JDSPorsche will refurbish your MAF with a new platinum Hot Wire and recalibrate at a competitive price. We also offer to check your MAF for a nominal charge. To assist your fault finding and have compiled the following FAQ for your information, and hope you will find them useful.

E-mail us at JDSPorsche for our current charges; let us know the model and year of your 928 and the country you are in.

Q Which 928 models use the Hot wire Mass Airflow Meter (MAF) ?

A. Any 928 fitted with the Bosch LH Jetronic system. This includes all 1984-86 UK S2 and Euro "S"(except cat equipped German cars), and all Worldwide S4, GT and GTS models. The LH system was also fitted to the US market "86.5" 32 valve 5 litre in 1985 and early 1986. The same Bosch MAF is used in all these cars, Bosch part number 0280 214 001, Porsche part number 928 606 141 00

Q. What is a "Hot Wire" Mass Air flow Meter ?

A. It is an electronic unit that measures the amount of air being drawn into the engine. Its output is a variable voltage that changes in a direct relationship to the mass (weight) of air passing through it into the engine. The fuel injection "brain" uses this voltage as one of several inputs in order for it to calculate the length of time the fuel injectors need to be open and hence maintain the correct fuel/air ratio mixture under all conditions.

Q. How does it work ?

A. The Mass Airflow Meter (MAF) is situated between the air filter and the throttle body, where is measures all the air used by the engine.. A fine platinum wire, 0.07mm diameter is electrically heated and mounted in the intake air stream where it is cooled by the flow of incoming air. A control circuit varies the heating current to maintain the temperature of the wire at 100 degrees Celsius above that of the incoming air. This varying control current is therefore a direct measure of the volume of air passing through the meter. Because air density is temperature dependent, a temperature sensor is also inserted into the airflow. These elements are configured in a bridge circuit, which includes a precision measuring resistor. It is the voltage generated across this resistor due to the varying heating current, and hence proportional to airflow, which is used as the output voltage fed to the LH computer.

Q. Why do MAF's fail ?

A. The surface of the thin platinum wire can become contaminated with oil vapour from the engine. This contamination will cause the sensor to output incorrect voltages. To eliminate any possible deposits on the wire, it undergoes a "burn off" cycle every time the engine is switched off if the engine temperature is above 60 degrees C. and the engine has been above 2000 rpm. Approximately 4 seconds after the engine is stopped, the wire is heated to 1,000 degrees C for about 1 second. The 4 second delay assumes that the engine is unlikely to be re-started while the burn off is in progress, as any airflow past the wire when heated to this temperature would accelerate the surface erosion of the wire due to reaction with the oxygen in air.

Unfortunately, some erosion does occur with each burn off cycle, even with these precautions. A car that has covered 80,000 miles may have had as many as 8,000 burn off cycles activated. Eventually, due to the erosion of the hot wire, the MAF's output will inevitably reach a point where the engine will not run correctly. **The MAF is a precision instrument and an error of only 5% in the output voltage will make the car undriveable !**
Other MAF failures can be due to moisture ingress into the electronics assembly.

Q What are the symptoms of MAF failure ?

A. This can vary, depending on whether your 928 has a catalytic converters or not. But MAF failure can result in weak mixture, giving low power and hesitation under acceleration. Or at the other extreme, over rich mixture with black smoke, a strong smell of petrol in the exhaust, black sooty spark plugs, and a reluctance to run unless the throttle is opened. For less dramatic symptoms, see below.

Q. Which LH equipped 928's have cats, and which not ?

A. All 1984-86 Euro S and S2's are non-cat. Early UK S4, GT and the UK only S4 "Sport" SE are also non-cat. After 1990 all UK market cars were cat equipped. In Europe all 928's from 1986 were cat equipped. The early "86.5" 32 valve 5 litre and all other 928 models imported into the US from 1987 onwards were also cat equipped

Q OK my car is non-cat, what now?

A. Because this system does not have a catalytic converter with an oxygen sensor, the LH computer and MAF operate as an "open loop system". That is to say, it does not have any type of automatic compensation for small errors in the MAF output. So if (for example) the MAF gives a lower output voltage than it should, the LH computer outputs fuel from the injectors corresponding to a lower airflow, and the mixture is weak. This will reduce power, and may cause hesitation when the throttle is opened quickly. These effects will gradually get worse with use over some time, due to hot wire erosion.

As well as a gradual weakening of the mixture due to wire erosion, other types of MAF failure have resulted in excess rich mixture, with lots of black smoke, a strong smell of petrol in the exhaust, black sooty spark plugs, and rough running. If the MAF output voltage eventually reaches a point well out of calibration, or for some reason the output suddenly jumps out of normal tolerances, the LH computer will ignore the MAF output voltages entirely, and should revert to a stored "limp home" programme. (see later)

So MAF failure often is a gradual degrading of performance, often first noticeable with "flat spots" causing hesitation during acceleration, especially when engine water and ambient air temperatures are high. Maximum power at wide throttle openings will also decrease, due to the resultant weak mixture

Q. And my car has a catalytic converter, what now ?

A. An oxygen sensor which monitors the exhaust gases before the catalytic converter feeds a signal back to the LH computer, forming a closed loop system.- a "lambda control loop". This loop adjusts the amount of fuel injected, keeping the air/fuel ratio within the very narrow limits required in order to meet emissions standards. The cat can be contaminated by an incorrect fuel/air ratio, so this feedback loop is essential. So if the MAF drifts gradually from its correct calibration, the LH computer will adapt to these new settings and the car will run well.

However, this compensation only applies steady state conditions. When the throttle is opened quickly for acceleration, the O2 loop is disabled. This is to allow enrichment of the fuel/air mixture which is essential to prevent hesitation and a "flat spot". Under these O2 "open loop" conditions, the LH ECU critically depends on the output voltage registered by the MAF. As the MAF reads progressively lower output voltages as it ages, and fuelling is proportional to the MAF voltage, it follows that the ECU is instructed to deliver less than the necessary amount of fuel. Hence the hesitation and "flat spot".

The same "open O2 loop" condition is also used at large throttle opening (> 2/3 throttle) - also known as WOT ("wide open throttle"). An aged MAF will result in a weak mixture and low maximum power.

Eventually when the MAF drifts too far, the O2 loop will no longer be able to keep the mixture under control, and the LH computer will revert to the pre-set "limp home" programme, as for the non-cat cars. So MAF failure can be often appear sudden, without warning, when in fact the MAF has been slowly ageing over several years.

Q. What is the "limp home" programme ?

A. This is a programme within the LH brain, which allows you to drive the car home or to a workshop, even if the MAF fails. It gives two pre-set fuel injector opening
times- 3.5milliseconds when the engine speed is less than 2000rpm, and 6.3mS. when the engine speed is greater than 2000rpm. Because this is a crude approximation to the constantly variable correct injector settings, the mixture will only be correct at two points. At other throttle openings the car will run rich or lean, but it's good enough to drive the car with care.

Q. How do I tell if the MAF has failed, or my car has another fault ?

A. If the car runs much better, although not perfectly, with the 6-pin connector to the MAF disconnected, then MAF failure is a strong possibility.

Q. How do I find the MAF and the 6-way connector ?

A. The MAF is located directly under the air filter assembly, which is the large rectangular box at the back of the engine bay with a long air intake tube at each end. To get to the MAF, remove the two long air tubes. Release the four straps that hold the upper half of the box to the lower part. Lift the top cover up slightly at the right hand side, it will not lift far due to the hose which connects underneath, from the air pump. (RHS here means facing the front of the car from the driver's seat) A worm drive clip retains the hose. Undo the clip and pull off the hose. Remove the upper housing. Then remove the air filter, keeping it upright. Note or mark its top face so it can be replaced the same side up. Turning it over may deposit debris into the engine !

On pre S4 cars, two 13mm hexagon headed bolts secure the lower half of the air cleaner box. They are captive in the lower half, so will not pull out when fully loose, but it will be obvious when they have been fully unthreaded. Lift the lower half up, the MAF will come out of the throttle casting with the lower half of. Do not lift it by more than a couple of inches, as there are leads connected. There is a 2-pin plug connected to an air temperature sensor on the underside of the housing. Disconnect this by wriggling it from side to side while pulling. Only pull the plug, never the wire ! Then disconnect the 6-way connector on the MAF. The lower housing half complete with the MAF can now be removed from the car, and the MAF taken off by releasing the worm drive clip.

On the early 5 litre USA "86.5" cars, the lower half of the housing is held by one 10mm bolt each side.

On all the later cars from 1987 onwards, the lower air filter housing is held with two 10mm bolts at each side. On these cars the MAF will remain in the rubber elbow connecting it to the throttle housing when the lower casing is removed. The MAF is held in the elbow by a worm drive clip, which is a little tricky to get at. Use a 7mm spanner to undo the clip drive about one turn. The MAF can then be eased out of the elbow and disconnected.

To check if the car runs better with the MAF disconnected, clear the engine bay of all loose parts and tools you have been using and try and start the engine. If it runs better than with the MAF connected, (but not perfectly) then MAF failure is a strong possibility.
Note that if the car has not already reverted to "limp home" mode, the engine may have run with an excessively rich mixture, and may not start and run with the limp home programme until the spark plugs have been removed and allowed to dry out. Alternatively, the car can be left for several hours to "dry out", or you can try starting the car with the throttle to the floor.

Q. It doesn't run any better, or any differently, what now ?

A. This could be the case if the MAF failure is total e.g. a broken hot wire. The car would have already reverted to limp home mode. To confirm this carry out check No. 4 below.
If the MAF does have output, then it is possible that the fault is not due to the MAF. For a cat car, it could be a failure of the lambda closed loop. It is out of the scope of this document to give you a full fault find analysis procedure. Possible component faults that could cause weak or rich running include: LH computer failure; faulty Temp sensor 2; faulty O2 sensor (cat cars); low fuel pressure; air leaks into the intake system If your car is 1988 or later, it has a built in fault diagnosis facility. Your local Porsche specialist should be able to read out the fault codes with a dedicated tester - "Bosch Hammer"

Q Well, it runs much better, or differently, with the MAF disconnected, what now ?

A It is almost certain that the MAF is faulty. If MAF failure is not total, but due to the output being out of calibration, cat equipped cars will often run very rich, or not run at all, until the MAF is disconnected. Then they will run in limp home mode. Non-cat cars typically run with an increasingly

weakening mixture over time, in limp home mode they will tend to run rich at small throttle openings.

Note that if the car has not automatically reverted to “limp home” mode, the engine may have run with an excessively rich mixture, and may not start and run with the limp home programme until the spark plugs have been removed and allowed to dry out. Alternatively, the car can be left for several hours to “dry out”, or you can try starting the car with the throttle to the floor. With the Limp Home programme, the car will run very rich at idle, especially once the engine reaches normal temperature. But if it runs at all, whereas it will not run at all, or much worse with the MAF connected, it is highly likely that the MAF is faulty.

If you can borrow a known good MAF from another 928, try that first as confirmation. You can do a quick stationary check by fitting the other MAF into the throttle housing and just connecting the 6-way connector. The car should start, idle and respond to the throttle without hesitation or black smoke. If the engine does run OK, then your MAF has been diagnosed faulty. But sometimes intermittent connections can cause problems. Just as a second check, substitute your old MAF, and make sure the car still does not run correctly. Just disturbing the connectors can sometimes have a beneficial effect !

Q. I can’t borrow a MAF, what else can I do ?

A. You can make some basic checks on the 6 way lead going to the MAF, and on the MAF itself. This will help eliminate other possible faults. You will need a high impedance voltmeter and ohmmeter :

1) To check that the MAF is being powered up :-The engine should run with the MAF disconnected, so measure for battery voltage between pin 2 (positive) and pin 4 (negative) of the disconnected flying lead. The pin numbers are not shown on the flying lead connector, but the corresponding numbers are shown on the connector on the body of the MAF. The voltage should be battery voltage (about 13v). No voltage would indicate a fault with relay XXV (relay XVI on ’84 Euros)
2) To check the sensor resistor is OK:- connect an ohmmeter between pins 3 and 5 of the disconnected MAF, the reading should be approx. 4 ohms.
3) To check the idle mixture pot is OK, measure with the ohmmeter between pins 3 and 6 of the disconnected MAF. The reading is typically between 300 and 600 ohms. It is adjusted for correct idle mixture CO on non- cat cars with the hex head adjuster which is on the side of the MAF, next to the 6 way connector. Note that this idle mixture pot is only in circuit with 84-86 cars. The early non-cat cars (S4, SE & GT) have a "remote"pot, which is on a bracket near the fuse panel. Cat equipped cars do not have an idle CO pot, as idle mixture is automatically set by the lambda loop.
4) To check the MAF has an output voltage: -. The easiest way to do this is to measure the MAF output voltage at pin 7 of the LH computer, which is in the side of the passenger footwell Bridge contacts 30 and 87 on relay XXV (relay XVI on ’84 Euros) with a suitable jumper lead and measure for battery voltage between pin 2 (positive) and pin 4 (negative) on the disconnected plug at the MAF as a first check. The ignition does not need to be on. Reconnect the MAF, and measure the voltage at pin 7 on the disconnected plug of the LH computer (+ve) with the –ve lead of the voltmeter contacting a chassis or battery –ve point. The voltage should be about 1.7 volts d.c .If you get a helper to blow onto the hot wire, the voltage should rise up to a maximum of 5 volts. Note that this is only a crude check of circuit functionality, the MAF can still be out of calibration even if it passes this basic check. Zero voltage under all conditions indicates gross MAF failure – the car should have reverted to limp home mode.
5) To check the hot wire burn off: the car must be at normal operating temperature. Take off the upper air cleaner casing and remove the air filter. Start the engine, and take the revs above 2000rpm for a few seconds. Then switch off the ignition and observe the hot wire through the air filter housing. 4 seconds after ignition switch off, the hot wire should glow an red/orange colour for about 1 second.

Q: I can’t do these 5 checks, and I can’t borrow a MAF, what shall I do ?

A: You can send your MAF to us at JDSPorsche and we will check it out for you, for a nominal charge. E-mail us for details.at JDSPorsche

Q **I have made the checks you mention and I am sure the MAF is faulty, what now ?**

A Send your MAF to JDSPorsche. We will confirm if it is faulty, and if so will replace the platinum wire. The unit is then re-calibrated on our special jig at 12 preset flow rates, accurate to better than 0.5%. All our work in guaranteed for 1 year. E-mail us at JDSPorsche for latest prices. Our prices are based on repairing your MAF, so it must be basically sound. Please do not remove the black cover over the electronics, any damage inside could make repair impractical.

Disclaimer: These FAQ have been compiled for your information and assistance, and we have tried to make them as accurate as possible. We hope you find them interesting and helpful. However, we do not accept responsibility for any errors contained, or accept any liability for loss or injury if you undertake any of the procedures outlined. If you are in any doubt about any issue, always seek expert advice.

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