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D-Jetronic articles series by Dr-DJet

D-Jetronic chapter 9: Cold start and auxiliary air (aka air slide) valve



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Auxiliary air valve

Chapter 9 of **Dr-DJet's** article series describes auxiliary air valve (or air slide valve), cold start valve and thermo time switch. They are not controlled by ECU (exception BMW) and determine the engines cold run.

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9.1 Cold run

During cold start not only in winter, the spray of fuel drops tends to condense on the cold walls of intake manifold. The colder these walls are, the higher this effect. That is why you would have to extensively run the starter and afterwards the engine would tend to run badly until it finally reaches its temperature. To avoid this, 3 things are happening:

1. While starter runs, cold start valve can inject additional fuel if the engine is cold.
2. With cold engine, auxiliary air valve opens and increases the flow of air to the engine, you could also say that it slightly pushes gas pedal.
3. ECU increases amount of fuel injected up to a factor of 3 (at -30°C or -22°F).

This ensures that the engine will start at -30°C / -22°F as well as it will at $+20^{\circ}\text{C}$ / 68°F and that it will not die at first red lights. All these effects are reduced by increasing engine temperature until they are finally completely stopped.

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Mounted cold start valve and idle-speed screw



Cold start valve form below

nd thermo time switch

Cold start valve is connected to pressure regulated fuel hose and thus gets same constant fuel pressure as injectors. Some of them only have one connecting pipe and others have two as they sit in the middle of fuel hoses. They all have a determined flow rate and spray angle fitting to the engine. They spray fuel in a similar way as an injector. In order to distribute this fuel to all cylinders they are in a central location of the intake manifold, often close to idle run adjust screw. It opens magnetically by a coil that pulls a needle against a spring, without power it is closed. Like injectors a cold start valve can become dirty, can leak or not create a proper spray any more. You can only check that when you dismount it, apply +12V to its electrical connectors and let it spray in a glass. If spray is well distributed in a cone I do not consider that measuring of flow rate is necessary.

Cold start valve is only supposed to inject while you operate your starter! BMW is the only exception as they use the cold start valve for after start enrichment via ECU. Injection time during starting is determined by a thermo time switch. It consists of a bimetal switch measuring engine temperature and a heating coil. The bimetal switch will connect pin "W" to ground if engine temperature typically is below 35° C / 95° F. Above this temperature it will not close this switch any more. In order not to flood intake manifold with fuel if you try to start your engine several times in a row, this bimetal switch is additionally heated through pin "G" and thus open the switch no matter how cold your engine is. Thermo time switches were built by VDO and they differ in thread, electrical connectors and especially in engine specific parameters:

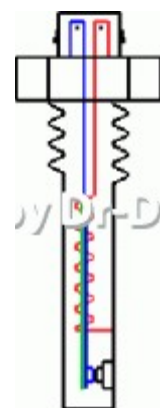
- At what engine temperature will switch always be open? Normally that is 35° C / 95° F \pm 3° C. You will find that on the housing.
- What is maximum opening time. This can be up to 20 seconds at -30° C / -22° F. Normally you find this engraved on the housing (e.g. 20° C / 9,5s)
- Additionally you will find a maximum temperature that can be applied like 120° C.
- Which power can it switch, e.g. 12V 3W

Thermo time switch control cold start valve in two different ways:

1. It directly connects to ground connector of cold start valve
2. It connects to a relais that finally opens cold start valve

You will find a detailed wiring diagram for your car in Bosch's workshop manuals. You can easily test your thermo time switch by measuring the voltage on cold start valves electrical connector. But remember that due to its heating coil, it will only operate once for a few seconds while starting. If you assume a leakage of your cold start valve, you can easily close connecting fuel hoses and watch whether this has an effect on your engine run or even better on your CO% in exhaust. If you have a cold start valve with just one fuel

connector, this is the easiest location to install a pressure manometer to adjust fuel pressure. you permit us to use cookies.



Thermo time switch

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9.3 Auxiliary air valve (AAV)

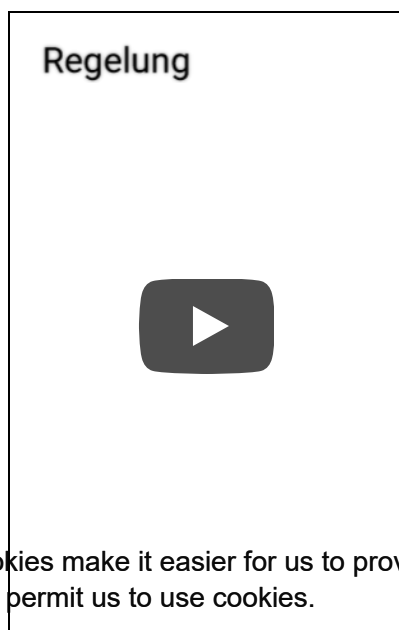
Auxiliary air valves measures engine temperature and operates like pushing down gas pedal a little, it bypasses idle speed screw and throttle, thus increasing the air flow to the engine. Nothing else! Despite of this, there are many rumours in forums where it is claimed to also effect fuel / air ratio. This is definitely wrong! Fuel is dosed by ECU which senses the increased engine speed. It is well known for the sawing of the engine if it fails. This happens by an AAV staying open even if the engine is already hot. If the ECU senses idle rung by a properly adjusted idle run switch and if the ECU has over-run shutoff capability, then the engine will first increase speed, until it finally reaches the over-run limit. ECU shuts off injectors and speed drops totally. At the lower limit of over-run shutoff it will open injectors again and so we start from beginning. It is nothing that will harm the engine, even that it sounds frightening and your neighbour will consider you a 16 year old youngster playing with the gas pedal. But have a look at Winfried's video.



Auxiliary air valve (AAV)

An auxiliary air valve is made of an aluminium housing with two air hose connectors in upper part. Versions for water cooled engines have a thermo expansion element in its bottom that expands with increasing temperature and thus operates a piston. It seems that this element is the same for all water cooled engines, even MB K-Jetronic cars have this one. The piston inside regulates the air flow between the two air hoses. It normally closes fully at $+70^{\circ}\text{C}$ / 158°F . Below 70°C it opens an air slit, the colder the wider. Now air can flow from upper air hose to the lower one going to intake manifold. The colder the engine, the higher this air flow and the higher will be your engine speed. If water temperature is above 100°C / 212°F the piston will push above the upper air hose and thus increase engine speed again. Such a device is not a precision instrument! Normally they are not adjustable, with the exception of Volvo. It has no sealings, so it will never cut off air 100%. Remember this is just something to increase engine speed during cold-run. After you replace your AAV, remember to readjust your idle-speed screw.

The piston inside pushes against a spring that is above piston in the housing. How do various auxiliary air valves vary? First in housing, as you can have different angles of connection of the two air hoses and the mounting foot on the engine. Secondly the air slit varies. BMW e.g. has a much smaller one as the MB 8-cylinders. One thing seems to be the same for all water operated AAVs and that is the expansion element with its holder. I estimated following opening slits on a 0 280 140 017 by looking into the lower air hose connector: 4-5 mm at -18°C (deep freezer), 2 mm at room temperature and fully closed at 70°C (oven for some minutes).



Air slits of MB 8-cyl, MB 280, BMW in comparison

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Winfried's engine MB 350 doing
the sawing. Linked with
approval by Winfried - many
thanks

9.3.1 How do Auxiliary air valves fail?

Over time the expansion element dries out or leaks. Following the piston will not reach movements as desired. Additionally dirt can attach to piston and gliding walls and make it move slowly or even make it stuck. It might still principally move, but it can take a long time. You will face sawing of your engine at first mainly in winter, when you start your car and go to Neutral at first red lights. You can try to clean it with break cleaner, but if the expansion element is worn, there is no help. **Please do not try to force the piston with screwdrivers or other tools. You destroy the air slit or the expansion element!**

How does sawing happen? In your cold garage in winter, AAV opens wide and slides to an area that is normally not used. When you start to drive your car, engine temperature quickly goes up from let's say -10° C to +20° C. However the piston still is a bit stuck in -10° C position. When you come to first red light and switch to neutral, your engine will go to such high revs that your ECU will start over-run shutoff, believing that you are running the car down hill in idle. I see that often on old D-Jetronic cars and if it is just at this point of time, don't worry too much. But if your engine shows such behaviour in spring and summer or if it does not increase idle speed in cold-run, then it is time to replace your AAV. If you want to be sure that it is the guilty one, just close one of the two air hoses. If this solves your idle-speed problems on a warm car and if it does not reduce idle-speed on a cold one. then you know it's the AAV.

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an auxiliary air valve



Scratched piston



Expansion element in special holder

Unfortunately your AAV is constructed as a throw-away part. If it was broken, your workshop would just swap it with a new one. You can not adjust it (exception Volvo) nor can you open it with normal tools. Additionally you need a holder (not available on the market) for the thermal expansion element that fits in your AAV without letting any water leak into the air section. I have seen AAV that were overhauled so badly that cooling water will leak to the air section, thus creating calcination on the piston walls. With all tricks and force I was not able to extract that normally freely gliding piston from its housing, it was scrap! You can not apply too heavy force as everything is made of aluminium. As Bosch "Reman 1:1" asks outrageous prices (400€ in 2014) for the repair of AAVs or nowadays delivers an ugly and big new design, I tried to repair them on my own. You need a new thermo expansion element and a holder as seen in the picture. I manufactured that on my own lathe. It seems that this holder with a diameter of 28.0 mm is the same on all water cooled engines. I could verify that on BMW, Citroen and Mercedes-Benz. Of course you should clean everything and ensure a proper gliding of piston. Often they are badly scratched and should be polished before you reuse them. Finally the whole housing should be reassembled so that you permit us to use cookies.

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the air slit fully closes at 70° C. Now do not forget to repace the paper sealing when you remount it on your engine and it should run again for the coming decades and it still looks original!


Your Dr-DJet (Volker)

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