CVVT Hub Change Guide – P2 Vehicles, Rev.2

Compiled by F250 with input from MANY others

Important information:

VIDA instructions may not have the correct information with regards to clockwise (CW) or counterclockwise (CCW) movements when setting the hubs and gear rings, depending upon which version of the software is being used. VIDA 2014A and newer reportedly has the correct information.

Within this document, to try to keep the mental imagery simple, the clockwise (CW) direction/position will be referred to as the FORWARD direction/position, which is easy to remember because it is comparable to rotating the top of the hub FORWARD towards the front of the car. Consequently, the counterclockwise (CCW) direction/position will be referred to as the REVERSE direction/position – equivalent to rotating the top of the hub towards the rear of the vehicle. Rear wheel drive engine setups can still use this easily because we're familiar with the "righty-tighty" rule of thumb, and we all read left-to-right.

Even with the correct directional instructions, the VIDA instructions are confusing. This Guide is meant to clarify the process offsetting up CVVT hubs, and the information contained below is compiled from multiple resources, and credit has been given to each resource.

Earlier versions (2001 and older) of the exhaust VVT hubs were spring loaded, and this is a little more tedious to work with because those hubs MUST be physically held in the spring loaded fully clockwise position while installing the belt.

SPECIAL TOOL Requirements:

Volvo (or similar) cam and crankshaft locking tools

Volvo crankshaft lock may also be necessary.

VIDA 2014A (or newer) can be helpful as well.

Torx T55 socket and T55 key

Breaker bar

Sockets - 8mm, 10mm, 14mm, and 30mm

Torque Wrench (10-120 NM, or 7-90 ft-lbs)

Universal Pulley Holding Tool can also be helpful when making fine adjustments to the CVVT hub gear positions (i.e. OTC 4754 or similar).

THANKS to those who contributed the information in this Guide.

From swedespeed.com: **Carsv70r**, **contrast**, **CamZH**, **cattlecar**, **thegrapist**, **Ihatespeedbumps**, **Loki**, **garbergtsi**, **Rmind, qaz996, LloydDobler, covert24, Mikeisftw,** and **me (F250)**

From matthewsvolvosite.com: **abscate**

From volvospeed.com: **wizzard_al**

Additionally useful web links:

http://volvospeed.com/volvo_repairs_how_tos/engine_repairs/cvvt-hub-removal-and-set-up.html (CVVT Removal and Setup – 9:44)

http://forums.swedespeed.com/showthread.php?225475-Car-wil-not-start-after-CVVT-hub-change.html

https://www.youtube.com/watch?v=IK_zH8g8Fow (Replace S60 timing belt, water pump, tensioner, and idler, by FCP – 24:00)

DATE	REVISION COMMENTS	Rev.
8/09/2016	Initial Document Release	0
8/11/2016	Changed directional comments to Forward and Reverse, and added details in Steps 37-43	1
10/14/2016	Corrected explanation re. rear cam slot positions on Page 2	2

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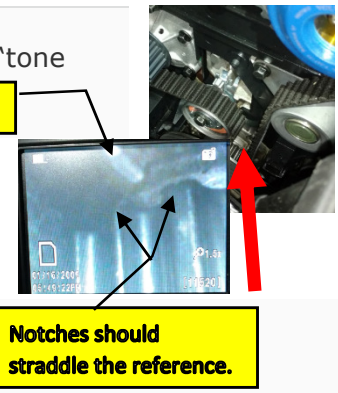
Proper timing can be checked like this (**cattlecar**):
Remove Cam Position Sensors (CPS's) and the reluctor wheels (sometimes called "tone rings") so the slots on rear cam ends are visible.



Turn engine over by hand and carefully stop with the crank pulley mark aligned with the "pointer" on oil pump as viewed straight down front of engine.

DO NOT go past and then turn crank CCW to get the marks aligned.

IF you go past, then just make two more full FORWARD turns of the crank and then try again to carefully to align marks. The mark should be aligned if you were to look straight down between cam gears.

Look at the full-width slots on the rear of the cams. These slots should be parallel to the line formed by the top half of head meeting the bottom half. Each cam also has one offset slot as shown by the arrows in the picture to the right.

The intake cam's offset slot should be above the horizontal line, and the exhaust cam's offset slot should be below the horizontal line.

If the full-width slots are parallel to the head joint seam and the extra key slots are offset above and below the seam line, then it is timed right. If the slots are parallel but either a) not offset above & below the line, or b) offset opposite to what is described above, then the timing is not correct and the engine will not run.

INSTALLING NEW VVT or CVVT HUBS… GENERAL EXPLANATION (cattlecar):

> Originally Posted by **thegrapist**
> *… If you are tearing apart a motor, how are you supposed to put the engine back in time?*

To summarize the method of installing the VVT or CVVT hub (hereafter referred to "the hub") onto a referenced cam – the new hub gets mounted onto a cam which was previously rotated into its correct position and locked there with the rear cam locking tool. This locking tool not only holds the cams in the right place, but it also serves as the counter hold for torqueing the hub's T55 center bolt into the cam. The proper hub position is only when the hub is fully rotated to its FORWARD end point. If it is an earlier model which has the spring, the spring naturally holds the hub in its REVERSE endpoint, so you have to overcome the spring's tension by manually rotating the hub fully FORWARD before torqueing the T55 center bolt.

As long as the crank is in the correct position as discussed above, the belt is only installed and tensioned AFTER the hub is fitted with the hub gear positioned in the center of its adjustment range and timing mark aligned. New hub gears will not have a timing mark on them, so you will need to scribe or file it on the gear after the timing alignment has been completed and verified by observing the engine run without timing error codes.

To properly position the gear ring on the hub, you loosen the three 8mm bolts holding the gear to the hub and then double check to make sure that the hub is still rotated fully FORWARD (it may have moved during belt install). You remove one of the 8mm bolts and look to see if the hub has stopped against bolts instead of going to FORWARD end point internally. IF the hub is bound on 8mm fine adjustment bolts, then you need to move the hub or see if moving the gear ring one tooth will remedy the issue. If the hub is stopped properly, then the three 8mm fine adjustment gear ring bolts can be torqued to the correct value and you can finish the assembly. IF it is put together properly, the ECM can control the hub to the correct position once engine runs. There is 4-5 degrees of extra travel in CVVT so the ECM can still get cam to target position after belt stretches or wears.

The other CVVT hub method is for a hub that has a locking pin. For this style of hub, make sure the hub is locked with the pin, then fit the hub onto the cam, fit and tension belt (or chain). Then, with referencing tool installed and crank in correct position, torque the center bolt holding the hub to the cam.

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INSTALLING NEW CVVT HUBS… STEPWISE PROCEDURE

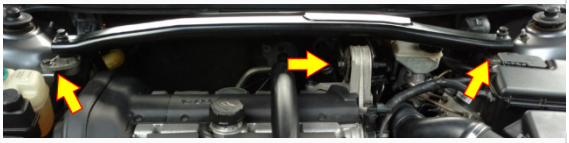
(CamZH, with a few extra pointers from **F250):**

Again, in summary, with the cams locked and the crank set on its mark, the new hubs need to be placed onto the cams and rotated FORRWARD as far as they will go, and the timing marks on the gear rings should be aligned with the upper timing cover's reference slots. There needs to be good tension between the crank and the intake hub, and also between the intake and exhaust hubs.

A lot of the following steps are similar to replacing a timing belt, and it's probably not a bad idea to do this at the same time.

1) Jack up the car, put it on stands, and remove the front passenger wheel. This doesn't need to be the 1st step, but it gets everything off the ground which makes it easier to work on.

2) Remove the engine cross brace. This can be done by removing the 14mm bolts that attach the brace mounts to the shock towers, and the bolt that goes through the engine mount.



3) Remove the Air Box and MAF. If you have a Snabb intake, you may wish to remove the 1st silicone coupler to give more room.

4) Cover the open intake with something to prevent ingress of debris. A latex glove works great for this.

5) Remove the upper engine mount. You may need to remove the OTE pipe and Coil cover to access the engine mount bolts.

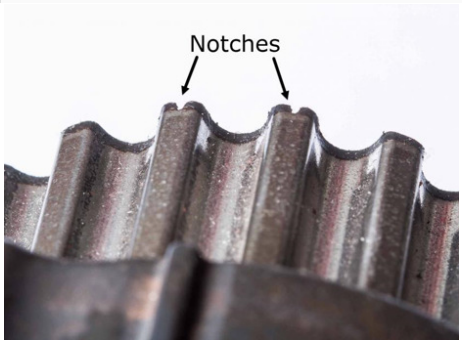
6) Remove the front and top timing covers. Front is a 10mm that is a bit tricky to reach. Top is T30.

7) Remove the nut(s) that hold the wheel well liner on in front of the strut, fold the liner along the crease and use some vise grips to hold it in place. (FCP's S60 timing belt change video shows this very well). Now you will have access to the crank/harmonic balancer.

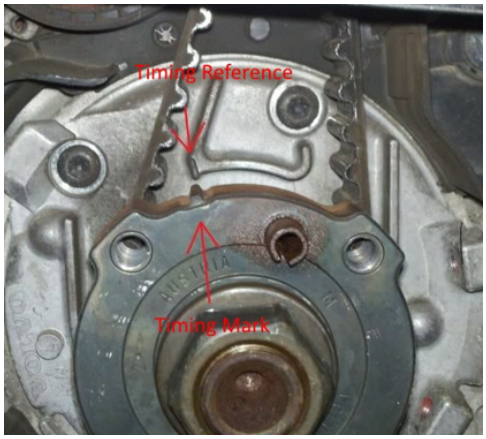
8) Slip the top timing cover into position, and use the 30mm nut on the crankshaft's serpentine belt pulley to rotate the engine FORWARD until the cam gear timing marks align with the top cover's slots.

9) Confirm that the crank gear's timing marks align properly with the reference mark on the oil pump housing. Refer to the pictures at the bottom of Page 1 (It is rather tricky to see with the harmonic balancer, serpentine belt and timing belt tensioner in place.)

10) There is a set of 2 marks on the crank (notches on the back edge of two adjacent timing gear teeth, as shown in the picture below). These notches should straddle the mark on the block. There is also a mark where the Harmonic balancer attaches. Both reference marks can be seen in the second picture below.



The picture to the right shows the timing mark on the block and crank (not the little notches on the back edge of two teeth on the crank timing gear which are shown in the picture to the left). This is hard to see with the harmonic balancer attached, but not impossible.



11) Unplug and Remove the Cam Position Sensors (CPS). Intake is a T25 and Exhaust is a T40.

12) Remove the CPS triggers (reluctor wheels, tone rings, etc.). These are marked as IN and EX on the back side and are mounted with 10mm bolts. As these mounting bolts are removed the cam shaft will probably rotate a little.

13) Now, rotate the crank shaft again through 2 complete revolutions to re-set the cam shafts. Re-rotating the engine should have re-aligned the cam shaft slots and the tool should go straight in. If necessary, use the cam locking tool for any minor cam rotational adjustments.

14) LOCK THE CAMS using a Cam Locking Tool. Tighten the cam locking tool bolts rather TIGHT! The Bolts that hold the CVVT hubs onto the cam are set at 88 ft-lbs (120 Nm), and the Cam Locking tool must be firmly in place to prevent cam rotation.

15) Move the rectangular cable housing out of the way, the one which is mounted against the passenger side strut tower, between the tower and the exhaust hub. If this housing is not moved out of the way, it is almost impossible to get tools into the exhaust hub for either plug or hub R&R. By moving this housing up on top of the strut tower, it is possible to gain enough room for a breaker bar and/or torque wrench to fit into that space if you are very careful.

a. Make sure that the upper timing cover has been moved out of the way, and that the coolant and power steering reservoirs are also moved out of the way. You can use large rubber vacuum caps to plug the coolant hose and hose nipple to prevent coolant loss, but you will have to use a small clamp on the coolant reservoir's hose nipple to prevent seepage.
b. There are two bolts which protrude through two molded plastic flanges (one above, and one below) the rectangular housing. Firmly push the housing away from the strut tower, towards the engine, and then forcefully, but carefully, rotate the housing upwards towards the engine. You have to be very careful to not break off either of the two plastic bolt flanges on the housing, but it CAN be done!
c. Once this housing is shifted up on top of the strut tower, you can easily get a breaker bar or torque wrench in between the strut tower and exhaust hub as shown in the picture below. There are also a few shots of the bolts and strut tower bolts and plastic housing flanges.





16) Bunch up a large rag under both cam hubs and remove the T55 hub plugs because oil will flow from the hub when each plug is removed. Also, the exhaust cam hub tends to lose more oil than the intake hub.

17) Use a breaker bar to carefully loosen, but do not remove the hub's T55 center bolt which is under the hub plug. If you do not move the plastic cable housing as described in the step above, you might have to use a large T55 key (like an Allen key) and a cheater pipe to remove the hub plug.

18) Remove the timing belt. This could be done earlier, but the belt's tension helps to take a bit of the load of cracking the T55 bolts in the hub.

19) Using the lever on the tensioner, you can remove the belt without a lot of trouble by pushing the top tab lever FORWARD. It is normally recommended to replace the tensioner with the timing belt.

20) Remove the crank serpentine belt pulley. Without removing the serpentine pulley from the crank, the timing belt CAN come off completely, but it is very difficult. It is better to have it out of the way enough to replace the hubs. An air impact wrench may be helpful with this.

21) Check to confirm if you have a spring loaded exhaust hub by simply trying to rotate it in REVERSE to see if it springs back when you let go. 2002 and newer year models should have "floating" hubs (no internal spring), and the floating hubs were reportedly never used in the exhaust position.

22) Remove the CVVT hubs.

23) Remove the gear rings from the old hubs.

24) Install the gear rings onto the new hubs so that the 8mm bolts are almost at the FORWARD end of the slot, but not making contact with the end of the slot in the oval adjustment window.

25) Install the new CVVT hubs onto the camshaft, and place them such that the timing mark on the gear rings are at about the 1:00 o'clock position.

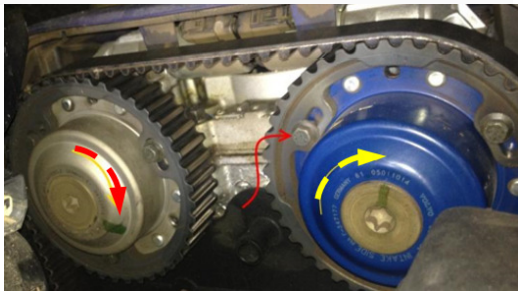
26) Clean the T55 center hub locking bolts to make sure they are free of oil/grease etc.

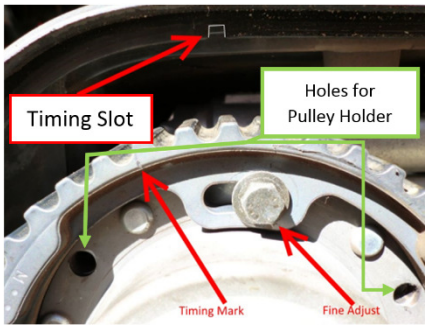
27) Install the T55 bolt in the first hub, but only finger-tight… do not fully torque it down… just snug.

28) Now rotate the gear/hub FORWARD until it is at the FORWARD limit (that is, the limit of the hubs movement). You can rotate the hub back and forth to confirm this, but if you rotate the hub very far at all in the REVERSE direction, it is likely to dump some oil, so have a rag underneath to keep from getting oil all over the timing gears.

29) Install the upper timing cover with the timing slots. >>>>>>>>>>>

30) Continue to rotate the hub FORWARD with the gear until you cannot move it any further by hand – the FORWARD rotation will cause the center locking bolt to continue to tighten to the point where you cannot move it by hand, and that is what you WANT to happen!





NOTE: The specific technique described in the next several steps (using the pulley holder) was discovered while working on a dual CVVT hub setup, and it works beautifully. The result is less frustration in getting the timing perfect with proper belt tension on the hubs and crank. This technique virtually prevents any undesired hub rotation while torqueing it down, and this means that the typical "trial and error" effort to keep the timing marks aligned is completely eliminated. One very minor potential consequence is that the timing marks on the hub gears rings may end up not aligning perfectly, but the goal is to get the TIMING perfect, and the position of the marks is not as important. If you do end up with timing marks out of alignment, simply use a small brush and touch up paint to mark the new alignment position once the job is complete.

31) Set up your universal pulley holder with the smallest pins, and insert it into two of the open holes in the hub so it can be used to complete the FORWARD rotation until the timing mark on the gear aligns with the timing mark on the cover. This is very tricky to get it exact. If you go past do not rotate the gear/hub backwards, or REVERSE, but continue FORWARD for another full rotation, continuing to use the pulley holder as your rotation tool. Refer to the picture in Step 29.

32) Once the hub is in the correct position (timing mark lined up with timing cover slot and hubs rotated in full FORWARD position), tighten the T55 center hub bolts to 120Nm (88ft/lbs).

33) Confirm that the timing marks are still correct while the hub is in its full FORWARD position. You can spin the hubs by hand in both directions to confirm they are correct. Again, keep a rag handy until you install the T55 plug back into the hub face. If the timing mark is not correct, loosen the T55 center locking bolt and rotate the hub for realignment of the marks, but again, only rotate in the FORWARD direction.

34) Make sure again that the hub is its most FORWARD limit position, and then install the CVVT hub plug.

35) Repeat steps 31-34 for the second hub.

36) Install the timing belt (and tensioner if you replaced it). There are two sequences for installing the belt, and some have found one to work better for them than the other.

SEQUENCE "A": 1) Seat the belt on crank, 2) Keeping tension on belt, feed it over the idler and around the intake gear, 3) Feed the belt over the exhaust gear, then around the water pump, and finally over the tensioner (again using the tensioner arm to help get the belt on).

SEQUENCE "B": 1) Seat the belt on crank, 2) Keeping tension on belt, feed it over the idler and around the intake gear, 3) Feed the belt over the water pump gear, and finally, by relaxing the tensioner with one hand, work the belt onto the exhaust gear.

It is rather tricky to get a good amount of tension between the crank and the intake cam, so it might take a few attempts to get it right. It is also possible that the intake or exhaust will not line up with the teeth on the belt, and this is where the 8mm bolts and elongated holes in the gears are use… for fine adjustment.

It is very important that proper tension be applied on the belt between the crank gear and intake hub, and also between the intake and exhaust hubs. If fine adjustments are necessary to achieve this, continue with the next steps below.

Otherwise, you can skip to Step 44.

37) Remove the upper timing cover.

38) Loosen the three fine adjustment bolts on each hub.

39) Press firmly downwards on the timing belt between the intake and exhaust hubs until the intake hub rotates REVERSE enough to create solid tension on the belt between the crank and intake hub gears. At this point, the hub has also rotated in REVERSE to some degree, and you must by using the pulley holding tool to rotate the hub back into its fully FORWARD position while still pressing down on the timing belt. With the hub back in its fully FORWARD position, IMMEDIATELY tighten one of the fine adjustment bolts on the intake hub to maintain the proper belt tension.

40) Tighten the remaining two fine adjustment bolts on the intake hub. (10 Nm)

41) Next, pull on the timing belt between the exhaust hub and the water pump gears to establish solid tension belt between the intake and exhaust hubs, and IMMEDIATELY tighten one of the fine adjustment bolts on the exhaust hub.

42) Tighten the remaining two fine adjustment bolts on the exhaust hub. (10 Nm)

43) Make sure that the fine adjustment bolts are not at the extreme right or left position in their respective oval adjustment windows. If they are bound at their limits, you need to remove the belt, carefully

loosen the T55 center locking bolts, and try again starting at Step 27. Otherwise, re-install the upper timing cover and continue with the next step.

44) Make sure the timing marks are still correct, and use touch up paint to mark the exact gear and timing cover slot alignment for future reference.

45) Remove the cam locking tool.

46) Rotate the engine FORWARD, do it slowly. It has been reported that valves can be bent when rotating by hand, but this can only happen if the timing is off far enough to allow the pistons to make contact with the valves. By turning the engine slowly, it will simply stop rotating completely if this contact is made, and you will then know that you have to start over with your timing setup… all the way back to Step 22!

47) After 2 rotations of the crank, the marks on the cams and crank should still be aligned. The slots in the cam shafts should also be parallel to the cam cover seam (same positions as when the as the cam locking tool holds them).

48) Reinstall the CPS triggers and CPS units.

49) Reinstall intake and MAF and you should be good to start her up.

50) If all goes well… put it back together, and smile!

Last edited by F250; 08-10-2016.