in case you drop a bolt. Once the cylinder you are working on it at TDC, remove the key, throw the kill switch and don't think about bumping the motor over until the cams are back in place. Aprilia calls out a tool to lock the crankshaft in place. This is really not necessary.

**Mark the cam to chain alignment.** If you haven't already removed it, start by unbolting the nylon chain guide on the top of the gears. Once the top guide is off, use contact cleaner to clean the chain and gears, and make an indelible mark on the top of each gear (12 o'clock) extending onto the chain. This will help you get the chain back on the sprockets in the right position. Now, count the number of chain pins between the marks. If you rub one mark off, you can use this count to replace it. Every orientation mark you can make will help. If you are working on the rear cylinder, you have the balance shaft drive to work around. Mark the backside of the gears if it is easier.



*Remove the upper nylon chain guide, but don't drop the bolts in the case. Front cylinder has two vertical bolts. Rear has two horizontal bolts.*



**Remove the chain tensioner.** The next step in cam removal is usually to release the chain tensioner. The Falco tensioner is a hydraulic plunger that pushes on a nylon guide on one side of the chain run from the cam to the crankshaft (the side facing the "V" between cylinders). After removing the tensioner, the chain should be slack enough to be removed from the gears (you must hang it from a coat hanger because dropping it into the cases would be bad!). If there isn't enough slack from just releasing the tensioner, sliding a guide out should do the trick. I believe only the guide opposite the tensioner should slide out. I say "should" and "believe" a lot in this paragraph because I found it very difficult to get onto the tensioner plug for the front cylinder. After rounding out a spot in the plug with a ball-end allen key, it looked like I was going to have to drain the cooling system and start removing the coolant manifold. Looking for a lazy way out, I sought another way to release the cams. So, not having even seen a manual, I can't offer any tensioner removal advice yet.

*The chain tensioner access plugs are on the sides of the cylinders. The front is well hidden beneath a coolant manifold. The rear is more easily found.*



**Alternatively, unbolt the cam gear.** There really isn't any tension on the chains at all. So it appeared to me that I could unbolt the cam that I needed to remove from the gear. This turned out to be just the trick. Before starting, I zip-tied the chain very tightly to each gear. This way, I didn't have to worry about re-alignment of the chain and gear. The only possible misalignment now is the cams to the gears, and since the cams can only go on one of three ways this is very easy. In fact, if you remember the cams face away from each other at TDC you're all set. On the rear cylinder (which I didn't touch), there's the extra gear on the exhaust cam to drive the balance shaft. Make sure you mark this gears alignment to the cam gear and to the balance shaft gear. You must put the balance shaft back in phase with the rest of the motor! Now you can unbolt the gear on the cam you need to remove. Again, keep a rag stuffed in the case so you can't drop a bolt into the engine.



*Three socket cap bolts (removed in this picture) hold on the cam gear. The boss on the cam will retain the gear while the bolts are removed. These bolts are installed with thread lock. Note the zip-tie maintaining chain to gear alignment, and the rag stuffed in the case.*

**Remove the cam holder.** It's time to free the cams! On the front cylinder, there is a cam position sensor covered in silastic. You do not need to remove this. The cam holder isn't going far and there's plenty of slack in this sensor. On the rear head (which I didn't do), there's a balance shaft. It *appears* to me that the shaft is retained by two additional bolts behind the cam gears (which you can leave alone) and remains in the cam holder. It shouldn't cause any extra grief, except that it must be properly realigned when reinstalled. There are eight socket cap screws retaining the cam holder. Remove them in a crossways pattern. Make sure you get the washers with the screws, and don't drop them!

*Remove these eight bolts and the cam holder can be lifted out of place and set aside. There isn't enough chain tension to rock the cams, so don't worry about that.*



**Remove the cam.** Now you can slide the gear off the cam and lift the cam out of its seat. The buckets over the valve you need to adjust can be lifted out with a magnet, or a suction cup valve lapping tool. Sometimes the shims stick to the underside of the bucket, so be prepared for that and don't drop the shim in the motor! If the shim is still on the valve stem, you can lift it off with the magnet. If you remove more than one bucket, remember to mark them so you can reinstall buckets on the same cam lobe they came off of.



*Once the cam is out, you can pick up the bucket with a magnet. The shim can be seen here still on the valve, but I've had them stick to the bucket if the magnet is powerful enough. Don't pull the bucket off the magnet over the motor or the shim could drop out into the cases.*

Click [here](#) to continue to the [New Shim Selection](#) page.

Click [here](#) to go back to the Falco page.

## *Servicing Your Aprilia Falco Valves (continued)*

Click [here](#) to go to the beginning of this article.

### *Selecting A Replacement Shim*

There are a few ways you can go about selecting the new shim. The quick way is to add or subtract half the adjustment range to the shim you've removed. This assumes the valve was marginally out of spec. A more accurate but time consuming way is to measure the shim you've removed, and use this along with the present clearance and new clearance target to calculate the new shim size. I would not recommend that you sand down a shim to change it's size. This would probably only work if you can guarantee that the shim was not just surface-hardened.

Replacement shims are available from Aprilia in 0.025 mm increments, ranging from 2.300 mm to 3.000 mm. This is a 10 mm diameter button shim, and is probably available for other manufacturers too. Shims are almost always marked with the size in mm on their surface (sometimes the decimal is dropped). The shim that I removed from my bike had no markings, so I had to measure it with micrometers. A dial caliper doesn't really have enough resolution, but you can use it in a pinch.



*Measure the shim with a micrometer if it isn't marked.*

**An Intake Valve example.** My smallest micrometers measure in inches, as do my finest clearance feelers, so I'll do the math in inches here. If you are using measurements or shim markings in mm, divide the measurement in mm by 25.4 to get to inches, or multiply inches by 25.4 to get mm.

[1] Clearance measured:	0.0045 in
[2] Add size of shim you removed:	+ 0.1026 in
[3] Result: Clearance with no shim	= 0.1071 in
[4] Subtract desired final clearance (center of range = 0.0060)	- 0.0055 in*
[5] Result: New shim size required	= 0.1016 in

Multiply by 25.4 to get mm:	x 25.40 mm/in
Result: New shim size in mm:	= 2.5806 mm
Round to nearest 0.0025 mm:	= 2.5800 mm

\*Note! When I did this, I thought the intake clearance spec was 0.005 - 0.006 in, but I've since been told that its 0.005 - 0.007 in. So the target I should have used to center the clearance would have been 0.0060 in, not 0.0055 in. What I did is OK, but its more likely my valves will be out of spec again at the next interval because I set them closer to the limit than I had to.

**For an exhaust valve**, the desired clearance (line 3) is 0.0100 in.

**B**e prepared to settle for a different shim size if your dealer doesn't have a large selection in stock. There's a ten shim size range that will probably set up your clearances correctly. You may want to redo the shim selection example plugging in the extremes of the range for line 3 to see which shims are acceptable. When you get your new shim, you may want to measure it just to be sure it's marked correctly. The new shim I installed in this example measured 2.578 mm.

**S**ome dealerships are cool and if you go to the service department they'll just swap you shim for shim, no charge. My Aprilia dealer and Yamaha dealer were like that. Other dealers will insist you buy the shim, which I've done. After a few services, you have enough shims to swap around yourself. The worst are the dealerships that won't sell out of service stock, and want you to order the shims and wait 5 days for them. There is a chain of dealerships like this in Boston, and I take great pleasure in bring all the bikes I've bought at other dealers to them for inspection every year so I can show them the business they are losing.

Click [here](#) to continue to the [Reinstallation](#) page.

Click [here](#) to go back to the Falco page.

## *Servicing Your Aprilia Falco Valves (continued)*

Click [here](#) to go to the beginning of this article.

### *Installing The Replacement Shim*

After you've verified the shim size, drop it in place on the valve stem. Placing number markings up may be better so the numbers don't wear off you can see the shim size without removing it. It's a good idea to clean the inside of the buckets before reinstalling. Squirt a little motor oil on the valve and replace the buckets on the same valves they were removed from. Most manufacturers say to put a smear of moly assembly paste on the buckets before reinstalling the cams. I never have this stuff, but I am pretty liberal in pouring engine oil all over the cams and buckets. Squirt some motor oil in the cam bearing surfaces, then install the cam(s). Remember to reinstall the cams so that the lobes are away from each other. The gears should line up on the TDC marks when you index the bolt holes.



*These cams are at TDC. The gear that I removed is bolted lightly to the cam already.*

**Reinstall the cam holder.** On the front cylinder, don't forget the cam sensor wire was held down by a clip under one of the cam holder bolts. I didn't do the rear head, but it appears that the balance shaft gear should be aligned with its drive gear at this point too. You'll want to tighten the 8 bolts gradually in a crossways pattern, working inside to outside. Final torque on these and all the other M6 bolts you've removed is 11 N/m. Before reinstalling the cam gear bolts, clean the threads on the bolt and cam with contact cleaner and apply some thread lock (Loctite 243). The cams should now be bolted to the gears, the timing marks are now aligned, and the cam lobes are facing away from one another. Verify all the registration marks you made align too.

**Reinstall the chain tensioner.** Again, I didn't remove my tensioner, so I don't know the procedure here. I do know they have a copper crush washer and need to be tight or they will leak. If you zip-tied the gears to the chains, you can cut these now. Reinstall the upper chain guide. I used Loctite on the chain guide bolts too. M6 bolts should be torqued to 11 N-m.

**Verify the valve clearance.** Remove your rag from the cases and bump over the motor a few times to seat everything. Try not to start the bike! Naturally, the motor should spin freely with no bad noises if you've timed the cams correctly. Bring the timing marks back to TDC and verify that you've corrected the valve clearances. You may want to verify all the clearances in case you swapped a bucket or something else. My intake valve clearance was right about 0.0055 inch after installing the new shim.

**Install the valve covers.** Push any wire looms or cables aside so you have free access to the head. No sealant is necessary on these gaskets. They are cut into the covers and sit flat on the head. On the front head, I left the gasket tacked to the head, so I just aligned it to the bolt holes, then very carefully dropped the cover on top of it. After starting the bolts, I used an inspection mirror to verify that the gasket was seated around the front of the head where it isn't visible. On the rear head, you can hold the gasket on the cover as you drop it in place. Torque all M6 bolts to 11 N/m (tight).

**Button it up.** Pop your throttle bodies back into place and snug down the boots with no intake leaks. Reinstall the spark plugs if you haven't already. At this point, if your tank is installed you could run the bike to make sure it started. Install the airbox--don't forget the breather line and to clip the sensor to the airbox lower.

Click [here](#) to go back to the Falco page.