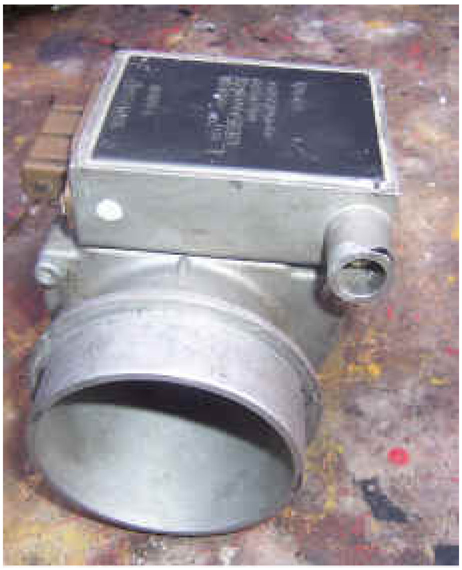


Setting the Air flow sensor.

Applicable to NON catalyst cars only. Using a voltmeter between red and black wire and blue and red wire check the voltage with the ignition on, but the engine not running. Recessed Hex head screw allows you to set the carbon monoxide base line with these voltages. NOTE these are base settings ONLY. Turn the adjustment screw clockwise to richen the mixture, and anticlockwise to lean the mixture. The screw has multiple turns, that will go from 0 volts to over 3.5 volts.

This unit has 4 connections:

Red/black. Ground

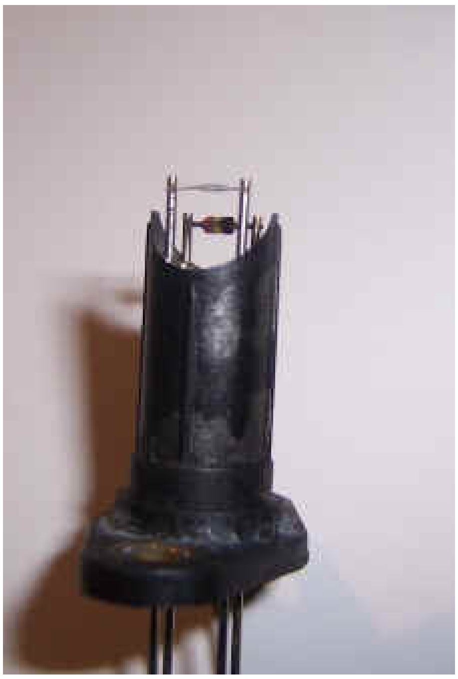
Blue/Green Air flow signal- should be .2-.7 volts (no air flow). Tick over on the 3.9 is about 1.7 volts

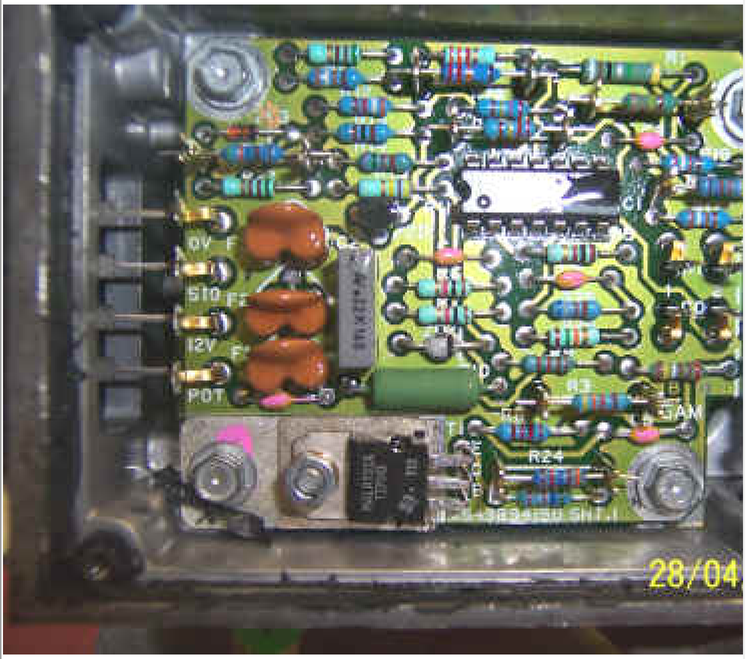
Brown Orange +12v

Blue/red CO trim value. This is factory set 1.8 volts for catalyst engines, although I believe this setting is ignored with Lambda correction. Non cat cars are in the range of 1-1.5 volts, although accurate setting will

	require the use if an exhaust gas analyzer.

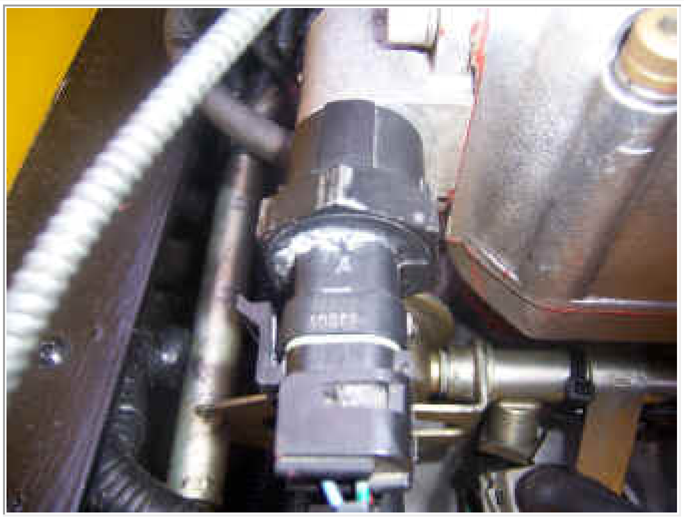
<table>
<tr><td></td><td>To test the air flow sensors output, connect the meter between the the ground (red black wire)and air flow sensor output (blue green wire). By removing the air filter and looking into the mouth of the air flow meter, a small hole will be seen in a cutout that runs around the edge of the air intake. By blowing gently into this hole the voltage should rise sharply on the airflow output. Not a scientific calibration, but a basic confidence check.

At tick over the output voltage is around 1.7 volts. This will rise to approximately 4.5 volts under full load / airflow. Peak output is 5.4 volts, but this is well beyond the range seen on the car.</td></tr>
<tr><td></td><td>This is the hot wire sensor (enlarged). The grey sensor in the foreground is the actual hot wire sensor, with a temperature sensing thermistor behind it. The hot wire can get coated in road dirt, that changes its cooling characteristics and causes the output from the AFM to be incorrect. It is difficult to clean without removal, although a blast of “easy start” or the like might be enough. Removal requires a complete strip down of the AFM</td></tr>
</table>

	to remove the electronics board. The hot wire connections are also spot welded to the PCB, and very difficult to re-solder reliably.
	This is the internal electronics module. You have to cut around the plastic cover to remove the sealant, and then remove a metal shielded plate to get this far. Electronically is pretty simple, with just a single op-amp IC to measure the output change from the hot wire itself. There are several trim resistors used to calibrate the unit, with R24 having the greatest effect. A variable resistor of 50k will allow the output to be tweaked. The variable resistor seen on the right simply connects between the "pot" connector and ground, and is used to set the mixture on the ECU. This has no effect on the operation of the AFM electronics.

Idle stabilising system and its problems.

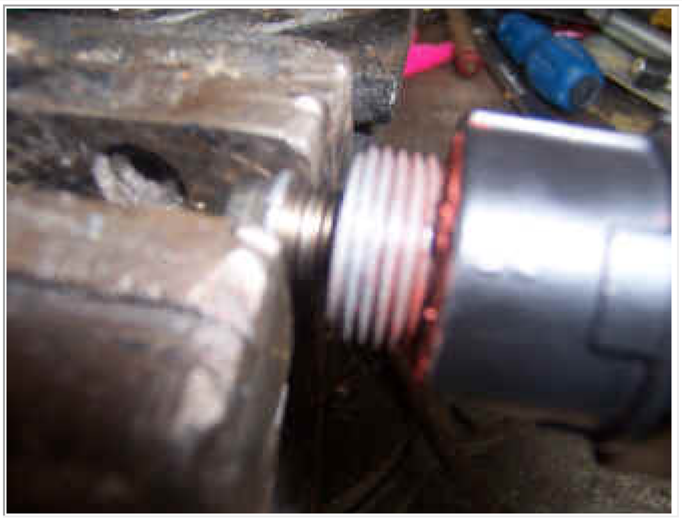
The stepper motor is always the first culprit for unstable tick over, but due to a very crude “pulse and wait” system used by the ECU to stablise the tick over, other factors like wrong CO settings, air leaks and wrong timing can cause the the engine revs to rise and fall as if the stepper motor was sticking. If you have cleaned the stepper motor shaft (as below) then look else where before replacing the stepper motor



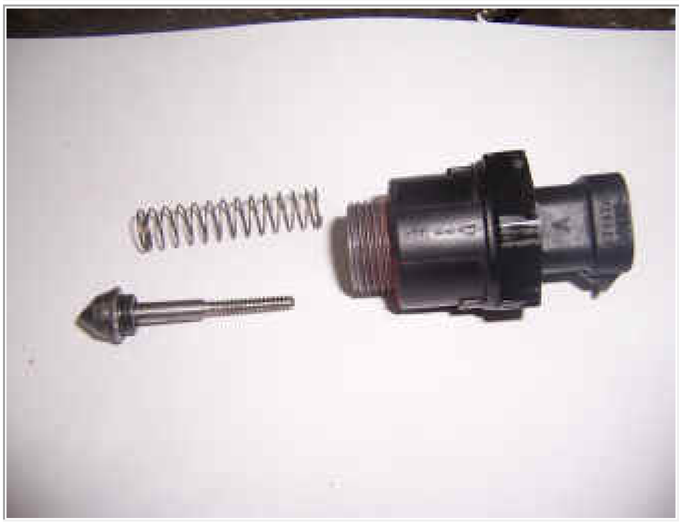
Air control valve. This comprises of a stepper motor, with a worm drive that moves a conical valve to control the amount of air by passing the throttle butterfly, and hence the tick over. Very prone to sticking, leading to erratic tick over.

Servicing the stepper motor.

Although the units appear to be sealed it is possible to strip the mechanics to clean them. The easiest option is to remove the unit, and clamp the head of conical valve in a vice. Now pull against the cone and rock the body of the stepper side to side at the same time, and with a bit of luck the cone and rod will pull out very slowly. Its on a screw thread (worm drive) so the motor has to spin as it pulls out. If it wont move, try soaking it in WD40 or the like to see if it will free. Assuming you can get the cone and shaft out, now clean the keyway and area behind the cone free of all carbon and muck. I found a bit of Chrome cleaner and a mini drill and rotary fibre brush did a good job, but you could probably use a stiff paint brush.



Clamp the cone securely, then rock the motor side to side and pull.



The component parts. Clean the cone, shaft and keyway.

Reassembly.

Firstly lightly lubricate the threaded area then refit the spring and screw the cone back into the motor, until the keyway just snags on its locating lug in the motor. Now reconnect the stepper into the car, and cycle the ignition on and off. The unit will wind the assembly back in as the ignition goes off. Disconnect and refit to the plenum chamber.

Other factors in idle control.

With erratic idle, the stepper motor is normally the first suspect, as they get fouled up with carbon, and may need a clean. If this does not cure the fault the reasons can be many fold, but some basic trouble shooting steps can help isolate the fault. Firstly the reason the engine rpm cycles up and down is due to the crude system used to control the stepper motor. The ECU will try and hold the tick over at around 800-900 rpm when the car is stationary, and if the rpm is too high, if simply fires a pre programmed series of pulses at the stepper motor to reduce the airflow into the plenum chamber. The ECU then waits for several seconds for the engine to respond, and then applies a further burst of pulses should the RPM still be wrong. In an ideal world the drop in engine RPM in these waiting seconds should be uniform and controlled. So as an example the engine is running at 1200 rpm, and after the stepper pulses are applied, it should drop to say 900 rpm in say 3 seconds, and no further correction is required. This works well enough if everything is spot on with everything in the fuel injection system, air control, and ignition, but all goes very wrong if ANY parameter is wrong.

The result of something being wrong is the RPM now drops much faster than the ECU program expects, so lets say the engine drops to near stall at 500 rpm. After the wait time the ECU rechecks the tick over and finds its too low, so winds the steeper motor back to let in more air to increase the RPM again. This may now go to high, so again the ECU tries to correct it back down and the cycle repeats itself. Typically the engine can cycle between around 500 rpm up to 2000 rpm.

To get a perfect tick over all the following conditions have to be met:

1) Correct air fuel ratio.

The ECU will get its total airflow reading from air through the AFM, and supply a relevant amount of fuel for this airflow. Problems occur if there is any air leaks anywhere in the plenum feed pipe, plenum chamber seal, stepper motor housing, stepper motor itself, vacuum pipe to fuel regulator, vacuum pipe to distributor, or a split diaphragm in the distributor advance mechanism. Everything is very sensitive, as the actual airflow through the AFM is very low at this point, and any air leaks will significantly reduce this reading so the ECU reduces the amount of fuel to the injectors. The engine then leans out and the RPM drop is rapid. This is combined with a high vacuum in the plenum chamber as the throttle plate is shut, so any small leaks in this area have a much greater effect due to the greater pressure difference.

To compound the issue, if the ECU is running the catalyst map and lambda feed back, it will then try to correct the lean mixture at tick over (although this takes over 15 seconds of running), but this correction is now distorted by the extra air getting in. basic fueling is now wrong, dependent on how bad and where the leak is.

On the non catalyst fuel map, the CO setting on the side of the AFM has a huge effect on the tick over mixture. So if during normal running the mixture is near correct, once the engine drops to the tick over range the mixture can change significantly, so again the RPM can drop faster then expected. It can be impossible to stablise an over rich mixture, as variable amounts of un burnt fuel remain in the inlet system that alters the burn properties , that will only clear once the throttle is opened, so the idle conditions constantly change.

Another area of possible fueling issues can be the fuel pressure. The pressure regulator holds fuel pressure at around 37psi above the pressure in the inlet manifold. This vacuum level is fed to a control diaphragm in the pressure regulator through a rubber pipe from the plenum chamber. If you measure the actual fuel line pressure at tick over, it may drop to say 20 psi when the throttle is closed, but will rise rapidly as you snap open the throttle. If anything in this system fails and the fuel pressure is not accurately controlled the mixture will alter from its correct values, changing the fueling.

2) Perfect ignition /burn.

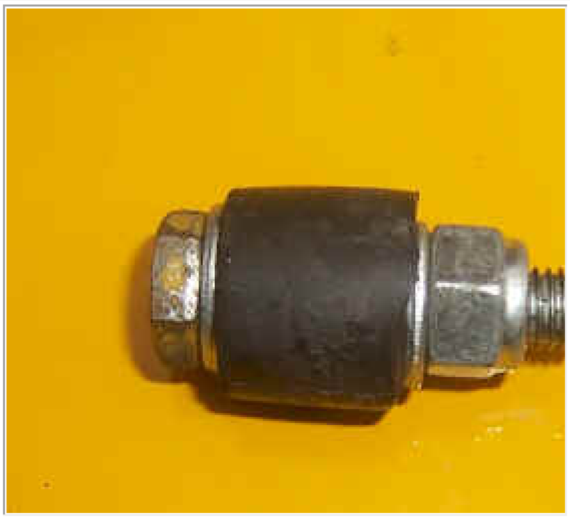
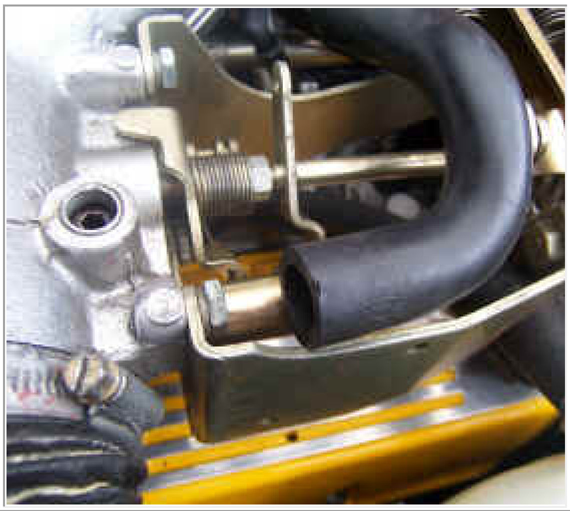
Some what statement of the obvious, but any poor performance of any ignition component, (That is HT leads, distributor cap, rotor arm, ignition amp coil, plugs, etc) could cause the engine to misfire at tick over, so the engine looses power, and the revs drop too rapidly. As the ECU applies more air and fuel, even if the spark is weak, the mixture may now burn fully, so the engines power suddenly picks up and the RPM shoots up too high. The ECU then overcompensates once more and the idle speed cycles.

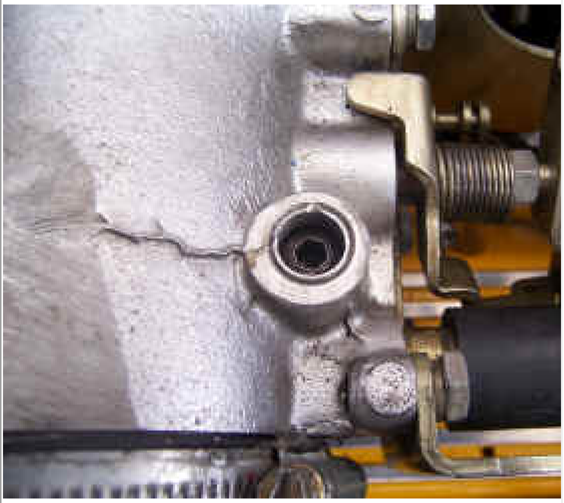
3) Ignition timing.

Although a less likely cause if the engine is running OK under load, if the distributor advance curve is not functioning correctly, (distributor bob weights , springs or shaft wear), scattered timing at tick over will cause the RPM to vary. As can be seen from the above, this is a complex control system, relying on part mechanical, and part ECU control, all working in close "harmony", until something drops out of specification.

Practical steps.

Firstly look for air leaks. Assuming none are found then try and get the engine to tick over without stepper motor control.

	Make up a sealing plug with a M6 bolt and a bit of fuel hose. Tigtening the bolt will expand the hose to provide a good seal (see below).
	Remove this pipe from the plenum chamber, and insert the sealing plug to make an air tight seal. Refit the pipe to prevent air reaching the air control valve.



Base idle adjustment is made by turning a set screw that's normally hidden under a tamper-resistant plug on the Throttle body. To access the screw, first drill a small hole (typically 1/8") in the tamper-resistant plug. Thread a sheet metal screw into the hole, and then pry the screw & plug out together. The main throttle butterfly is fully closed at idle, so there is a air bypass screw adjustment on the top of the plenum chamber that works together with the stepper motor. The screw adjustment is factory set, and sealed with a cap, **and normally will not need adjusting.** How ever the system will work quite happily without the stepper motor being connected at all, using just the base idle adjustment to bring the tick over up to 900 rpm when warm. This setting will need the engine to be rev'd slightly when cold to keep it running (for 30 seconds or so).

This is not a permanent fix, but if the engine ticks over nicely and does not stall then chances are the basic ignition system and mechanical systems are working OK. If the engine runs roughly or inconsistently, then firstly look at the service items around the ignition system.

If these steps fail, then a simple voltmeter across the lambda probe outputs will tell you if the correct fuel air ratio is being maintained . An analogue voltmeter is best, but a digital will do at a push, and you need to read a signal of 0 -2v DC across the black and white wires. Meter probes can be forced into the rear of the Lambda connector. With the engine running the voltage should constantly switch between about .3volts and .7 volts at about ½ second intervals , and you may see the odd peak of 1.2 volts once the probes are hot (after 20 -30 seconds). If the voltages do not switch constantly, either the Lambda probe has failed, or the fueling is a long way out, exceeding the lambdas monitoring range, so investigation for air leaks or fuel pressure problems need to take place. Another test is to reset the ECU, and monitor the voltages straight after a reset. The voltages are likely to stay static for a short period (high or low) until the ECU readjusts the basic fueling, and brings it back under lambda control. This should take no more than 30 seconds at most on a warm engine, and proves the lambda feedback is working. If the ECU is running outside these conditions, the fault codes should be generated and stored within the ECU.

A fairly brutal way of removing the ECU's ability to control its mixture at tick over, is to revert to the non catalyst fuel map by changing the under dash board resistor, and then set the mixture by hand with the setting screw on the side of the AFM. Although it can be set with DC voltages, it is far better to set it with a gas analyser to get it spot on. This method may damage the catalysts however if the engine over fuels, and is a test at best. If the engine runs perfectly like this, then its likely the ignition system is OK. By manually setting the CO output however, you could end up compensating for fueling or air issues, so simply masking he fault.