

Bosch Mechanical Fuel Injection

ADJUSTMENTS TO THE MFI PUMP FOR TIMING AND MIXTURE

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Adjustments to the MFI Pump

I once saw a perfectly-maintained early 911 that just didn't have that crisp acceleration. It did burp and bang a lot, though. The problem turned out to be the MFI drive belt. This belt is supposed to have cogs on the inside, but in this case it was completely cog-less. Both metal pulleys were just fine, but there wasn't a trace of the rubber cogs to be seen anywhere. The belt was totally smooth. As a result, the MFI pump was turning somewhere close to cam speed, but was big-time out of spec. A new belt and re-timing solved the problem. (*Ed. - My problem was exactly the opposite - great cogs on the belt, none at all on the pulleys!*)

The moral of this story is that this is where you must begin when you adjust the MFI pump: #8 of the Ten Demandments: Injection Timing.

TIMING THE MFI PUMP TO THE ENGINE: You will need a 5mm Allen wrench, 13mm socket wrench, fan pulley turning wrench, very bright flashlight, small mirror, sharp scribe, white paint with small brush and solvent, and a rag.

Start by setting the crankshaft position. The two landmarks you need in order to do this are stamped on the face of the crankshaft pulley.

The first mark is "Z1" which shows TDC for cylinder #1. The second mark is "FE." This is found exactly 40° to the left (counter-clockwise) of the Z1 mark.

Here's how to proceed: Start with the crank set at TDC on the compression stroke for #1 cylinder. In other words, the Z1 mark exactly lines up with the timing mark on the fan housing, and the distributor rotor is pointing toward the spark plug wire that leads to #1 cylinder. Now, rotate the crankshaft 400° clockwise (normal direction of rotation). That's right, one full turn (360°) plus an extra 40° to get to the FE mark. Stop with the FE mark exactly in line with the timing mark on the fan housing.

Once you've got the crank in this position, be sure it doesn't move again 'til you're finished. Take the car out of gear and remove the wrench from the fan or crank pulley so nothing will bump it and change the setting. Also check periodically to be sure it hasn't mysteriously moved by itself (it happens!).

Now, to time the pump, all you have to do is align the mark on the pump pulley with the mark on the pump housing. Unfortunately, since the pump pulley is on the back of the pump, this is easier said than done.

Remove the air cleaner and use your mirror to look at the back of the pump. The mark on the pulley is on the side of the pulley that's closer to the pump. Even after you use the rag to wipe the area clean, the marks are usually very difficult to see. It will be easier if you use the sharp scribe to very carefully enhance the original marks. Once I've cleaned up the marks with the scribe, I also like to paint them with white paint. This makes the adjustment much easier.

Small adjustments can be made with the belt still in place. Use the 5mm Allen wrench to loosen the three pump pulley bolts and adjust it

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to align the marks. If you can't get the marks aligned, you will have to remove the belt so that you can turn the pulley. Check again to see that the crank is still centered. When you're sure everything is just right, tighten it down and you're done (with this part, at least).

MFI TIMING BELT: Start the engine and carefully use the mirror to take a look at the belt itself. It should be running straight without flexing, and should be centered on the injection pump's non-shouldered pulley.

Stop the engine and use the flashlight and mirror to look down, under, and behind the belt to inspect the cogs on the belt. They should be square and pliable with no cracks or tears, and the belt must be clean. Next, check the condition of the pulleys. Any wear is unacceptable.

Look down into the sheet metal pulley cover for dirt and debris, leaves, twigs, gum wrappers, chewed-up Barbie dolls, etc. It is possible to wash this area out with a strong water hose spray. If the water blast doesn't get the junk out, you'll have to jack up the left rear of your Porsche (put a safety stand under the torsion bar tube), remove the left rear wheel, and remove the sheet metal belt/pulley cover to remove all the junk. Clean the belt with mild soap and water. Avoid solvents and "Brake Cleaning" sprays.

MFI TOOLS: Over the years, I've found that it is easy to make these tools myself. My source for MFI tools is my local welding supply store!

1. The AIR FLOW ADJUSTING SCREWDRIVER is the tool I use to make the adjustments I described in my last article about getting the air flow dialed in. It is especially useful because you can adjust the air flow screws even with the air cleaner installed!

To make it, obtain a piece of 1/4" diameter welding rod about 19" long. Use a grinder (or

file patiently) to form a flat screwdriver blade on one end. On the other end, carefully bend a one-inch section down at a 90° angle. When viewed from the blade end, this bent piece should be exactly parallel with the blade. The bent end will then be handy not only when trying to align the blade into the slot in the adjusting screw, but also to gauge how far you are turning the screw.

Typically, after doing a re-adjustment of the airflow system as I explained in my last article, the idle RPM will drop off 50-75 RPM when you install the air cleaner. With your new air flow adjusting screwdriver, you can open each air screw 1/16th to 1/8th turn to bring the idle back up. Do this very quickly before the upper engine heat-soaks and changes things even more.

2. MAIN ENRICHMENT ACCESS TOOL. Access to the main rack and its adjustment screw is by removal of the 5mm Allen screw. This is usually the only screw with an Allen head on the face of the MFI pump (facing toward the rear of the car). On '70 and newer cars, it is just above and to the right of the solenoid (the barrel-shaped object with an electrical connection on the face of the pump). On '69s, it is to the right between the two solenoids. I use a HAZET 5mm Allen socket with a 1/4" drive and 14" long extension. You must grind smooth the back side of the socket so nothing can snag it during removal and pull the socket off the extension. With the screw removed, the main rack enrichment is accessible and ready for adjustment.

3. MFI PUMP MAIN ENRICHMENT SCREWDRIVER: This is what you use to adjust the main rack once you've removed the 5mm Allen screw.

Use a 1/8" stainless rod 22" long. Make a small flat screwdriver blade on one end. File down the blade to about 1mm thick and 5mm

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long. On the opposite end, bend down a one inch piece to 90°, directly parallel with the blade, just as you did with the air flow screwdriver above. This will help you judge the "clicks" as you turn the screw toward rich or lean. Please note: the Main enrichment screw has 12 clicks per one full turn (360°).

4. IDLE ENRICHMENT SCREW DRIVER:
The best tool for this job is made from a 1/8" stainless rod 16" long. I weld an 8mm 1/4" drive socket to the end, and grind down the socket opening so the socket is only 4mm deep. If you don't do this, the socket is too deep and won't work. I also grind down the back side of the socket to ease removal. If you don't it will catch and snag on the air shroud, fan hub and blades. Once again, bend the opposite end down 90° to give you a reference and a way to turn the tool.

I used to use a 1/4" shallow socket on a very long extension, but after having the socket snag and pull off and then spending an hour fishing around for the darned thing, I use this new tool exclusively.

Unlike the main rack, the adjuster for idle enrichment is on the outside of the pump. The actual adjustment is made inside the pump, but there's a handy little adjusting tool built right into the pump body so you can fine-tune the idle without removing an access screw.

This built-in tool is like a very small screw driver about 1/2" long. It is spring loaded so that when it is not in use, it snaps back out of the way. The head part that you turn has an 8mm hex drive head. The reason you have to grind down the 8mm socket as I said above becomes apparent when you try to push the adjuster back in against its spring loading. A normal-depth socket is so deep you can't push the adjuster in far enough to engage the internal adjustment.

Now comes the reality of doing it. Access to the 8mm hex drive is through the fan. You need to thread the tool through the fan blades (yes, idle adjustment can only be made with the engine turned off!) at about the 10 - 11 o'clock position. From there, back behind the fan blades, the tool goes through a small access hole in the air shroud. It seems this hole is seldom in the right position.

Once you've gotten the tool through the blades, through the access hole and have properly engaged the 8mm socket on the 8mm hex drive, the actual adjustment is easy. Lightly push in against the spring load and slowly turn the tool. It will pop in a bit further and become more difficult to turn as the inner blade engages the idle enrichment screw. Holding that engagement by constant inward pressure, lightly turn the screw one or two clicks either rich or lean. The idle adjustment has only 6 clicks per full turn (360°).

With these tools, you can fine tune your 911's MFI to sing well enough to make an opera singer jealous. But how?

Two things are of utmost importance here. First, make scrupulous and exacting notes of just how many clicks and in which direction you turned the adjusters. That way, if your car's performance starts getting worse instead of better, you can quickly and easily get back to where you started.

Second, I encourage you to write a note inside your tool box, make an engraved placard, or tattoo on your arm the following:

MAIN CONTROL MIXTURE

Rich: Counter-Clockwise

Lean: Clockwise

IDLE MIXTURE

Rich: Clockwise

Lean: Counter-Clockwise

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Yes, the two adjustments are in *opposite* directions! This can be confusing when you are trying to think about the whole system and how each adjustment may effect something else. I use a phrase each time I pick up one of my MFI tools: "Main Enrichment Counter-Clockwise." You only need to remember one little phrase like this since it will only work on one thing. All three other adjustments are opposite. *(Ed. - I like the phrase "I Lean Left" (for Idle Leans counter-clockwise (Left)). It's easy for me to remember because it describes my politics, but I guess it may not work for everybody.)*

One time I got mixed up and "clicked" in an adjustment thinking I was doing one thing, but was doing something else. This little episode taught me once again to stop, "Check...Think...Repair."

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Throttle Plate Correlation

Correlation: The equalization of the angle of displacement of the throttle butterflies throughout accelerator pedal movement.

On a Porsche, this is done by measuring the flow of air at each stack at different pedal angles. In order to measure this, we first must know if all the cylinders have the same capability.

The first thing to do is a leak-down test. If there is any more than a 10% difference, we are already done, tools down, job over. If you don't fix this problem first, throttle correlation won't make much difference.

Next, check and adjust cam timing and injection pump timing — everything to "spec." On we go ...

Over the years, the air bleed holes have a tendency to carbon up. Take them all out and look at them closely. Check the tips of the screws to make sure they are all straight and not messed up in any way. If they are, replace.

Now to cleaning the holes. I use surgical tubing and aerosol carb cleaner so I can blow the cleaner through the hole. I tend to use a lot. This is a critical step, so be very sure the holes are absolutely, completely squeaky clean.

We then replace the air bleed screws and set them at a balanced setting. I choose two full turns from bottom stop.

The next step is to remove all the linkage rods from the butterflies.

Gentlemen, start your engines. Let the beauty warm up, and we are ready to begin.

The factory used mercury-filled tubes to record air flow. I use a Synchronometer — at least it's German.

I have always found that Porsches seem to run best when the air bleed screws are all adjusted the same. Since you just did that, we will leave them alone. Any imbalance you discover is adjusted by the throttle stop on each butterfly. Read all six stacks — the majority rules. Adjust only those that disagree with the rest (less to adjust that way).

When all six cylinders are pulling equally, adjust the linkage rods to match and reinstall.

Voila, "throttle correlation!"

The last test I do is to use the hand throttle to bring the engine to 2000 RPM and check the flow one more time. If your adjustments to the throttle stops were accurate and all the air bleed screws are still set the same, any imbalance discovered here is probably due to faulty linkage rod adjustment.

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Cam Timing: You're absolutely right. Cam timing must be investigated if you've checked the "Ten Demandments" and the engine still runs poorly.

Also, regarding heat exchanger air, it's amazing how much this can affect engine performance. Any rips, dents or holes in any of the hoses you mention can dramatically reduce the air flow in this system.

I once had a customer who had recently installed new heat exchangers. They were generic exchangers: meant for MFI, carburetor or early CIS 911s. For months afterward, he complained about the MFI not working properly. After checking the car and finding *no air flow at all* to the MFI thermostat, I tore into the hot air supply system. After removing the heavy rubber hose that attaches to the heat exchanger "U" pipe, I found that the new heat exchanger had a metal plug blocking off the supply of hot air. After removing the plug and reattaching the hoses, everything worked great.

Fuel in oil: Yes, I've run into this problem, too. Inside the MFI pump the only seal that separates the oil from the fuel is the close machine tolerance between the individual fuel plungers and the MFI case. The only cure I know of is a complete overhaul of the pump.

After a very long time, the MFI can still work very good, but may leak gasoline into the oil system. This makes the oil thinner and less effective.

Therefore, if your MFI is still original, it is advisable to check the oil very carefully when drained.

Accelerator Linkage

The linkage by the trans was fine, but wait . . . what's this? At the point where the throttle cable disappears into the body, there was some sort of rubber connector in-line with the cable. The rubber in the connector was so old and rotten that it had split, and the severed accelerator cable was dangling loose under the car.

All I had to do was tie the ends of the cable together somehow. Now I understood why some people always carry a bit of bailing wire and some duct tape in their tool kits. Unfortunately, I was not one of those people.

The next day, in to see my favorite mechanic, Charles Koff. He explained that the rubber bit had been put in the cable to isolate engine vibration from the driver's foot, but was amazed that my car still had the "old style" (PN 911.423.223.00) throttle cable in it after 27 years.

"This should have been replaced years ago," he said. I blamed the former owner.

The new-style (PN 911.423.081.02) cable still has the rubber vibration damper in it, but it is now surrounded by a small metal "barrel." If the rubber splits, as mine did, the barrel catches the ends of the cable, and all you end up with is a slight decrease in power — the split rubber makes the cable just a bit longer, and thus might not open the butterflies far enough to provide full acceleration. Big deal! You still get to drive it home.

The obvious moral of this story is to check to be sure you have the late-style throttle cable in your car, and if you don't, by all means install one!

Sticking MFI Pump Rack

Tech Tidbit: Recently, had a problem with a sticking rack in "Elvira" my silver '72 S. As the shop manual shows, there is a rubber plug on the backside of the pump (firewall side) that you can remove to allow you to push on the rack with a small bolt or punch. The rack should push in and spring back. Mine didn't.

To unstick it, remove the fuel inlet hose (that's the one on the passenger side of the pump — okay — in Australia, it's on the driver's side). Loosen the banjo bolt so you can turn the fuel nozzle straight up and lightly tighten the banjo bolt to hold it there. Remove the four screws holding on the side access cover of the pump (the one that's nearest the thermostat rack).

You are now looking at lots of levers and springs. You will find one that pushes the rack forward (toward the front of the car). Now pour Gumout in the inlet nozzle and start working the rack back and forth. Keep pouring Gumout in the nozzle so the nozzle is always full.

It took several sessions and an all-night soaking in Gumout before the rack was finally free. Now I always add Gumout and occasionally fuel stabilizer to the gas tank.

Rebuilding MFI throttle bodies

My '70 S was running a bit rough, so I took it to Charles Koff to have a *complete* tune-up done - starting with cam timing and working right straight through until everything was exactly to factory spec. I was more than a bit disappointed when Charles told me that a tune-up wouldn't help.

Over the years, the holes for the butterfly shafts in the MFI throttle bodies had worn oval and were sucking air, leaning out the mixture uncontrollably. The ball-and-socket joints in the linkage had also worn oval, making for an unacceptable amount of play. Charles, in his inimitable manner, knew the fix.

We sent everything - throttle bodies, all the linkage rods (including the one to the injection pump and the one that goes all the way back to the pivot by the pump sprocket), and even the big cross shaft that connects the two sides together, to a place called Eurometrix (address below).

First, they drilled out the butterfly shaft holes and installed new, perfectly-fitting shafts. Same for the cross shaft holes, though you get your original shaft back. Next, they put new balls and rod ends on all the linkage so even the slightest hint of play completely disappears. Last, they put the assemblies on a flow bench and dial them in so all you have to do when you get them back is put them on the car - no adjustments necessary (they even paint the screws so you *can't* adjust them without breaking the seal).

As if that weren't enough, all of the linkage hardware is given a new coat of gold anodizing, and the throttle bodies are re-painted original black. Better than new for around \$600!

After this fix, my S will run so sweet it'll seem like a new car! My understanding is that the same folks will work similar wonders on Weber, Solex and Zenith carbs - 1967 and '68 S owners take note!

This is a fix that most of our cars probably need by now, and I can definitely recommend Eurometrix - their work is to the highest standard.

EUROMETRIX
PO Box 1361
Campbell, CA 95008
(408) 296-1533

Charles Koff tells me that 9 times out of 10 the mechanical fuel injection pump does not need to be rebuilt even when you *think* it does. However, just in case you need it, here's the address of the folks who do that job as well:

Pacific Fuel Injection, Inc.
153 Utah
South San Francisco, CA 94080
(415) 588-8880

In Australia contact:

Walz Diesel Fuel Injection
48 Alfred Road
Chipping Norton
NSW 2170
(02) 9755 1422

Also:

Gerry Fairchild Industries
CA (?)
USA