

How-To: VTCS Removal and Porting

Written by flat_black

Welcome to my how-to on porting and removing the VTCS butterflies on the manifold designed for FS-DE engines, featured in 1997 and up 626's with the 2.0L engine, and in the Mazda Protege with the 2.0L engine from 2001 and up.

Firstly, this is just designed to be a more or less general guide; I assume you know basically what you're doing, and are comfortable with operating tools of various types. Also, I'm not going to go into how to install and remove the intake manifold from your head. Maybe that later, though!

I'm going to first explain the basics of the FS manifold; This manifold features a dual runner design, meaning that there is a plenum attached to the throttle body, and from the plenum, there's two paths available for the air to travel. This is called VICS, or Variable Intake Charge System. One path is a longer path, which is the typically open path, which enables higher air velocity, but lower volume, which allows for a good deal of low end torque to be had. However, this would strangle the intake charge during higher rev operation, and would thusly cause an extreme dropoff in power thereabouts, if not for the following. At 5250 rpm, the ECU sends out a signal to actuate the armature that opens the VICS valves. Once these open up, you have two runners, one short, one long, forcing in a large volume of air, which makes for much better high end breathing. So, in summary, VICS good.

Now, on to VTCS. Whew, am I long winded, or what? VTCS, or Variable Tumble Control System, is a system put in place on some of the FS manifolds which essentially is designed SPECIFICALLY to cause turbulence in the air charge. Sounds like a horribly silly idea, doesn't it? Well, let me go on. This tumbling of air actually causes the intake charge to swirl the gas more, and causes a higher level of heat to be discharged from the exhaust side of things. This, in turn, causes the catalysts to get up to operating temperature much faster, and therefore reduces startup and cold-operating emissions. The VTCS system turns off after the car has reached a designated temperature, and doesn't close the tumble valves completely until 3000rpm, anyway. In summary, VTCS isn't BAD, perse, but it certainly staunches flow, and causes unwanted turbulence. Remember, we want laminar flow into the head, so we don't get lean and rich spots, and funny air velocity problems!

Alright, then. On to the meat-and-potatoes of this page; 'How' you may be asking, 'How is it he's said so much, but hasn't yet taught me how to port my intake manifold, or remove the VTCS, even?'... Well, I'm trying to be as complete as possible. =) Please use the links at the top of this page to navigate; This page is the Intro, Tools is a list of all the tools that you'll need, VTCS Removal is the page detailing removal of the VTCS butterflies, and Porting is the page devoted to walking you through porting out your manifold afterward. Enjoy!

Here's a list of the tools you're going to need for this ordeal:

- #2 (Decently large) Phillips Screwdriver
- Small Flat Screwdriver
- Pick(s)



- M10x1.5 Tap



You can use any size that works; 1/8" NPT would be my next suggestion.

- Rotary Tool



I would suggest a high quality air grinder tool that you can adjust the speed on, or, on the cheap side, a Dremel/Craftsman rotary tool, with ADJUSTIBLE SPEED. This is very important.

- Rotary Bits



Stone/Ceramic Grinding Bits, Sanding Drums (Fine and coarse), Polishing Wheels, at least, and a lot of the extra drums.

And here are the various 'extras' you're going to need, including chemicals and whatnot:

- Threadlocker/Gasket Sealer
- Metal Epoxy Putty
- This is to fill the holes between the runners, and at either end. I personally like QuikSteel, but JB Weld or similar metal fillers can be used easily enough. Just make sure you use something pretty thermally resistant.



<http://www.kalimex.co.uk/section.html?secpath=01.02.&pgid=6>

- Machining Oil



- 3-in-1 Oil is preferred here, really, but I used WD40, because I had just run out of 3-in-1. All it does it keeps the surface cooler, and smoother as you're grinding away at it.
- Compressed Air
- Either in can form or from an air compressor. Just to remove metal shavings and whatnot.
- Breathing Mask/Safety Goggles
- For the flying metal shavings... Duh. =)

Removing VTCS!

Okay, then. Now that your manifold is reasonably clean, and sitting in front of you, and you're ready to start this, look at the manifold where it bolts onto the head. You should see four valves sitting happily in the air stream, quite content to block flow. Time for some retribution. Take your Phillips screwdriver, and unscrew all four of the butterflies. If you haven't removed the actuator arm yet, do so now, so you can turn the butterflies so the screws face you. There are two screws per butterfly, and once you get it unscrewed, you'll need to turn them so the butterflies are in the 'open' position, and slide them out of the runner. Repeat for every one of the four, then pull the rod from the end where it protrudes, and it should slide right out. Done! Your VTCS is now gone! Or, or your table as the case may be.

Now we can get onto the entertaining part; Blocking the LARGE vacuum leak that you just made in the manifold. There should be a little rubber retaining ring (**Figure 1**) that can be simply removed. Use a pick, be it straight, 90 degrees, or whatever, and pull it out, somehow. It'll come out eventually.

Once you have the ring out, you'll see the area (**Figure 2**) that you need to plug. This is as simple as getting a short bolt (or plug), and tapping out the hole where the rod passed through. First off, clean the area you're going to be tapping, and get it covered in 3-in-1 or whatever oil you're using. Then, take the tap, and put it into the tap handle, and tighten it down as much as you can, then oil up the threads of the tap. Now, push the tap into the hole a little bit, so you can line it up as straight as you can, and start turning it. It might take a little bit of persuading, but after that, it should start forming a path, and cutting metal shavings out. Go in a couple of threads, then back it off some so the metal can back out, and reoil the threads of the tap. Keep doing this, pausing every few threads to back the metal shavings out of the hole. After some persistence, the tap should emerge on the opposite side of the runner, and the hole will be fully tapped. Back the tap out, spray some compressed air over the hole, and wipe it down a little. It should look like this (**Figure 3**) once you're done, only minus the metal shavings. =)

So, you've got threads now, so get some threadlocker (Blue should be fine, but anything will work, even just some gasket sealer; It's just to make sure there's no air leak, and it doesn't vibrate free at any point) and apply it to the bolt or plug that you have. At that point, thread the plug/bolt into the hole that you just tapped, and make sure it doesn't protrude into the airstream; A bolt is much harder to grind down than the metal putty we're going to be using to fill the holes. Here are some pictures of what it should look like outside (**Figure 4**) and inside (**Figure 5**) the runner (Taken after porting).

Figure 1



Figure 2

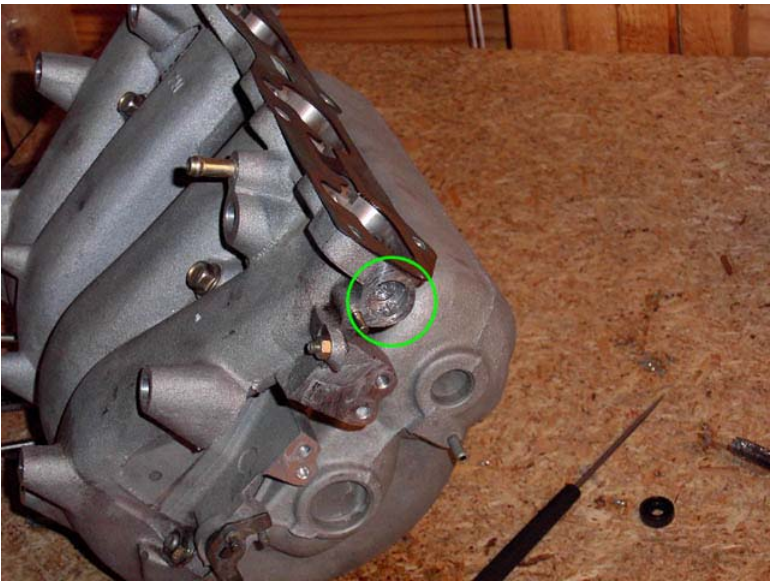


Figure 3

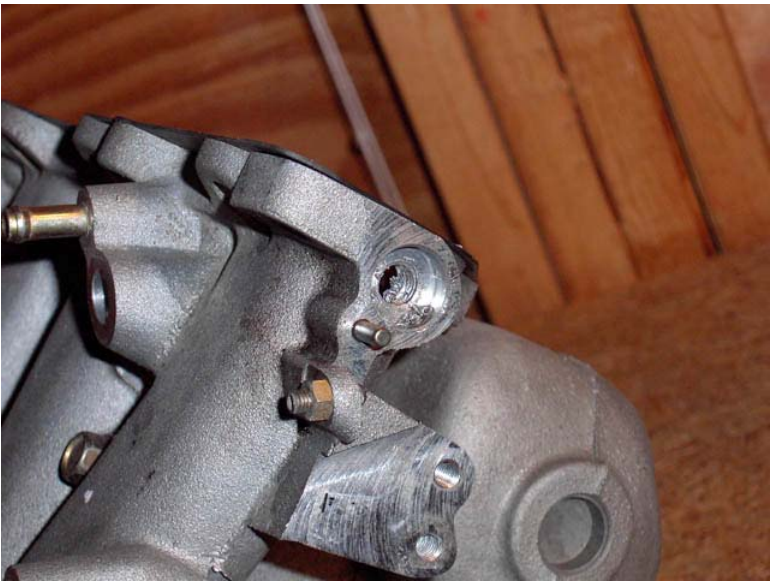


Figure 4

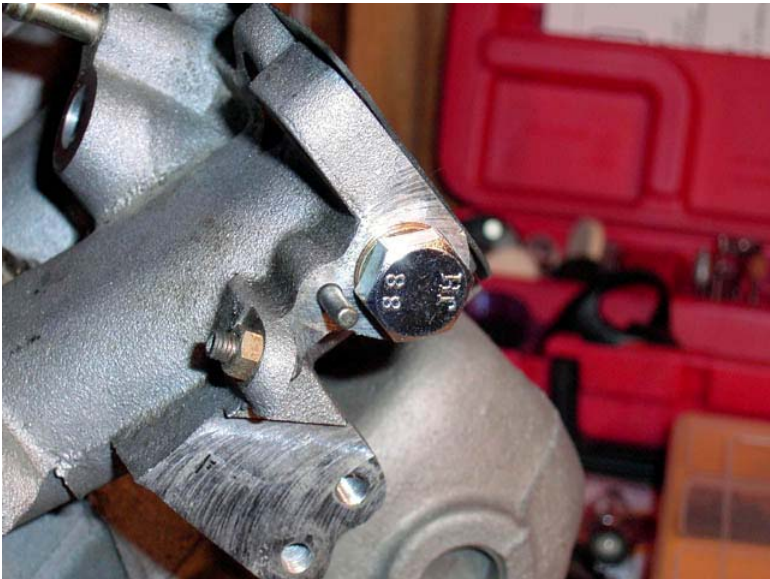


Figure 5



Ready to start porting the manifold?

I actually decided to start porting the inlets before I put the metal epoxy in, for some reason... I'm not quite sure what made me think it was a good idea, but it shouldn't matter much, either way. So, that being said, it's time to look at the trouble spots of the intake manifold. There are two lips on the intake manifold; One on the ceiling of the runners, protruding into the airstream, and one below, dipping below the airstream... This is pretty obviously a detriment to the air flow, causing the air to 'stumble', even if those butterflies aren't there. These two areas are the ones we're going to focus on first.

If you have a scrap piece of aluminum around, it's best to practice on that first, so you know how each tool affects the aluminum, and at what speeds. **READ THE MANUAL TO YOUR ROTARY TOOL.** Especially if it's electric. Here's why; Setting 4 on my electric rotary tool is actually ~10,000rpm, which is the highest speed setting you want for porting aluminum, whereas 10 is actually 24,000rpm, and would kill the material, and overheat the aluminum. So, read, and know what rev ranges you're working in. I've found that you shouldn't exceed 10,000rpm on aluminum, and don't bother going lower than 5,000... At that speed, you're not really removing much metal with any tool.

Start with the stone/ceramic grinding bit. These remove the most metal over the shortest amount of time. For the lips that we're trying to remove, I start at 10,000rpm with this tool, and get it as close to level as reasonable, using my fingers in between sessions to see how much I've milled down and how smooth it is. As I finish up, I go down toward 5,000 more, and just smooth it out. This is the first step to getting the port work done. Just using the rotary stone, this (**Figure 6**) is what I ended with. The rightmost port has been ground down, and the lip has been smoothed over, using only the rotary stone. The port to the left of that has just been lightly cleaned; The dark spot toward the back isn't a shadow; It's where the original lip drops off. That's what we're working on. Remember, take your time doing this, and work slowly if you have to; It's easy to remove material with this rotary tool, but not so easy to put it back on. Heh.

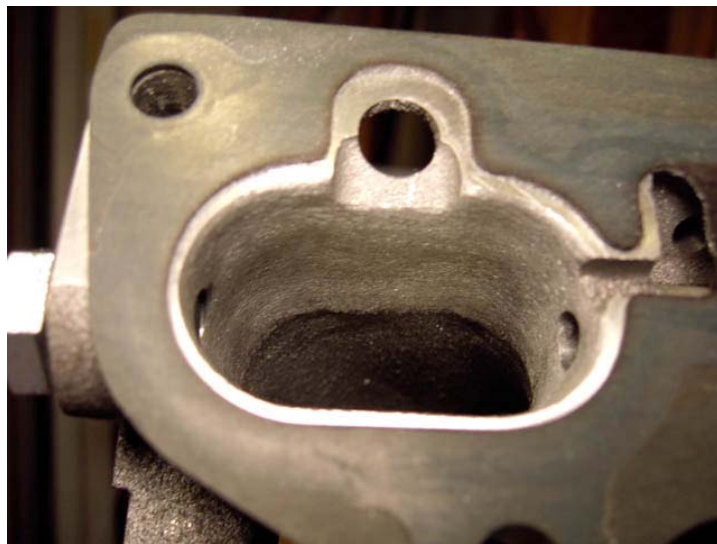
The same principal applies to the lip on the bottom, as well. Take your time, and go nice and smoothly. Below are some pictures of what it should look like after using the rotary stone. I managed to get it pretty smooth with the stone, so your may be a little rougher looking, but that's what the sandpaper drums are for! =)

Ceiling:

Before

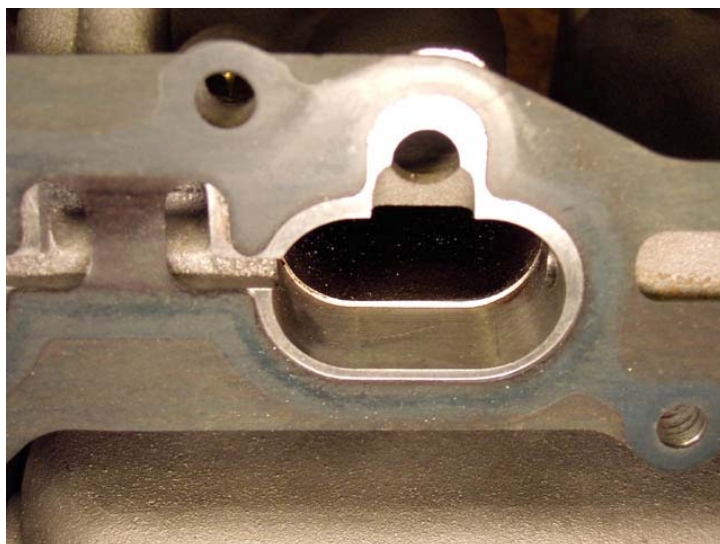


After



Floor:

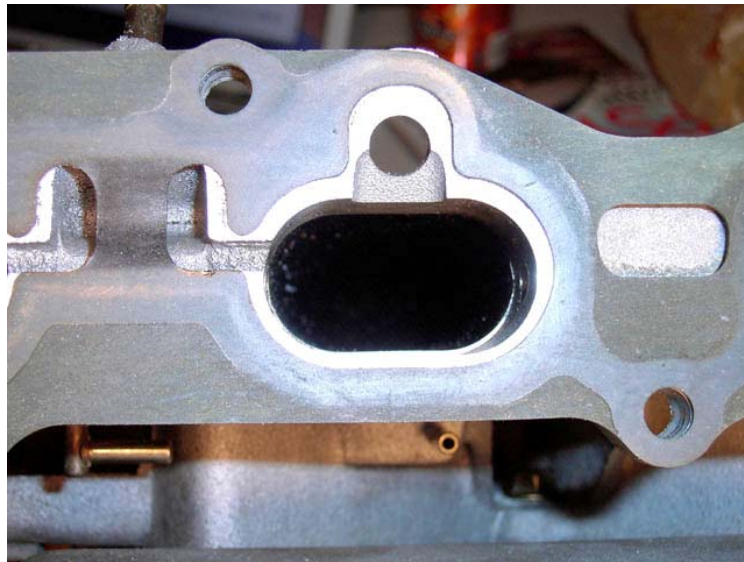
Before



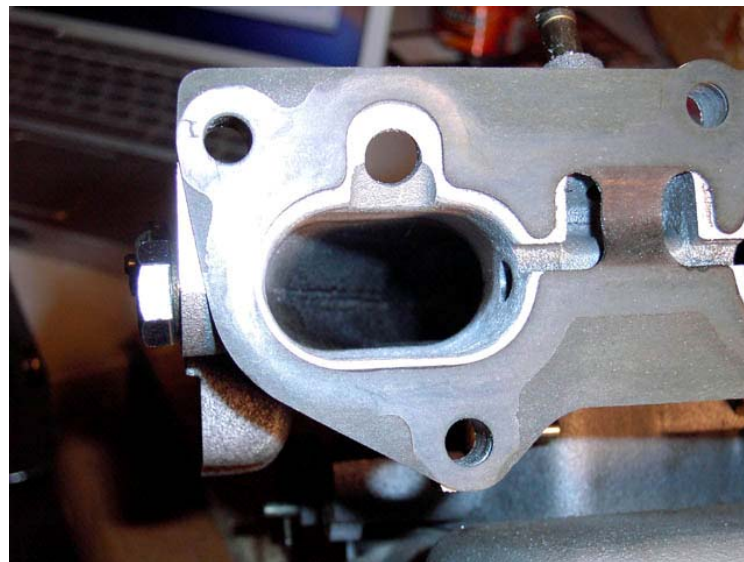
After



Mouth:



Before



After

Now, then. A little time lapse here; Do the other three runners like you did the first one. I didn't, but do as I say, not as I do! As a note, you'll **GENERALLY** only port down about 3 - 4" on the runners. Once you're done with that, get out your metal epoxy putty, and mix a bit of it together. I'm running on the assumption that you are using QuikSteel, here, so knead/mix the piece you're working with together (Start with about 1/6th of the roll of QuikSteel), and make sure it's a nice, uniform color. Once you've done that, work quickly; Roll it into long lengths and stuff it into the small holes left by the VTCS rod, and either of the end caps. Don't worry too much about it getting hot while you're working with it, because that's just the putty curing. Once you have all of the holes filled, make sure they're overfilled a little bit; We'll grind away the extra. It should look more-or-less like this (**Figure 7**) once you've got it filled, or like this (**Figure 8**) if you decided to fill first, then port. Now, let this stuff cure for as long as directed, times two, at least. QuikSteel cures in 15 minutes, but I let it sit for four hours before I started back in on it.

Alright, all cured, now. Break out the coarse grit sanding rolls (My coarse rolls were 80 grit, I beleive). If you've ported the manifold already, this is going to be the touchup step, too. But if you're still working on stock ports, this will just be to sand down the excess plug material that you left. Starting on top of the plug itself, sand

up, down, back and forth to smooth out the area where the plug is. Use your fingers here to make sure it's flush. If you haven't ported the manifold yet, go back and do just that once you're done sanding all of the plugs smooth. Now, work over the rest of the the runner with the roll to smooth it out. Then do the same using the fine grit (120 grit for me) drums, until it's as smooth as it can get. This (**Figure 9**) is what it should look like once you're done smoothing over the plugs and smoothing it all out with the sander.

Now we get to the fun part; Polishing. This step is actually kind of fun, for me! Put the wire wheel in your rotary tool, and start at lower (5000ish should be fine) rpm, and work over all of the surface that you've ported out. This should give it a very distinct look of polished metal... Don't worry if it's uneven, though, as you DO need a little roughness to the surface, but only a little. Use your fingers to feel it to make sure it's getting nice and smooth. Now, increase the rpm a little, and go over it again. This will produce a nice, smooth runner that looks like this (**Figure 10**). The picture doesn't do it justice, either; If you feel over the runner of the intake manifold, now, it's actually much smoother than stock. Continue this for each runner as well.

Figure 6

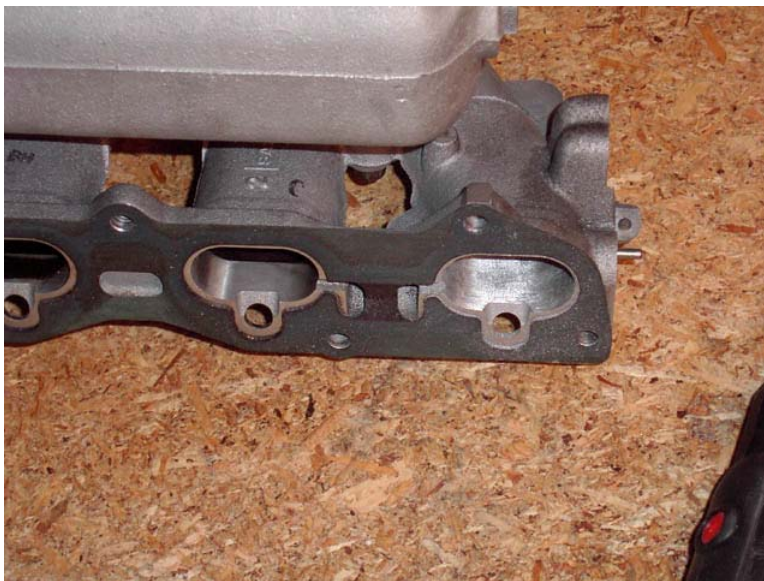


Figure 7

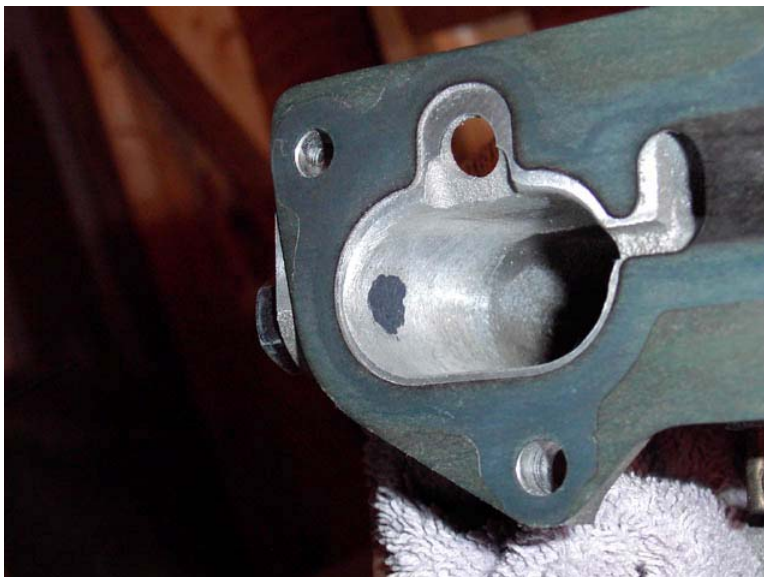


Figure 8



Figure 9

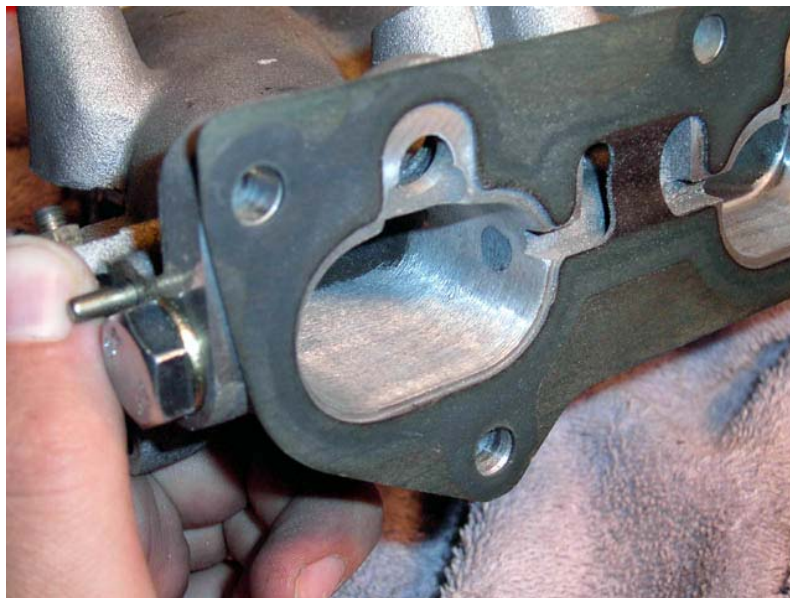


Figure 10

