

HOW-TO: Set The Injection Pump Timing

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Wednesday, 01 October 2008
Last Updated Sunday, 14 June 2015

```
var gaJsHost = (("https:" == document.location.protocol) ? "https://ssl." : "http://www.");  
document.write(unescape("%3Cscript src=" + gaJsHost + "google-analytics.com/ga.js'  
type='text/javascript'%3E%3C/script%3E"));
```

```
try {  
var pageTracker = _gat._getTracker("UA-356307-2");  
pageTracker._trackPageview();  
} catch(err) {}
```

This HOW-TO describes using the factory-proscribed "dial indicator" method of setting the timing on a VW IDI diesel engine.

There are other methods... by ear, using a piezo adapter on a standard timing light, using a glow-plug sensor on a standard timing light. The static dial indicator technique is the "official service manual" method and IMHO a good way to ensure things are set correctly **before** troubleshooting further, or before refining further with a different technique.

Like all recipes you need some specific ingredients and equipment... I recommend you read all the way thru before starting.

Your comments/suggestions are always welcomed... this is how I tend to do things but I make no claims to having a monopoly on the truth !

DISCLAIMER:

- Use these instructions at your own risk
- Read them through from beginning to end before starting
- This is how I do things… it is not necessarily the right way nor the best way !
- Using equipment,tools, and supplies incorrectly could result in serious injury to you or your property or even death
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Please note: You can click on any thumbnail below to see a larger version of the image. After viewing the large image, you can click on "close" to return to your spot in the text

Overview:

Although it looks complicated and terrifying it's actually fairly straightforward. There are four main parts to this procedure, in summery it looks like this:

- 1)
Preparation…. pulling things off to get ready

- 2)
Confirming the timing belt timing
 - a.
Getting the engine to TDC using the timing mark on the flywheel

 - b.
Getting the cam to TDC using the cam lock

 - c.
Getting the injection pump to TDC using the pump lock

- 3)
Setting the injection pump timing

- a.
Inserting the dial indicator

 - b.
Rotating the engine backwards (counter clockwise) until the dial indicator stops moving

 - c.
Zeroing the gauge

 - d.
Rotating the engine forwards (clockwise) to exactly TDC

 - e.
Reading the timing value on the dial gauge

 - f.
Adjusting the pump timing, if required
- 4) Putting it all back together

Specific Tools needed:

A cam
lock

There are a bunch of options here.

-
You can purchase the official VW tool (Mantra 2065A or equiv.)

-
Many eBay suppliers carry them

A 3/8" brass hinge

-

A straight file

A pin
lock for the injection pump

Again there are a bunch of options:

-

The official VW tool (Mantra 2064 or equiv)

-

Many eBay suppliers carry them

-

A deep socket, metal rod, etc, that's 0.600" or 15.35mm in diameter

- a big bolt ground down to fit

Dial
gauge adapter… one end has special metric threads on one end to fit into
the injection pump, the other is the right diameter for the dial gauge to
fit in

-
the official VW tool (Mantra 2066, 3313, or equiv)

-
many eBay suppliers carry them

Dial gauge

This can be metric or imperial and should have at least an inch (25mm) of travel.

The shaft needs to fit the dial gauge adapter. I bought a cheepie and ground the shaft down to fit.

19mm

12-point socket…. needed for the crankshaft bolt. If you have older diesel you may have the original 6-point bolt… if so, consider getting a replacement soon since the old bolts tend to loosen (hence the new design!)

Sprocket

puller…. sometimes needed to loosen the cam sprocket. Some people are able to tap the sprocket off with a hammer…. never ever worked for me.

two sets of feeler gauges…. used to make sure the cam lock is exactly parallel. If your particular cam lock is a perfect fit you won't need these

large (12")

Crecent wrench or sprocket locking tool….used when loosening the camshaft sprocket

I personally recommand the actual sprocket locking tool... very cheap, can't damage anything , and is also great for other sprockets like the injection pump.

Parts needed:

-
valve cover gasket

-
depending on the length of your dial gauge adapter and dial gauge you may need to remove the vacuum pump.
If so, replacing the vacuum pump o-ring is a good idea

Supplies needed:

- spray can of brake drum cleaner to make the business end of the injection pump surgically clean
- shop air if you have it

Detailed Procedure:

Part 1: Preparation

- 1)
car in neutral, rear wheels chocked
- 2)
cold start handle pushed in all the way in…. VERY IMPORTANT
- 3)
pull off the valve cover, exposing the cam shaft
- 4)
remove the timing cover on the top of the transmission <picture of timing hole cover
- 5)
remove the timing belt cover

6)

I like to pull the air filter housing… gives me more room to see what I’m doing

Part 2: confirming the timing belt timing

1)

Find ignition TDC for cylinder #1.

a)

rotate the engine clockwise until the engine is at TDC (as shown by aligning the timing mark on the flywheel

I have a dot of whiteout on the crankshaft to help me find the TDC line.

As a random aside, if you look closely you may see some yellow and red fingernail polish as well... last time I had the engine apart I put a 4 inch strip of each on the flywheel... yellow for BTDC and red for ATDC, again to help me find the marks under dim conditions. I also punched a mark at 12 degrees BTDC for that magical day when I finally win an eBay auction on a piezio timing adapter... those things are both rare and spendy.

b) and both lobes of the camshaft for

cylinder #1 are pointing up (meaning that both valves are closed)

2)
Insert the cam shaft lock into the slot at the back of the camshaft. If needed by your particular locking tool, use an equal number of feeler gauges on each side of the lock, to ensure the lock (and thus cam) are completely parallel. You may need to rotate the engine a bit to make this happen.

cam slot

cam slot with lock in place

3)
Confirm you are still at exactly TDC according to the flywheel… if you had to rotate the engine a bit getting the cam lock in place you probably won’t be. If you are no longer at TDC, you need to adjust the camshaft timing:

a)
loosen the nut on the camshaft 1 turn and then gently loosen the camshaft with a rubber hammer or puller. The camshaft has no key and so this will allow the camshaft and engine to rotate independently. DO NOT use the camshaft lock to hold the cam steady as you loosen the bolt…; a large crescent wrench grabbing on to the sides of a cam lobe works really well, and won’t scratch the working surface of the cam

you can also use a sprocket
locking tool:

b)
rotate the engine back to exactly TDC on the flywheel

c)
tighten the camshaft bolt to XXX ft lbs using the crescent
wrench or sprocket locking tool

The concept of concept of "Top
Dead Centre" often confuses people... because the engine has several
TDC cycles...two for cylinder, and the cylinders operate in pairs. And
then they start thinking about how the crank rotates twice as fast as
the cam and injection pump, and what about the phases of the moon....
argggggggggggggg !

Don't let it freak you out. We time the engine at the classic and universal definition of TDC: piston #1 is at the top of its compression stroke and fuel is being injected into it. We know the #1 is at the top of its compression stroke using the TDC mark *and* having the cam lock in place with both cam lobes for #1 up (meaning both valves are closed). We know fuel is being injected into #1 with the next step.

4)

insert the pump locking pin into the locking pin hole (smallest one on the sprocket) in the pump sprocket and thru to the pump mount

If you can't get the locking pin installed this probably means the timing belt is not installed correctly.. you'll need to loosen the timing belt tensioner, the cam shaft sprocket, and then move the belt to a new position on the injection pump so that the hole lines up.. again, with the engine at exactly TDC according to the flywheel.

Some people report that they can't always get the locking pin in during this step even though everything else goes well. That can certainly happen if the pin is a really tight fit and you can try something else with a slightly looser fit. You can also try loosening the belt tension so that the sprocket can move a bit (don't forget to tighten up the belt again if you do this!)

The purpose of the locking pin is to make sure you are at the #1 injection cycle *and* have the timing belt on the right teeth on the injection pump sprocket. It's ok if you use a pin with a little slop, but if the holes are really out of whack I'd stop and figure it out... most likely the belt is off a tooth or two and you'll never be able to set the timing properly.

If you now have:

-
the engine at exactly TDC according to lining up the flywheel timing mark

-
the camshaft locked at exactly TDC with the locking bar (and two sets of feeler gauges if needed)... both lobes of #1 up

-
the pump locking pin inserted into the alignment hole

then congratulations are in order: you've confirmed that the timing belt timing is perfect, and you're ready to move on to setting the actual injection pump timing. If not, do the procedure over again… there is NO sense timing the injection pump if the timing belt is out of position… and in fact, if the timing belt is out much it can seriously damage the engine.

Part 3: Setting the Injection Pump Timing

1)
confirm that the timing belt timing is perfect one last time,
and then REMOVE the cam locking tool and the pump locking pin, leaving the
engine at exactly TDC

2)
confirm that the cold start knob is pushed all the way in. Not kidding... be darn sure that sucker is pushed in !!

3)
remove the timing gauge cover bolt from the injection pump

You don't want to introduce any dirt into the system here so make sure to clean the area well *before* removing the bolt. The can of brake cleaner (and shop air if you have it) will work wonders, and makes it much easier to spot leaks later on.

4)
install the timing gauge adapter and timing gauge. You may need to remove the vacuum pump to give you enough room.

5)
push the timing gauge into the adapter such that the gauge has a couple mm of "preload". "Preload" means to ensure the gauge has enough travel that it will track the plunger inside the pump all the way. You can set the preload by zeroing the gauge once it starts to move, and then pushing in the gauge an additional 2 mm

6)
insure the engine is still at exactly TDC… amazingly the engine will want to move little bits on its own as you fuss with it, and we need to be at exactly TDC

7)
Slowly rotate the engine backwards (counterclockwise) until the dial indicator stops moving.

The timing gauge should move smoothly as you rotate backwards. If it doesn't there's a good chance it's binding... make sure nothing is touching the timing indicator and realign things as needed.

There are several schools of thought on how to do this rotation. The obvious way is to use the 19mm 12-point socket and a large ratchet or breaker bar on the crankshaft bolt. Some service manuals say "don't do this" since they are worried about accidentally loosening that very critical bolt. If you've ever torqued the bolt yourself you know that this is

very very very unlikely (the damn thing will often not come loose without a much bigger breaker bar, some strong language, and a long length of angle iron bolted to the sprocket), but if you've not done the bolt yourself and can't be sure it was done correctly you might want to avoid this method. Or, better yet, get yourself a new bolt and torque it properly in the first place… saving you the worry of it coming loose down the road.

Another way is to use the socket on the camshaft bolt. I don't personally like this method because imho it stresses the belt and can loosen the camshaft bolt, which is not torqued like the crankshaft bolt

Perhaps the safest way is to put the passenger side of the car on a jackstand, and then with the engine in gear rotate the passenger wheel.

However you do it, the trick is to make sure you have rotated backwards far enough. It's actually fairly obvious….as you rotate the dial indicator will move linearly until it stops. You can rotate the engine backwards just a bit more to prove to yourself that it really has gone as far as it can go… there's no harm in overshooting a bit just to make sure it really has stopped.

8)
zero the dial indicator... on most dial indicators you rotate the dial face

The service manual says to adjust for some preload here, but I find this just confuses people, and we already know we have enough preload. Make it easy on yourself, and just set the gauge to zero.

9)
slowly rotate the engine forwards (clockwise) to exactly TDC,
as indicated by the mark on the flywheel

It's ok to overshoot TDC a bit while you are trying to find it... just rotate backwards (counterclockwise) if you do .. the point is that you must (eventually) land on **exactly** TDC to read the timing value.

10)
read the timing value on the dial indicator

11)

compare to the required setting (in the example picture above we are a bit over 0.026"... a bit too low/retarded as we'll see below)

Again, several schools of thought in terms of what timing value to use.

The Bentley service manuals list the following "official" settings:

Early Chassis:
(1977-1983)

1.5l non-turbo 1977-1980	0.88 +/- 0.05 mm
1.5l non-turbo 1980 with yellow dot +/- 0.05 mm	1.15
1.6l non-turbo 1981, 1982, and 1983 pickup	0.88 +/- 0.05 mm
1.6l non-turbo 1983 Rabbit and Jetta	0.95 +/- 0.05 mm
1.6l non-turbo 1983 Vanagon	0.90 +/- 0.05 mm
1.6l tubo diesel (1982-1983) +/- 0.05 mm	1.00

MK2 / A2 chassis:
(1985-1992):

Engine ME (1.6l non-turbo) 1985	0.95 +/- 0.02 mm
Engine ME (1.6l non-turbo) 1986 and up +/- 0.02 mm	0.90
Engine MF (1.6l turbo)	1.00 +/- 0.02 mm
Engine 1V (ECO diesel) +/- 0.02 mm	1.00

MK3 / A3 chassis (1993-1997):

Engine AAZ (1.9l turbo) +/- 0.02 mm	0.80
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Many performance tuners use the following:

-
non-turbo pumps:
0.95mm to 1.00 mm (0.037" - 0.039")

-
turbo pumps: 1.00mm to 1.05mm (0.039" - 0.041")

Note to those of you rockin' a Giles pump: Giles builds in a lot of dynamic advance to his pumps and generally recommends using 0.95mm as the starting point when setting the static timing of one of his beasts. If in doubt, contact him directly and seek his advice...he built the pump, he knows what's best. ;-)

Unlike a gas car you can't really hurt a diesel with a little bit too much advance… you just get more noise, less power, more emissions, and less fuel economy. If you go overboard the engine will be hard starting, sluggish, noisy, and possibly trail white smoke (unburned diesel).

I personally use the upper end of both those settings.. . nothing has blown up so far. If the engine rattles even when warmed up, and/or it actually is more difficult to start in cold weather you have probably gone too far in the advanced direction.

IMPORTANT: If you get a wacky reading at this stage (something really small or really large) **STOP and PONDER !!!!** Assuming the car ran before you started this procedure you should see a reading somewhere within the 0.8 - 1.05 mm range. If you are way outside this range consider the possibility that you've done something wrong. No sense adjusting the timing until you straighten this out. The usual suspects are the timing gauge binding, not finding the right TDC, and the timing belt being off a few teeth.

In fact, if this is your first time doing the timing you might want to consider repeating the steps a few more times to confirm you get the same reading. If you get the same reading 3 times in a row you know you're doing it right !!!

12)
adjust the timing as required:

a)
loosen the four bolts holding the injection pump in place…
three at the front and one at the back

Three front mounting bolts... two that you reach with a 13mm socket thru the holes in the sprocket, and one you get with a 13mm wrench on the front mounting plate:

One rear mounting bolt... the side you can see is 13mm and the other side is 15mm, reachable from below the pump thru its mounting bracket:

b)
to advance the timing (move the dial indicator to a bigger number) rotate the top of the injection pump towards the engine. Conversely, to retard the timing (move the dial indicator to a smaller number) pull the top of the injection pump away from the engine.
Easy does it…we are talking small adjustments here.

Here we are at 0.039" (1.00mm)... exactly what we had in mind:

c)
once you get the correct number, tighten the pump mounting bolts, rotate the engine all the way forward to exactly TDC, and then confirm that you're set correctly by repeating steps 9-11

d)
once you have confirmed you have the right setting it's a good idea to loosen all four injector lines at the high pressure side of the pump and then tighten them again; this relieves any stress in the steel lines caused by moving the pump. Again, you don't want to introduce any dirt at this stage so clean well with brake drum cleaner and compressed air.

<picture>

Part 4: Putting it all back together again

1)
remove the dial indicator and reinstall the bolt. The service manual calls for a new copper o-ring; I've never had it leak but there's always a first time.

2)
replace the vacuum pump, if you removed it to give yourself room for the timing gauge

3) **VERY IMPORTANT:** slowly rotate the engine a couple of revolutions by hand, stopping IMMEDIATELY if anything seems to bind. This confirms that everything is free to turn and confirms that the valves and pistons are not on a collision course. It also confirms you really have removed all the locking devices !! About once a month I read a story about someone who worked on the timing belt and then enthusiastically cranked over the engine.. bending valves in the process. It's a real bummer to have timing work turn into a full-blown engine rebuild, and if you don't take the time to turn the engine over by hand you're gambling on your mechanical prowess. The question is: do you feel lucky, punk ? Well, do ya ???!

4)
reinstall the valve cover, using a new gasket

5)
standing clear of the engine; start it up and confirm that it's running properly. The car will probably take a bit of cranking to start and will run rough for a little while (30 seconds or so); you introduced some air into the system by opening the timing port and loosening the injector lines. If it is consistently hard to start once, runs rough even when warm, or has a lot of smoke there's a good chance you need to start over !! Inspect carefully for fuel leaks at the injector hoses you tightened and the timing plug bolt.

6)
reinstall the timing belt cover

7)
reinstall the air filter housing, if you removed it initially
to give yourself more room

8)
replace the inspection cover on the timing mark port on the
top of the transmission

9)
congratulate yourself on completing what is probably the most
complicated procedure a VW diesel has to offer !!