Ford Mustang 1993 GT Convertible 5.0

Rough Idle Problem Solving Guide

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Source: Various Mustang forums on the Internet, credits are in the back of this document

Solving Idle Problems

Cleaning your IAC

Does your idle rise and fall over and over again? Does your 'Stang stall when you come to a stop, or even when you put it in gear? Well if so then this series of articles is for you.

In this age of fuel injection, idle problems can literally be caused by hundreds of different things. What this series of articles is aimed at is how to fix the most common idle problems found in the Mustang.
The fuel injected Mustang uses a small motor/valve assembly that allows a specific amount of air to enter the *engine* to control it's idle. This valve is comonly called the idle *motor*, the *IAC* (idle air control) or the IAB (*Idle air bypass*). When your car is new the IAC works remarkably well. The problem arises when the car gets some miles on it (usually 75K+) and carbon fouling takes its toll.
What happens is dirt, excess *air filter oil*, and most notably carbon gunks up the *IAC* valve and doesn't allow it to either open or close properly. This can cause an really high idle, a lumpy/surging idle or no idle at all. The solution is to either replace or clean the IAC. Obviously we are going to do the later and here is how.

1. What is needed?
- 8mm or 5/16 socket and ratchet
- Can of Carburetor/throttle body cleaner

Photo taken by Mr. Fox

2. Locating the IAC valve:
Depending on the year of your Mustang the *IAC* can be in a few different locations.
- On 5.0L Fox body cars the IAC is bolted to the side of the *throttle* body.
- On SN-95 cars it is bolted to the intake manifold
- On 4.6L DOHC and SOHC engines the IAC is located on the *upper intake manifold*.
In reality once you know what one looks like (picture 2 "B" from a 94-95, fox body's have longer silver IACs) you should have no trouble finding yours. They all look basically the same except pre-94 cars were made of metal and are silver, 94-up cars are black plastic.

3. Removing the IAC:
This part, like the rest of the steps in this article, is simple. The IAC has an *electrical plug* that needs to be disconnected (picture 2 "C") Then all you have to do is remove the two 8mm-5/16" bolts (Picture 2) that hold the IAC to the *throttle* body or intake. Watch out for the IAC *motor* to *throttle* body gasket, don't lose it!

Picture 2/Photo taken by Mr. Fox

4. Cleaning:
Next all you do is use the *carb cleaner* to clean the carbon out of both of the holes (picture 2) in the IAC valve and both of the holes in the *intake/throttle body*.

5. Putting it back together:
Yet another self explanatory step. Put the IAC in place and install/tighten the *8mm bolts*. Make sure you don't forget to reinstall the gasket.

6. Fire her up!
Finally you need to start the car and let it run for a few minutes to burn any leftover *carb cleaner* in the intake. You may have to crank the *engine* a little more than normal to start it for the first time and don't worry about the white puff of smoke you see coming from the *exhaust* because again it's just the carb cleaner.

Cleaning Your Throttle Body

In part one we covered the most common problem that will cause idle problems, the *IAC*, but there is an often overlooked area of the intake tract that also regulates how much air enters the *engine*. That part is the *throttle* body plate.
The throttle body plate is a part inside the throttle that flips open when you press on the accelerator and the amount it opens depends on how much you press the accelerator.
Well just like the *IAC* when the throttle body gets gunked up with carbon it can stop it from closing all of the way causing idle problems. So the obvious next step? Clean it!

1. What is needed?
- Flathead screwdriver
- Can of carburetor/throttle body cleaner

2. Getting to the throttle plate
The first step is to remove the cold air intake that goes between the *throttle* body and MAF (*mass airflow sensor*). There's not much work to be done because all that holds that air duct is two clamps that need to be loosened with a flathead screwdriver.

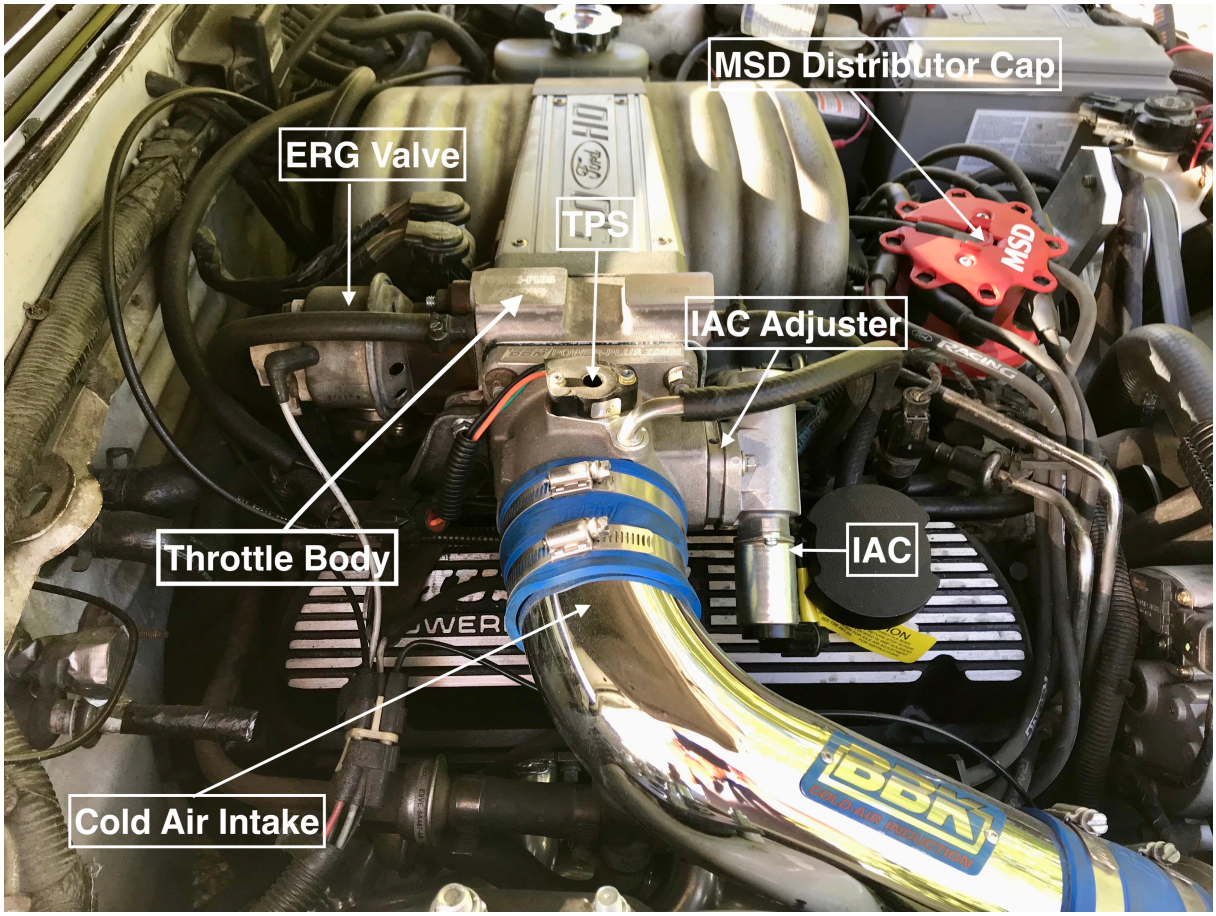
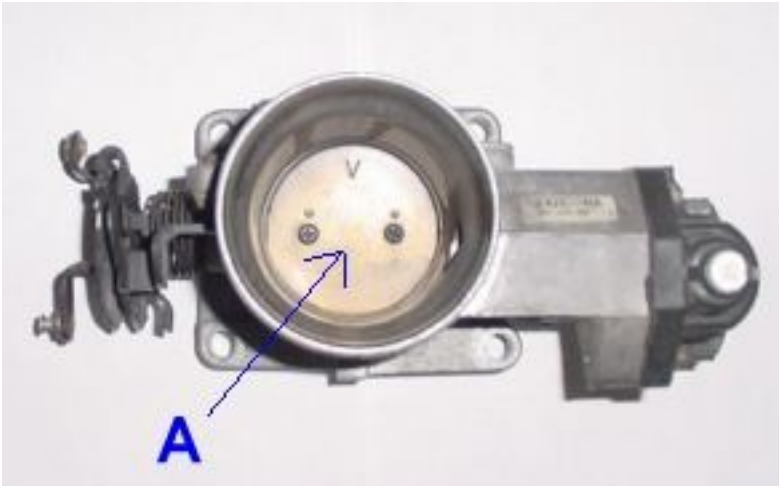


Photo by Mr. Fox

3. Cleaning the throttle plate

Look inside your throttle body. Do you see all of the gunked up carbon? (that black stuff) Well that's what you need to get rid of with your *carb cleaner* so get to it! You're going to want to either hold the throttle open with your hand or have somebody do it for you by pressing on the accelerator so you can clean all around the *throttle* plate. You might also want to put a shop rag or *paper towels* under the the throttle body to catch all of the *carb cleaner* before it goes all over your fender. The Throttle body in picture 2 was taken off the car for illustrative purposes.



Picture 2

4. Putting it back together

Replace the air duct, and any wires you disconnected. Then start her up!!! Again, just like when cleaning the *IAC*, don't worry if it takes a little longer to start. Also dont worry about that puff of smoke from the *exhaust*.

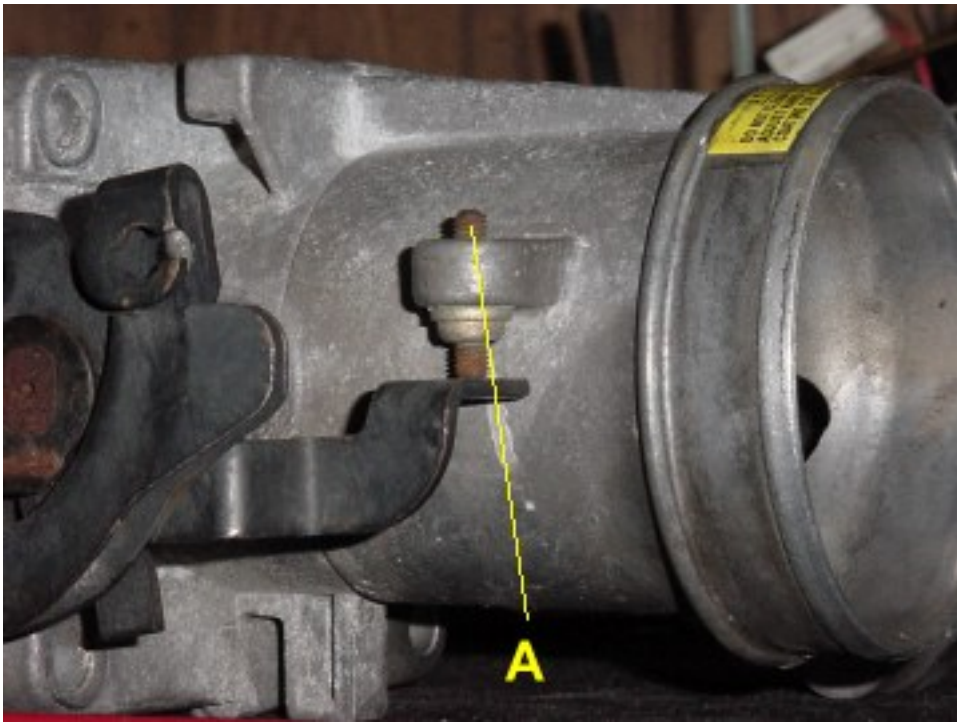
Resetting The Base Idle

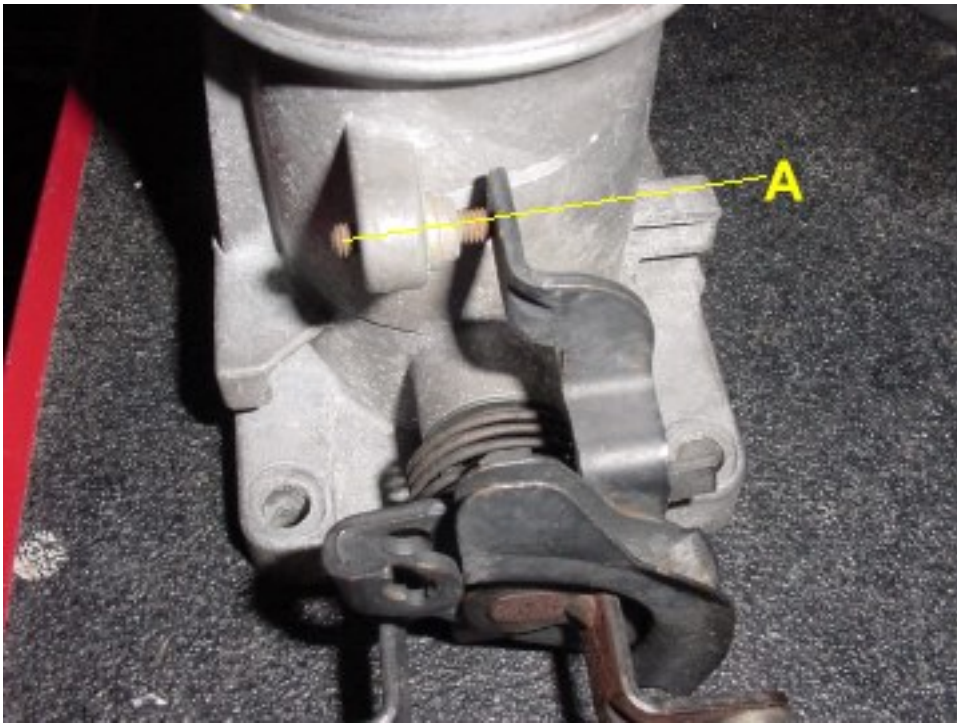
The base idle is nothing more than the idle that the computer has learned at whatever angle your *throttle* body is set at when at idle. This technically shouldn't change by itself but it's always good to check it because you never know what the dealer or previous owner did to the car before you had it.
Once you change the setting of the base idle you will definately want to go onto step 4 in this series of articles because if you move the base setting of the *idle plate* you also change the tps voltage at idle.

What is needed?
- Flathead screwdriver
- You'll also need a wrench to remove your *battery* cable

How to do it
1. Disconnect the battery's negative terminal to reset/clear the computer's memory. Leave it disconnected for 30 minutes. WARNING: Whenever removing your *battery* cables ALWAYS disconnect the negative *battery* cable first and reconnect it last. Otherwise you could destroy your computer or cause a *battery* explosion.
2. Disconnect the plug going to your idle *motor* which is located on the front of your *throttle* body.
3. Reconnect your battery's negative terminal.
4. Start the *engine*, and set the idle to the rpm you want with the stop screw on the bottom of the throttle body.
5. Turn off the engine.
6. Reconnect the plug on the idle motor
7. Make sure all accesories (radio, *blower motor*, a/c, lights, etc) are off and start the *engine*.
8. Let engine run for two minutes.
9. Turn engine off and wait two minutes then restart *engine* and let idle for two minutes with all accesories on.

EDIT: This article refers to "stop screw" on the throttlebody. We have noticed that on 94-95 (and probably 96-up) Mustangs don't have a stop screw but have a small piece of "threaded rod" (A) instead. This threaded rod can easily be turned with a pair of *pliers* to do the adjustment stated above. There are pictures below of this "threaded rod". Also note that the stop screw on fox body Mustangs are in the same basic place as the picture below (A).


A


A

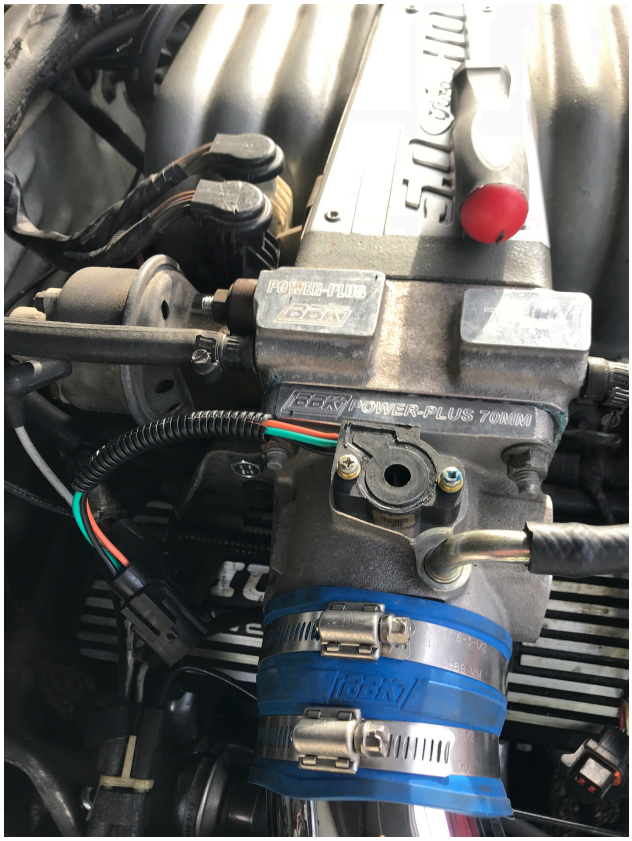
Setting The TPS Voltage

If you haven't already read how to do it a million times in all of the Mustang magazines then this is your chance. Here's how to check and adjust your TPS voltage. You may be asking, "What is a TPS"? Simply put its the *Throttle* Position Sensor. The TPS is a sensor that tells the ECM (computer) how much gas you are giving it, which in turn lets the computer decide how much fuel and spark to give you.

What is needed?
- Phillips head screwdriver
- Two small straight pins
- *Digital multimeter*

How to do it
The TPS (picture 2) basically bolts to the throttle body with two screws. (picture 2) The holes that the screws go through on the TPS are elongated so you can twist the TPS in either direction to adjust it. To adjust the TPS all you have to do is loosen (don't take them out) both screws and move the TPS until you see the right voltage.

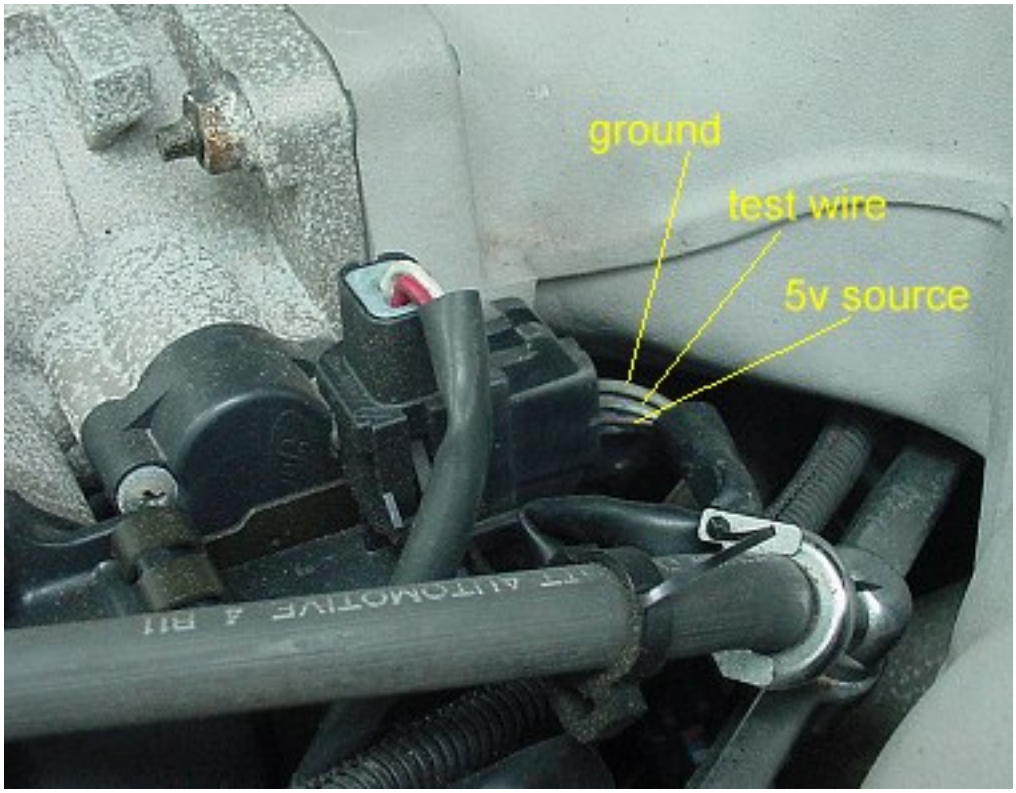
Picture 2 (Photo by Mr. Fox)



To hook the multimeter up you will have to pierce the green wire with a pin so you can check how much voltage is going through it. The red or positive (+) wire on your multimeter will go to the pin in the green wire. Then you'll have to either pierce the black wire and put the negative wire from the multimeter to it, or just put the black multimeter wire to a good engine ground.
Now to check the voltage turn on your multimeter and make sure all of the wires are hooked up right. Then turn the ignition key to the on position, but don't start the car. You should be getting a reading on your multimeter. It should be .98-.99 volts. If its not, then its time to loosen the screws on the TPS and move it around until you get it right. When its at the right voltage tighten the screws and re-check it. If you aren't too happy about piercing your TPS wires with pins then you could do what some Mustangers do. I've seen a few guys/gals buy a fuse holder and attach the two wires from the fuse holder to the green and black wires on the

TPS. Then they use the fuse holder holes to check their TPS voltage.....Whatever you do, make sure you never put a fuse in that fuseholder.
If for some reason you cannot get the voltage reading right you have two options. Either buy a new TPS or take off the old one and elongate the holes a little more with a file or a dremel.

***Update:** We were notified by one of our viewers that the tps wires on 94-95 (and probably modular cars too) were different colors than the 87-93 cars.*
On 94-95 Mustangs there are three wires just like the fox body cars but these have two grey wires (one with a white stripe) and one brown wire. After testing the wires we've figured out which ones are which. They are as follows: The first grey wire is the ground, the second grey (with white stripe) is the test wire, and the brown wire is the 5v source.
So to test a 94-95 car you would put the negative lead on your voltmeter to a good engine ground or the first grey wire. Then you would put the positive voltmeter lead to the middle grey with white stripe wire. If you need more help look at the image below



TPS wires on a 94-95

So you might be asking, "what if i have a modular car?". Well i haven't had access to a modular Mustang to be able to test the tps, but i can give you a way of testing them for yourself to figure out which wires are which.
First thing you do is put your negative lead to a good engine ground, then probe each wire (always with the ignition on, engine off) and test to see which comes up with 5v all of the time. This wire is the 5v source wire, which you don't need for this test. Then find the wire that gives you a reading of around .95-.99v with the throttle in

the closed position and around 5v in the fully open position. This wire is the test wire (same as the green wire on fox body cars), and the last wire will be the ground.

So what are you waiting for? Go check your TPS voltage.
If you have any questions let us know.

Cleaning The MAF Wires

First off you may be asking, what is a MAF? The MAF stands for *Mass Airflow Sensor*. The MAF is the sensor that tells the ECM (*engine* computer) how much air is entering the *engine* at any give time. The computer then in turn uses that info to calculate the air/fuel ratio, and timing tables. So it obviously stands to reason that a *MAF sensor* that isn't properly working would definitely make your idle rough. The fact is that not only will it make your idle rough but it could cause a whole other list of problems including bad fuel mileage, and lack of power.

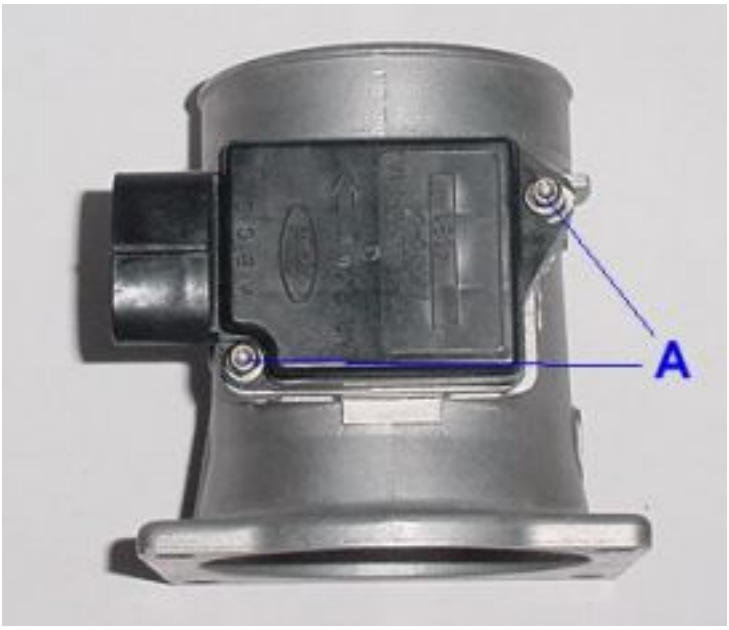
Photo by Mr. Fox

As the air flows through the sensor some air flows through a sampling tube (picture 2 "A") with a heated element in it. This element (aka "wire") is cooled by the air and the computer reads how much voltage it takes to keep it at temp which in turn tells it how much air is entering the *engine*.
The problem arises when that wire gets dirt and (mostly) excess *K&N air filter oil* on it. This causes an error in the voltage reading and the computer sets the wrong air/fuel ratio tables for the type of driving you are doing. The only thing to do when this happens is to clean the wire!

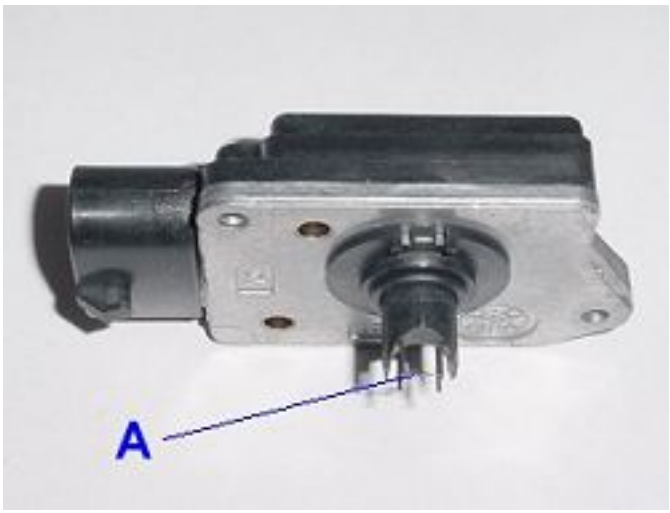
Picture 2

1. What is needed?
- This is kind of hard to say for sure because it all depends on the year/model you have. Usually its nothing more than a screwdriver to remove a clamp or two and something to remove a few bolts that hold the MAF in place. No matter which year you own you will need a security *torx* bit 20 to get the sensor off of the actual MAF tube.
- A can of *carb cleaner* - one Q-tip

How to do it
First off remove the negative *battery* cable. WARNING: Always remove the negative *battery* cable first and put it back last.
Since removing the *MAF sensor* varies depending on the year of Mustang you own you'll basically need to figure out how to remove it yourself...LOL
Once you have it out of the car it will look something like picture 3 unless you have a modular car then it probably has a black plastic MAF.
Take the sensor off of the tube by removing the two *torx* screws (picture 3 "A").



Picture 3



Picture 4

Once you have the sensor out you need spray the *carb cleaner* on the end of a Q-tip and gently....no very very gently clean the wire (picture 4 "A") on the sensor with the Q-tip. Be super careful because this wire is very fragile.
Let it air dry and put everything back together again. Reconnect the negative *battery*, start the car and take it for a ride.

Enjoy your new steady idle!!!

Many of you are familiar with the "Cranks OK, but No Start Checklist for Fuel Injected Mustangs" checklist and the No Crank Checklist, .They are very effective in finding and eliminating the problems by use of a systematic process and checks and eliminates possible causes. This idle problem checklist will use the same troubleshooting strategy and methodology.

By the term surging idle, I mean an idle that wanders up and down more that 100 RPM, or an idle that starts low and goes high and stays there.

The obvious first step is to dump the codes and see what the computer says is wrong…

Here's the link to dump the computer codes with only a jumper wire or paper clip and the check engine light, or test light or voltmeter. I've used it for years, and it works great.

See http://www.troublecodes.net/Ford/
OR
See http://www.mustangworks.com/articles/electronics/eec-iv_codes.html

IF your car is an 86-88 stang, you'll have to use the test lamp or voltmeter method. There is no functional check engine light on the 86-88's except possibly the 88 model Cali Mass Air cars.

Codes have different answers if the engine is running from the answers that it has when the engine isn't running. It helps a lot to know if you had the engine running when you ran the test.

Trouble codes are either 2 digit or 3 digit, there are no cars that use both 2 digit codes and 3 digit codes.

For those who are intimidated by all the wires & connections, see http://www.actron.com/product_detail.php?pid=16153 for what a typical hand scanner looks like. Normal retail price is about $30 or so at AutoZone or Wal-Mart.

Or for a nicer scanner see http://www.midwayautosupply.com/detailedproductdescription.asp?3829 – It has a 3 digit LCD display so that you don't have to count flashes or beeps.. Cost is $35.

Find and fix the coded items and that will clear many problems.

So far I have the common items that cause most problems:
1.) Dirty or defective IAB (or IAC) - clean or replace IAB. Some TB's are coated and are marked "Do not clean". If they have no markings, spray them down & use a toothbrush to do the tough places that refuse to come clean. Spray some more and wipe up the mess with a paper towel. The rest will go through the engine with no problems. The stalling when an engine is first cranked up or cold is a clue to a non-functional IAB.

First of all, the idle needs to be adjusted to where the speed is at or below 600 RPM with the IAC disconnected. Then the current through the IAC can vary the airflow through it under computer control. Remember that the IAC can only add air to **increase** the base idle speed set by the mechanical adjustment. Remember that changing the mechanical idle speed adjustment changes the TPS setting too.

The IAC depends on the computer to provide a ground to make the IAC work. Bad wiring, dirty connections or a failed IAC circuit inside the computer can keep the IAC from adjusting the idle like it should.

IAC doesn't work: look for +12 volts at the IAC red wire. Then check for continuity between the white/lt blue wire and pin 21 on the computer. The IAC connector contacts will sometimes corrode and make the IAC not work. The red wire on the IAC is always hot with the engine in run mode. The computer provides a ground for the current for the IAC. It switches the ground on and off, making a square wave with a varying duty cycle. A normal square wave would be on for 50% of the time and off for 50% of the time. When the idle speed is low, the duty cycle increases more than 50% to open the IAC more. When the engine speed is high, it decreases the duty cycle to less than 50% to close the IAC. An old-fashioned dwell meter can be used to check the change: I haven't tried it personally, but it should work. In theory, it should read ½ scale of whatever range you set it on with a 50% duty cycle. An oscilloscope is even better if you can find someone who has one and will help.

2.) Defective TPS - replace TPS. An idle that sticks high and won't come down unless you turn the key off & restart the engine is a sign of a bad TPS.

Try this... Currently there is some dispute about the effectiveness of setting it at .99 volts, but anything less is probably OK. All you need is less than 1.0 volt at idle and more than 4.25 at Wide Open Throttle (WOT). You'll need a good Digital Voltmeter (DVM) to do the job.

The Orange/White wire is the VREF 5 volts from the computer. You use the Dark Green/Lt green wire (TPS signal) and the Black/White wire (TPS ground) to set the TPS

Here's a TPS tip I got from NoGo50

When you installed the sensor make sure you place it on the peg right and then tighten it down properly. Loosen the back screw a tiny bit so the sensor can pivot and loosen the front screw enough so you can move it just a little in very small increments. I wouldn't try to adjust it using marks. Set it at .97v-.99v, the closer to .99v the better.

(copied from MustangMax, Glendale AZ)

1.) Always adjust the TPS and Idle with the engine at operating temp. Dive it around for a bit if you can and get it nice and warm.

2. When you probe the leads of the TPS, do not use an engine ground, put the ground probe into the lead of the TPS. You should be connecting both meter probes to the TPS and not one to the TPS and the other to ground.

3. Always reset the computer whenever you adjust the TPS or clean/change any sensors. I just pull the battery lead for 10 minutes.

4. Check the procedure for your year, on my 90 I have to turn the idle screw until it just touches the tab, then insert a .010 feeler gauge and give it about one more turn. Then you adjust the TPS voltage to .98v, reset the computer. Start it up, if the idle is to low then turn the screw in until it is just right, then readjust the TPS voltage to .98v and reset

the computer and start it up. The key is to adjust the TPS voltage and reset the computer whenever the idle screw is changed.

3.) Vacuum leaks - locate & replace leaky gaskets & hoses. Spend $8 or so at the auto parts store for enough various sizes and lengths of vacuum hose to replace all the vacuum lines. The hard plastic lines get brittle over time and will crack and leak. See http://www.veryuseful.com/mustang/tech/engine/images/mustangFoxFordVacuumDiagram.jpg and http://www.veryuseful.com/mustang/tech/engine/images/88Stang5.0Vacuum.gif for vacuum diagrams. The carbon canister plumbing is often damaged or missing, causing vacuum leaks. The big hose coming from the bottom of the upper manifold and going to the front of the engine is for the carbon canister.

To find vacuum leaks around bolted joints, use motor oil in a squirt can. When you find a leak, the oil will be sucked and the engine speed will change. The oil is messy, but works great and will not pose a flash fire hazard. Avoid using flammable fluids like carb cleaner or propane gas – flash fires are not pretty and are very hazardous to your health.

4.) Bad O2 sensors or bad or missing O2 sensor ground - replace o2 sensors and check the ground wire. The ground comes out of the fuel injection wiring harness & is a orange wire with a ring terminal on it. After 60 K miles of usage, the O2 sensors are generally on the downhill side of things.

Because the oxygen sensor generates its own voltage, never apply voltage and never measure resistance of the sensor circuit. To measure voltage signals, use an analog voltmeter with high input impedance, at least 10 megohms. Remember, a digital voltmeter will average a changing voltage Here's a tip: the newer the sensor, the more the voltage changes, swinging from as low as 0.1 volt to as much as 0.9 volt. As an oxygen sensor ages, the voltage changes get smaller and slower - the voltage change lags behind the change in exhaust gas oxygen.

Measuring the O2 sensor voltage at the computer will give you a good idea of how well they are working. You'll have to pull the passenger side kick panel off to gain access to the computer

connector. Remove the plastic wiring cover to get to the back side of the wiring. Use a safety pin or paper clip to probe the connections from the rear. The computer pins are 29 (LH O2 with a dark green/pink wire) and 43 (RH O2 with a dark blue/pink wire). Use the ground next to the computer to ground the voltmeter. You can expect to see the voltage switch from .2 volt to .6 volt on the average O2 sensor. More voltage swing is good, less voltage swing is bad.

5.) Insufficient voltage at idle - reduce electrical load, replace or upgrade alternator. Use a good Digital Voltmeter (DVM) to measure the voltage. At 1000 RPM you should see 13.8 – 14.2 volts on a warm engine. Keep in mind that at 650-725 RPM, the output will be less, and may be below the 13.2 volts required to keep the battery charged. This is not good and can cause problems: underdrive pulleys may aggravate the situation.

6.) Dirty 10 pin wiring connectors or damaged wiring going to/from the 10 pin salt & pepper shaker wiring connectors. See http://www.veryuseful.com/mustang/tech/engine/images/TPS_IAB_Pic.jpg for the 10 pin connector locations. See http://fordfuelinjection.com/images/harness02.gif / for the wiring inside the 10 pin connectors. Clean the 10 pin connectors with electronic parts cleaner or non-inflammable brake parts cleaner (same stuff in a bigger can and cheaper too).

7.) Dirty or defective MAF element: Clean or replace the MAF element. Disconnect the MAF and start the car. If the idle smooths out, then proceed from here. Keep in mind that this does not work on every car.

The MAF element is secured by 2 screws & has 1 wiring connector. To clean the element, remove it from the MAF housing and spray it down with electronic parts cleaner or non-inflammable brake parts cleaner (same stuff in a bigger can and cheaper too).

The MAF output varies with RPM which causes the airflow to increase or decease. The increase of air across the MAF sensor element causes it to cool, allowing more voltage to pass and telling the computer to increase the fuel flow. A decrease in airflow causes the MAF sensor element to get warmer, decreasing the voltage and reducing the fuel flow. Measure the MAF output at pins C & D on the

MAF connector (dark blue/orange and tan/light blue) or at pins 50 & 9 on the computer.

At idle = approximately .6 volt
20 MPH = approximately 1.10 volt
40 MPH = approximately 1.70 volt
60 MPH = approximately 2.10 volt

Check the resistance of the MAF signal wiring. Pin D on the MAF and pin 50 on the computer (dark blue/orange wire) should be less than 2 ohms. Pin C on the MAF and pin 9 on the computer (tan/light blue wire) should be less than 2 ohms.

There should be a minimum of 10K ohms between either pin C or D on the MAF and ground.

See the following website for some help from Tmoss (diagram designer) & Stang&2Birds (website host)

http://www.veryuseful.com/mustang/tech/engine/images/fuel-alt-links-ign-ac.gif

http://www.veryuseful.com/mustang/tech/engine/images/88-91eecPinout.gif

http://www.autozone.com/servlet/UiB..._us/0900823d/80/19/59/5a/0900823d8019595a.jsp

8.) MAF meter on CAI system that needs clocking or protection from engine compartment air turbulence. A cone type filter located inside the engine compartment is almost sure to have surge problems due to the turbulent airflow around it. Try cleaning the MAF element & then "clock" the MAF by rotating the entire MAF housing to see if changing its position helps any.

9.) Clogged fuel filter, damaged fuel lines or dirty fuel pump sock. Poor fuel delivery will cause severe problems.

10.) Bad grounds in a computer controlled engine will make all sorts of strange problems.

The secondary power ground is between the back of the intake manifold and the driver's side firewall. It is often missing or loose. It supplies ground for the alternator, A/C compressor clutch and other electrical accessories such as the gauges. **Any car that has a 3G alternator needs a 4 gauge ground wire running from the block to the chassis ground where the battery pigtail ground connects.**

The computer has its own dedicated power ground that comes off the ground pigtail on the battery ground wire. Due to it's proximity to the battery, it may become corroded by acid fumes from the battery. It is a black cylinder about 2 1/2" long by 1" diameter with a black/lt green wire.

All the sensors have a common separate ground. This includes the TPS, ACT, EGE, BAP, & VSS. This ground terminates inside the computer, but still uses the computer power ground as its source. See http://www.fluke.com/application_notes/automotive/circuit.asp?AGID=1&SID=103#volt for help troubleshooting voltage drops across grounds

11.) Dirty or defective ECT and ACT sensors. Look for codes 21, 24, 51, and 54 when you dump the codes. The ACT sensor will get coated with gunk over time and may need to be cleaned.
ACT & ECT test data:

The ACT & ECT have the same thermistor, so the table values are the same

Pin 7 on the computer - ECT signal in. at 176 degrees F it should be . 80 volts

Pin 25 on the computer - ACT signal in. at 50 degrees F it should be 3.5 volts. It is a good number if the ACT is mounted in the inlet airbox. If it is mounted in the lower intake manifold, the voltage readings will be lower because of the heat transfer. Here's the table :

68 degrees F = 3.02 v
86 degrees F = 2.62 v
104 degrees F = 2.16 v

122 degrees F = 1.72 v
140 degrees F = 1.35 v
158 degrees F = 1.04 v
176 degrees F = .80 v
194 degrees F = .61

Ohms measures at the computer with the computer disconnected, or at the sensor with the sensor disconnected.
50 degrees F = 58.75 K ohms
68 degrees F = 37.30 K ohms
86 degrees F = 27.27 K ohms
104 degrees F = 16.15 K ohms
122 degrees F = 10.97 K ohms
140 degrees F = 7.60 K ohms
158 degrees F = 5.37 K ohms
176 degrees F = 3.84 K ohms
194 degrees F = 2.80 K ohms

12.) Defective PCV. The PCV is almost impossible to see unless you have the engine out of the car, have the intake manifold off, or you are a snail & have an eyeball on a stalk.

The PCV fits in a rubber grommet that plugs in the block at the rear of the lower intake manifold. The rubber grommet is notorious for not fitting tight or sealing like it should. It connects to the upper manifold by a 3/8" vacuum hose coming from the rear of the upper intake manifold. The easiest way to find it is to follow the hose with your hand and pull it out of the rubber grommet. Check the screen below the PCV while you have it & the grommet out if you can get to it.

13.) Mismatched MAF and injector size. The MAF must have a matching flow rating for the injectors. If you have 24 lb in injectors, you need a 24 LB MAF. The Cobra computer is the exception to this rule, since it uses a 19 LB MAF & internal tables to modify the fuel curve. Some aftermarket devices can modify the mismatch, but they are not very common.

Now for some fixes courtesy of those who have made suggestions that worked for them.There were a lot of good ideas, but I only have a limited amount of space. These are some of the highlights...

Idle bypass plates - they work for some, don't for many. The idle bypass plate fits between the IAC and the throttle body and allows a screwdriver adjustment of the idle air. A side benefit is that it adjusts the idle air without changing the mechanical settings. This keeps you from having to re-set the TPS voltage settings every time you make an adjustment. Here is a link to mustangs unlimited. "Idle Adjustment Plate". http://www.mustangsunlimited.com/it...y=&catkey=74-01 or from your local Ford dealer, use #f2pe-9f939-aa as the part number for the idle air adjuster

***From dwhiskie and Hissin50**: I mounted my aftermarket IAC upside down, no more surge.*

Ranchero5.0's comments on engines with other than stock cams:
A little dragon slaying lore here:

99% of the time on a cammed car opening up the divider between the ports on the IAC with a dremel so the motor idles at 1000rpm with the IAC unhooked, the throttle plate shut and the TPS at .98vdc fixes all surge related problems. Found about to do that on my '93 with a very mild cam and good induction it didn't like idling below 900rpm. The IAC can't react quick enough to a lopey cam induced RPM fluctuation so instead of dampening the surge it increases it. Every E cammed car I've ever worked on needed this to keep a stable idle. Similar to Fords idle bypass plate without the cobbled look.

just dremel out a little at a time till it idles around 1k. In my experience the stock puter doesn't like to idle a cammed car down low.
Here are a couple quick pics of an IAC with the port mod sitting next to a stocker and the air die grinder I do it with.

If that doesn't do it check the 12vdc to the heater on the O2's. One smack of wiring on headers wipes out the fusible link hidden in the wiring on the engine side of the firewall where the main puter harness goes through. This will cause the o2's to slowly go out of tolerance and the puter flips out. check this if the car's running really rich a idle too. Ranchero got nailed when first installed and the '93's done it too.

I actually ended up soldering on a stereo inline fusible link and installing a 20a fuse to make the repair quicker.

For an elaboration on the o2's. The two white wires on the o2 sensor are for a the o2 heater. Without them working ,especially on long tubes the o2's cool off at idle and slow cruise and stop working correctly and the puter flips out. Use a paper clip or two and check for 12dvc between the two wires. No voltage, no heaters. Ford actually made a change and put the fusible link on the outside of the harness in the early 90's

More to come as I get time...

Jamie

From Snake1
If you have R12 in your A/C you might want to check the charge on your A/C.
Low Charge = hunting idle Only possible if the hunting idle only happens when the A/C is on.
unplug your compressor and see if it makes a difference.
did with my 88 GT and it went to a steady 650 RPM.

From ArtMan with a supercharged 5.0

One other cause of a surging idle that may have already been addressed (I didn't read every post of the past 5 pages) is one that afflicts supercharger owners.

After installing your Vortech you may find that the engine won't idle correctly. If you are able to rule out the other causes noted above, you should verify the crankcase is vented properly. This doesn't effect all sc owners the same, but be assured its an annoying problem.

The nipple at the oil filler can suck in air at idle. If this happens air is ingested into the combustion chamber that is not metered by the MAF. An erratic or sticky high idle results. When Vortech first sold their kits they had you run a hose to the filter "area". Now they include bosses so you may run a hose from that nipple to the intake elbow that fastens to the compressor. Since I own an older kit I had to order the updated elbow special.

But it cured my surging idle instantaneously and the car runs like silk (even with my cam)

From garystocker:
I had an idle of 1500rpm. And an occasional surge. Stayed that way until I disconnected the throttle cable! Idled right down!!

I pulled the cable backwards out throught he maze of vacuum lines and rerouted it in a nice sweeping way...Perfect idle. No surge. No 1500rpm. Bliss!

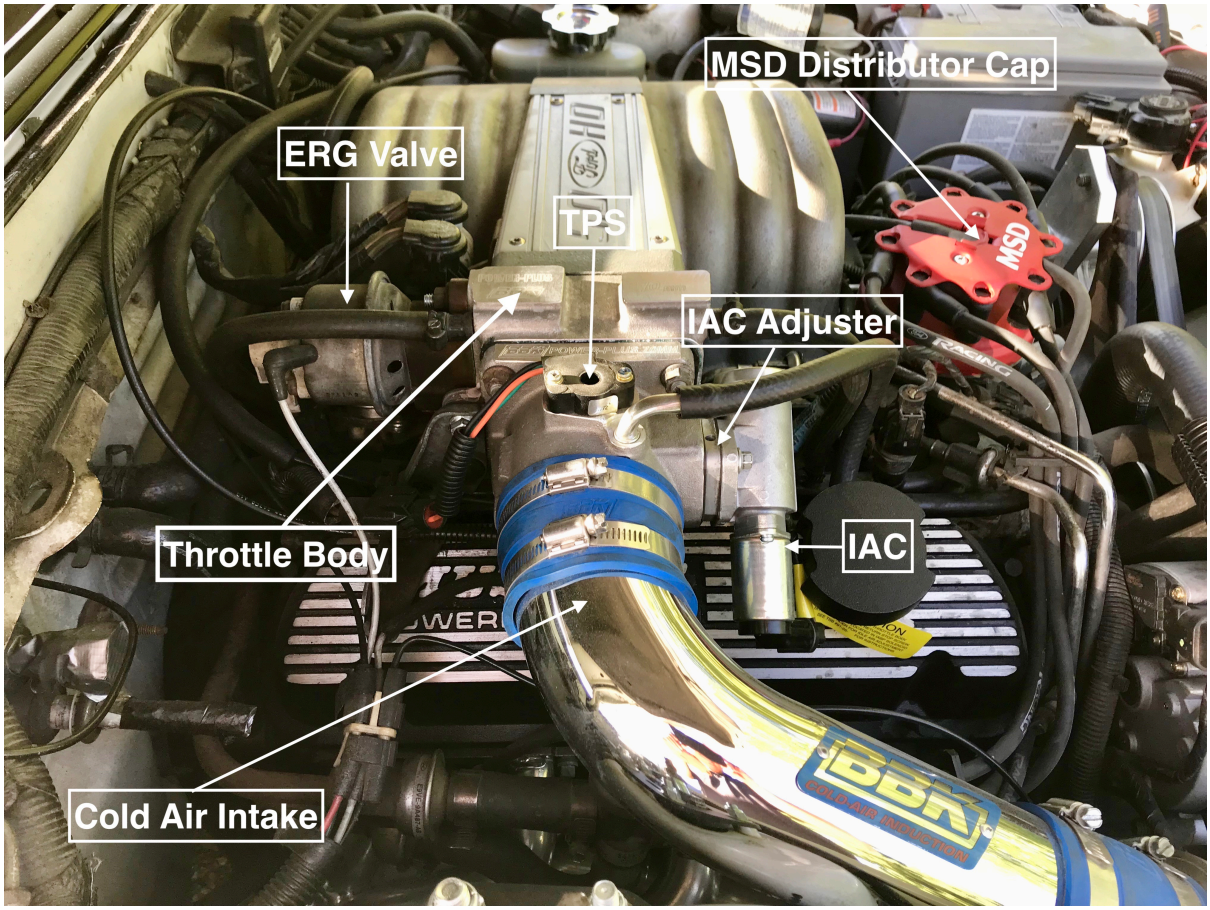


Photo by Mr. Fox

Idle Issue Trouble Shooting Guide

Cars need maintenance, there's no question about that. And when it comes to older cars and classics, well in many cases, they need even more maintenance, having at some point suffered from the ravages of neglect. And today many cars from the '80s fall into this category. Too new to really be considered coveted and yet old enough that they've likely gone through several owners, they're prime candidates for affordable wheels. Take 5-liter Mustangs. Today you can still net yourself a decent one for under $5,000, but chances are it needs some help. One of the most common problems is likely a rough running or poorly idling engine. The purpose of this article is to highlight some of these common problems and how to fix them, so your mighty "Five-Oh" runs just as good, if not better than it did during the Reagan/Bush Sr. years.

Idle Air Control

Perhaps one of the biggest issues, not to mention the most common problem to a stumbling SEFI 302 Mustang engine concerns the Idle Air Control valve; that governs the car's engine speed when it's stationary. Mounted on the throttle body spacer on 1986-1993 Mustangs and the back of the intake on 1994-1995 cars, it incorporates a valve that opens and closes, a bit like a flapper device to control said engine speed. The IAC is linked to the car's EEC-IV engine computer via an electrical connector and the computer is able to monitor, through its other sensors, how much to open and close the valve, depending on outside temperature and engine temperature when the car is at idle. However, as the years go by and the car is driven more and more miles, carbon deposits, a by-product of poor quality fuel that's burned and then reburned through the car's emissions control system, can settle on the valve, clogging it up. As a result it cannot open or close properly, which affects the engine speed, causing idle surge. By disconnecting the negative battery cable, then the IAC from the harness and removing the throttle body and unscrewing the IAC from the T-B, you can give it a good cleaning by delicately spraying carburetor cleaner into the valve. If the IAC is the problem, then once it is cleaned and restored, the car should run much better.

Throttle body

However, in most cases, if the IAC is clogged then there's a good chance the throttle body is too. On 5-liter cars the throttle cable, via the gas pedal, directly opens and closes a plate inside the throttle body – the further it opens the greater the air volume and engine speed. If the IAC is clogged and the throttle body can't close all the way, chances are the engine will be revving and stumbling at idle, because the valve can't control the idle speed and the throttle body will be sticking. So every time you hit the gas with the car in gear, it will stumble and in some cases stall out. On 1986-1995 5-liter Mustangs, the throttle body is secured with just four bolts and sealed with a gasket. It's easily removable for cleaning. On 1986-1991 models you can use general carburetor cleaner to get rid of the deposits, on 1992 and later models, which use a slightly different stock throttle body with ceramic coating, make sure you use a throttle body/carb cleaner that's formulated for use on coated T-Bs, since some traditional carb cleaners, because of the solvents contained within them, can damage the inside surface of the throttle body, which will cause further problems.

PCV Valve

If you've addressed the above problems and the car is still having trouble idling or running properly, it's time to look at the emissions controls. The first point is the Positive Crankcase Ventilation valve, which funnels unburned hydrocarbons (exhaust fumes), back into the intake manifold where they can be burned off again, reducing emissions. After about 40,000 miles, the valve can become clogged, but it's cheap and easy to remove and replace. It's located on the back of the engine, on the right side below the upper intake plenum.

Thick Film Module

First introduced on Mustangs for 1984, Ford's Thick Film Ignition system is a staple part of every SEFI 5-Liter. However, it can be problematic. An electronic module, mounted on the distributor shaft is linked to the computer via a wire extension that links up to the main harness and is responsible for controlling the spark on these engines. However, like most modules, it likes to operate in a certain temperature range (up to around 275 degrees F), beyond that heat affects its ability to operate and it can simply cut out. So, all of a sudden, you can be driving along the road and the car stalls out and then won't start. However, depending on how much heat damage has been done, sometimes the engine will start again once it's cooled down. Ford tried to get around the problem by fitting a rubber boot over the distributor to keep temperatures down, but it was barely adequate in most cases. If your Mustang experiences this problem, i.e. it will start when cold, but then dies when warmer, replace the TFI module with a new Ford Motorcraft unit (aftermarket versions generally aren't as durable). Some Ford enthusiasts joke that they always keep two TFI modules handy, just in case one goes bad!

TFI Coil

The actual coil for the TFI system can also cause problems. Over time, due to heat and age, it isn't able to step up the voltage from the battery, to provide adequate spark to fire the engine. Each time the coil operates it more than doubles the voltage in the car's electrical system in order to provide adequate voltage to crank over that big V-8. However when this happens, energy is depleted and much like a battery, it will eventually fail. In these cars the coil is mounted on the left side inner fender and can be easily replaced. Also check the top of the coil where it meets the coil/distributor wire, on cars that have been sitting for extended periods, this can corrode, affecting the coil's operation. Use a wire brush to clean

the rust off the top of it. Installing a higher capacity coil is often a good suggestion, especially if you plan on modifying the car (if it isn't already). Good options are available from MSD, Accel and Mallory.

Ignition Wires/Distributor

Plug wires are designed to transport the energy generated by the coil, to the spark plugs, in essence, they're electricity conductors. Like most ignition parts, heat is a big enemy of spark plug wires. Over time, heat causes the composition of the wires to break down, which affects their ability to efficiently conduct energy from the coil, since electricity is always looking for the path of least resistance. As a result this can cause arcing, which can make the car hard to start, or causes it to repeatedly stall, especially when the engine is cold. As they age, plug wires also give off greater Electromagnetic Interference, which causes radiation and affects operation of sensors like the MAP, TPS and even the hotwire MAF sensor, causing further driveability problems. Replacing your plug wires is cheap insurance, but remember, if the car is street driven, high output inductive wires, which are able to provide a longer spark for greater cranking power and smoother running, are a good suggestion. Another good idea is to check the underside of the distributor cap and the condition of the fittings. Original OE Ford Motorcraft caps use brass fittings, but over time these can corrode, increasing EMI and resulting in an engine that is both hard to start and runs poorly. Additionally the cap itself can crack, allowing moisture to enter the distributor, shorting out the electrical current, which will cause similar problems. The rotor arm is also a common failure point, since the tips can corrode, increasing electrical resistance and making the car harder to start. It's easier to replace the arm than trying to clean it.

Plugs

One other common area concerns the spark plugs. Like any other part of the Mustang's ignition system, the electrodes on the plugs wear over time and need replacing. The more times energy is expended in firing the engine, the more heat passes through the electrode. Over time the plug gap tends to increase, which along with carbon deposits from burning the fuel, makes it harder for the plugs to fire the engine, since the electrical resistance is now much greater. On cars equipped with electronic fuel injection, like our 5-liter Mustang, old or worn plugs; will often cause the computer to add extra fuel to start the engine when cold. This not only fouls the plugs (by coating them in gasoline), but can also cause problems with the car's emissions control system, specifically the

Oxygen sensors and catalytic converters. What results is an engine that runs rough and frequently stalls. Fouled plugs can be identified by a thick black coating around the base of the electrode, a result from too much fuel being dumped into the combustion chamber. A spark plug with normal wear, should display a slight grey, or red/brown coating at the base. Even if you've just bought the car, it's a good idea to change the plugs anyway. On 5-liter engines, replacement plugs should be gapped at .45 of an inch when installed on a relatively stock engine.

Catalytic converters

Another problem on these cars, concerning rough running can be attributed to the car's H-pipe system. From the factory, 5-liter Mustangs came with four catalytic converters, two pre-cats, mounted up stream and two main ones. An air injection system, that runs all the way from the smog pump, to just ahead of the main converters is also incorporated, as are two Oxygen sensors that relay the amount of O2 in the exhaust system and send voltage signals back to the EEC-IV processor so it can adjust the air/fuel mixture accordingly. The two pre-cats were largely incorporated to warm up the sensors as quickly as possible in order, to achieve the optimum air fuel ratio (13:1-14:1) and hence reduce both fuel consumption and emissions. However, over time the converters can become clogged, often due to extensive stop/start driving, lack of use, poor quality fuel or infrequent engine tune-ups. Clogged converters increase the exhaust backpressure, which causes the engine to run poorly and frequently stall. Eventually the internals of the converters can collapse entirely. You'll likely notice this by a rattle, especially when the car is at idle. Sometimes the oxygen sensors can become coated in carbon, which, much like the MAF sensors, doesn't allow them to accurately monitor the level of oxygen in the exhaust, which causes the computer to add too much or too little fuel. If that's the case, you're best option is to replace them.

Because it's been 15 years since the last 5-liter Mustang was produced, the supply of new, factory replacement H-pipes have become very limited in recent years. Thus a good option, if your factory H-pipe is tired, is to invest in a replacement H-pipe with dual high-flow converters, which further reduces backpressure, even over a stock system in good order. These are widely available through the aftermarket, with Bassani, BBK and MAC Products offering some good quality options.

Fuel system

Yet another possible cause of rough idling and stalling can be related to the fuel system, specifically the electric tank-mounted pump. This uses a pick up device mounted in the tank to draw fuel and pump it to the rails and injectors via a main line and approximately 45 psi, controlled by a pressure regulator. The excess fuel is then returned back to the tank via a secondary line. The pump's factory flow capacity is rated at approximately 88 liters per hour, but over time, this can drop, resulting in erratic fuel delivery and a rough running engine. Because the fuel in the tank also cools the pump, if a past owner has run the car dry on numerous occasions, the pump is more likely to overheat and fail. Generally the pumps start to deteriorate every 10 to 12 years. So, if your Mustang is proving hard to start and the idle noticeably dips and soars, regardless of whether the engine is hot or cold, check the fuel pump. Larger capacity pumps, 110 and 190 lph units are a good option on stock, or mildly modified 302s. Removing the pump on these cars simply requires disconnecting the electrical feed at the back of the car, unfastening the two tank straps, dropping the tank and pulling out the pump assembly. Make sure you use a brass instrument to undo the lock ring (to prevent any spark).

Another aspect that can affect fuel delivery is a clogged filter. On 5-liter cars the filter is encased in a metal bracket in front of the gas tank. Remove the filter and give it a good shake. If you hear rattling, it needs replacement.

Although generally not a common problem by any means, sometimes leaking fuel injectors can also cause idling issues. If you smell fuel in the engine bay while the car is running, it might be a crack in one of the injectors or a bad O-ring. It can also be the fuel rail coupling. On early SEFI 5-liter cars, the rail coupling was a notorious weak spot and fuel could puddle onto the intake manifold and exhaust, sometimes even causing fires. These were subject of a recall, so if you can, run your car's VIN to see if was subject to a recall and the problem has been addressed. Believe it or not, there are still some cars out there that haven't received this fix.

EGR Valve

Crucial to the proper operation of the 5-liter's emissions control systems, the Exhaust Gas Recirculation Valve, mounted on the back of the throttle body spacer (1986-1993 Mustangs) or intake (1994-1995), funnels

unburned hydrocarbons from the exhaust manifolds back into the combustion chambers to burn them off and reduce emissions. The valve is linked to the EEC-IV computer by a harness connector with a sensor to monitor exhaust gas flow (Delta Pressure Feedback), and various vacuum lines that run to the intake manifold, oil breather and plumbing from the smog pump to the back of the lower intake that incorporates a regulator and down into the air injection system that links up with catalytic converters (on 1994-1995 Mustangs there's a pipe directly from the valve to the right side exhaust header). If there's a problem with the EGR system, the first place to look, should be the vacuum lines. Bearing in mind that most of these cars are approaching 20-plus years in age, if the lines haven't been replaced, chances are they're brittle and at least one of them is cracked. When the engine is running, increase the idle speed and listen for a hissing sound coming from the back of the intake manifold. If you hear it, chances are you've got a vacuum leak.

If you have one or have access to one, you can also use a scan tool to check actual operation of the EGR valve itself. If the scan tool detects an error code, then it's likely that the DFP sensor has gone bad and will need to be replaced. Also inspect the tubing that runs from the exhaust manifold to the EGR as sometimes this can get clogged, restricting flow, which will cause a driveability issue. You'll be able to identify this by running the engine and then disconnecting the tube from the EGR. If you can't feel any vacuum pressure and the engine idle doesn't change, there's a clog somewhere in the system, as normally a leak in the EGR system, with exhaust gas still recirculating, will cause the engine to run rough. However, in most cases the EGR rarely fails, so if the car is running poorly, check the other problem areas mentioned in this article first.

SPEED DENSITY or MASS AIR

While it might not be an issue directly relating to the metering on your car that's causing the idling or stumbling problem, it's a good idea to have a basic understanding of what system your car runs, as both the Speed Density and Mass Air systems on these cars can have their own set of issues.

SPEED DENSITY

When Ford decided to install sequential fuel injection on the 1986 Mustang 302 V-8 it made enough changes to almost qualify it as a brand

new engine. Air was fed in through a square-shaped filter housing on the right side of the engine bay, up through a tube into the throttle body, mounted in front of a two-piece intake plenum. Just behind the throttle body was an idle air control valve and throttle position sensor. Mounted behind the intake plenum on the firewall was a Manifold Absolute Pressure sensor, which monitored engine speed and air density entering the plenum and sent the readings to the car's Electronic Engine Control (EEC-IV) computer, which along with data from the oxygen sensors, manifold pressure and throttle position sensor, would then consult its own internal look up tables and select the amount of fuel to deliver. In these Mustangs, eight individual injectors operating in sequence, squirted fuel into the combustion chambers under high pressure (around 45 psi). This system was called Speed Density, because it used the engine's turning speed and airflow, to determine the amount of fuel required to maximize power, fuel economy and emissions (generally between 13:1 to 14:1 parts air relative to fuel).

However, the problem with the Speed Density system used in these cars; was that it was rather basic. The computer was designed to operate the engine based on a set of fairly narrow pre-determined parameters, i.e. factory power and torque. Now while it's able to fairly accurately measure the airflow and calculate fuel delivery based on those readings, it doesn't take much to confuse the computer. In addition there are no cold or hot wire sensors placed directly into the air intake stream, so the computer cannot precisely measure the volumetric efficiency of air entering the engine, nor the temperature of that air. As a result, it can be more accurately described as assuming the required fuel load rather than precisely calculating it, which means even the smallest changes outside its regular operating parameters can cause driveability problems.

MASS AIRFLOW

Unlike a Speed Density setup, Mass Airflow incorporates two wires mounted directly in the engine's air intake path. Using voltage, one wire measures the ambient temperature of the air (cold wire), the other (hot wire) is designed to maintain a temperature that is constantly 200 degrees F hotter than the cold wire and read the airflow rate. Because the rushing of the air into the engine cools both wires, it triggers voltage from the wires back to the engine computer. From this information, the EEC-IV processor is then able to accurately measure the air and add the required amount of fuel based solely on the engine's volumetric efficiency (airflow). If you've ever driven a stock MAF equipped 5-liter

Mustang (1988 and newer California, 1989 and newer everywhere else), you'll have also noticed it idles a lot smoother than a Speed Density car. Also, because the MAF system doesn't rely on the manifold absolute pressure sensor, (it becomes a Barometric sensor on these cars) to help maintain the correct air/fuel ratio and the computer MAF equipped 5.0s tend to suffer less from erratic idling.

SPECIFIC PROBLEM AREAS

If you own or are looking at buying a Speed Density equipped Mustang (1986-1987, 1988 (non California) and it's running rough, one specific problem area concerns the vacuum line running from the Manifold Absolute Pressure sensor to the intake. Considering that these cars are well over 20 years, old, chances are, if the hoses haven't been replaced they'll be brittle. Even the smallest leak can cause the engine idle to surge and even the car to stall, since the computer can't accurately read the airflow from this sensor to deliver the required amount of fuel. If the engine is running, open the throttle and listen for a hissing sound at the back of the manifold, if you hear it, the hoses need to be replaced.

On MAF cars, a specific idling issue can often be traced to dirty sensor tips in the MAF unit (the hot and cold wires). If the car is equipped with a dirty or an aftermarket high flow filter that's coated in oil, some of that residue will eventually find its way up the inlet track and coat the wires. Dust and all other manner of objects can then attach to the oil or residue, which prevents the wires from accurately measuring the airflow, so the computer can't read the VE correctly and can't deliver the precise amount of fuel. Generally this problem seems to affect the 1994-1995 5-liter cars, more than the earlier ones. To fix the problem, simply remove the MAF unit and use a small dose of carb cleaner and delicate wire brush to clean the tips of the sensor, before reinstalling it back on the car.

Acknowledgements: Special thanks to Joe Da Silva and Rob Cohelo at Da Silva Racing www.dasilvaracing.com.

This neglected 1989 Mustang was purchased for less than $3,000. It had numerous problems, including a rough running engine.

One of the most common issues causing a poor idle, is a clogged idle air control valve. On 5-liter Mustangs; it's located by the throttle body on the right side of the engine by upper intake manifold, illustrated to good effect on this modified car.

Here's a sample of common components that can often be the cause of a poor idling or rough running engine – from right to left (clockwise) Mass-Air Meter housing, fuel rail, distributor, injectors, MAF meter, fuel pump, TFI module and ignition coil.

A very common issue, even if the car is relatively well maintained can be vacuum hoses. Considering the age of most 5-liter Mustangs, it's a good chance that one or more of the hoses has cracks, allowing vacuum air to escape, which will cause rough running.

Here the EGR hoses are inspected. The EGR is major part of the car's emissions control system and spent exhaust fumes are funneled through the valve, back into the combustion chamber where they're reburned to lower exhaust emissions. If the gas can't circulate properly, vacuum pressure is lost and the engine stumbles

Another problem; can be a worn distributor cap or rotor. Generally, the Motorcraft distributors and related parts are very reliable, but worn contacts can cause arcing and electromagnetic interference, which can make the engine hard to start and even damage other sensors. Replacing the cap and rotor is cheap insurance.

On 5-liter cars equipped with Speed Density reading, air density is monitored by the Manifold Absolute Pressure sensor; mounted on the firewall. Vacuum lines run from the sensor to the intake manifold, allowing it to read the air density. If a hose splits or cracks, again vacuum is lost, the sensor can't read the airflow and the EEC-IV computer, because of its very basic programming can't deliver the correct ratio of fuel to air, causing idle surge, stumbling and loss of power under load.

A very common problem on 5-liter Mustangs and many Ford vehicles dating from the mid '80s through the early '90s; concerns the Thick Film Ignition Module on the distributor that controls the spark. It often overheats, causing the engine to cut out as it warms up. If that happens, replace it immediately.

This picture shows the BP sensor on a Mass Air equipped 5-liter Mustang. Because these cars use a mass air meter to measure airflow coming into the engine, the MAP function becomes redundant. Instead the sensor is used to measure outside Barometric Pressure and the vacuum line to the intake is removed and the hole plugged.

Here's a factory Mass Air Sensor, as seen installed on a 1989 Mustang GT. This offers a far more accurate method of measuring airflow than Speed Density and also results in a generally smoother idle. However, it can become clogged, especially if an oil-coated aftermarket air filter is installed, as seen here.

With the sensor unit removed from the car's snorkel assembly, we unscrew the MAF unit from the housing.

The MAF uses two wires, a "cold" wire, to measure the air temperature and a "hot" wire that's maintained temperature 200 degrees F hotter than the "cold" wire to measure the rate of flow via voltage. Not only is the system more accurate than Speed Density, it's far more accepting of performance modifications. However the wires are very delicate, and should be cleaned with a tiny wire brush, if they're coated in debris.

If you've checked the IAC, throttle body and distributor, it's also a good idea to pull the spark plugs and examine the electrodes, especially if you've just bought the car or it's been sitting a while.

On this particular Mustang, the plugs were showing signs of corrosion, meaning they'd been in a car, which had been sitting around for a very long time.

Clogged catalytic converters can also be another problem affecting driveability. Sequentially injected 5-liter Mustangs came with this four-cat H-pipe system from the factory. A clogged converter will increase exhaust backpressure to the point that the car will frequently stall, because the gas can't escape

Two oxygen sensors are mounted close to the front pre-converters to monitor oxygen content in the exhaust and use voltage to tell the computer to adjust the air/fuel mixture to minimize emissions. Over time, they can become clogged in carbon particles, which results in too rich a mixture and rough running.

Shown for illustration purposes is a typical late '80s/early '90s converter, containing a honeycomb catalyst. The material inside the converter can break down, clogging it up and causing the car to run rich. You can often tell if you hear a rattling sound coming from the exhaust upon start up.

Generally, the Exhaust Gas Recirculation on these cars is very reliable, but sometimes a bad sensor or clogged vacuum tubing can cause the engine to stumble and run rough, both at idle and when the car is in motion.

Scan tools and timing lights can come in very handy when troubleshooting idle problems. Many 5-liter Mustangs run advanced timing, but sometimes a loose distributor can cause rough running. Using a timing light, you can determine how much advance spark the distributor is running. If it's being done in conjunction with old plugs and poor quality fuel, it can be recipe for disaster, because the more aggressive spark and low octane fuel can cause flameouts in the combustion chamber.

Stock fuel pumps in 5-liter Mustangs tend to fail about every 12 to 15 years. If the car is hard to start, or shows a loss of power and erratic idle whether the engine is hot or cold, chances are it could be a defective pump. Direct replacements with a higher flow rate, like this Carter 110 liters per hour, are a good substitution for the stocker.

If you can, take the Mustang to a shop and get them to put it on a chassis dynometer. This will be able to show you the power and torque curves, plus the air/fuel ratio right through the rev range, helping to pinpoint exactly what's causing a driveability issue – knowing your car's actual power and torque numbers are a side benefit.

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www.federalmogul.com

Ford Racing Parts (Ignition parts)
www.fordracingparts.com

MAC Performance Products (Exhaust H-pipes)
(951) 296-3077
www.macperformance.com

Motorcraft (Ford OE replacement sensors, ignition, emissions equipment)
www.motorcraft.com

MSD (Ignition parts)
(915) 855-7123
www.msdignition.com