

1 Idle Control

1.1 Theory on idle control

Setting up a proper idle control can be time consuming, but it is worth the effort since a bad idle is very annoying. The secret for a good idle setup is to tune "User Defined" IAC Actuator table so the IAC adaption is low or kept the same. If you get under 2-3 %, then you have done a good job! Setting up so the adaption stays the same when fans come on, AC is enabled and sometimes when drive is selected for automatic transmission takes time but below we describe how to do it!

The control strategy of the SM4 idle control is very complex, but still easy to set up if you get the basic of how to tune the IAC.

There is one way of doing a "Quick Idle control", this will have the idle increase for fans and AC. This method will quickly give stable idle but not any idle up or TPS follower. The method is described in the last chapter below.

1.2 Installation

The three wire Bosch is setup with 12 volt ignition in the middle pin, the two other pins are connected to SM4. Make sure to measure the resistance over the windings (from middle to left and right pin). If you get 12 ohm you will get more than 1 amps current when the alternator are charging. Make sure you connect the IAC to O/P's that can handle the current. If you do not have O/P's enough you can ground one pin and only connect one wire to SM4. Make sure you ground the wire that closes the valve or you will get stuck with very high idle and it will not be controllable by Sm4.

The two wire is just one wire and 12 volt ignition power, stepper is set up with the same strategy as mentioned below.

I prefer to adjust the idle to around 500-600 rpm when valve is fully closed and engine fully warmed up. Adjust the throttle blade until it idles at that rpm. You can choose what ever you want but preferred 100-200 rpm below idle. This makes it easier to get the "IAC closed value rpm".

1.3 Calibrating IAC control

First we need to enable IAC control by assigning an output for it in menu **M1 / O/P setup** and configure the output for the IAC valve we are using.

In this example we select **O/P PWM 1 and O/P PWM 2** as output for IAC control, with its output on pin 14 & 28. This is one of the dedicated PWM output pins, and it provides a reliable PWM signal with selectable frequency ranging from 9.5 to 1220 Hz. For the three wire Bosch we select **H-bridge control**, which will help making valve more stable. When we have selected the H-bridge 1, we can go into the H-Bridge setup and select PWM 1 & PWM 2. If you choose them in wrong order the engine will idle up, then just choose the opposite, PWM 2 on top and PWM 1 below. Then you can select the frequency the valve will operate on, here we select 76 Hz PWM frequency, which is a good starting point for most Bosch IAC valves.

O/P setup						
	O/P type	H-Bridge setup	O/P	Pin	Properties	
O/P IAC control	<input type="checkbox"/> H-bridge 1	<input type="checkbox"/> O/P PWM 1 <input type="checkbox"/> O/P PWM 2	<input type="checkbox"/> O/P PWM 1 <input type="checkbox"/> O/P PWM 2	028 014	76 Hz 76 Hz	
O/P Boost	Disabled					
O/P Anti lag	Disabled					
O/P Air con	Disabled					
O/P GPC 1	Disabled					
O/P GPC 2	Disabled					

Figure 1 - IAC control O/P setup

If the engine idles up and is not controllable you need to switch the O/P's or the outer wires to the valve, see below for switching the H-Bridge O/P.

O/P type	H-Bridge setup
<input type="checkbox"/> H-bridge 1	<input type="checkbox"/> O/P PWM 2 <input type="checkbox"/> O/P PWM 1
Disabled	
Disabled	

Figure 2 - IAC control O/P setup, switched position

When the IAC control is assigned to an output, the IAC settings can be configured in the menus under **M4**.

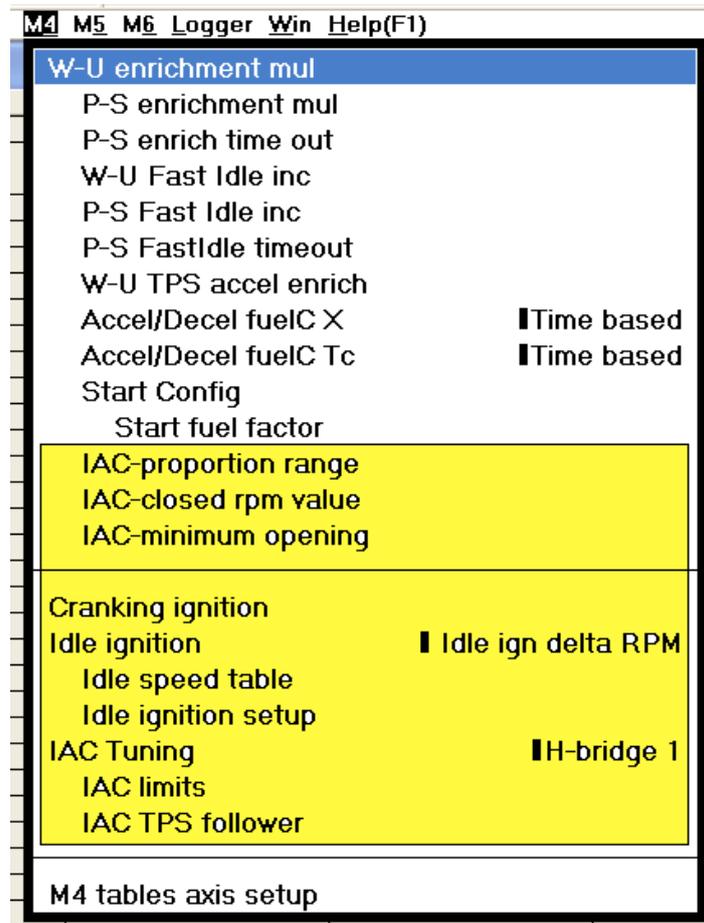


Figure 3 - IAC configuration menus

Next step is to find the **IAC-closed rpm value** and **IAC-Proportion range**.

Make sure you have a copy with another name of your cal file on hard disk before proceeding. First you have to lock timing at the wanted angle, I want idling at 8 degrees and uses Idle ignition timing so I set all values to 8 degrees here. You can easily import the earlier values from the stored cal file when Idle tuning is done.

Make sure engine is fully warmed up and not only the water temp the oil temp need to be warm since it affects the engines VE mostly because they cool down the pistons.

Put in 50 rpm in **Idle speed table**, and record the rpm engine is idling on, if not idling open the throttle stop screw until it idles 100-200 rpm below wanted idle. This idle rpm is now you **IAC-closed rpm value**. I have 650 rpm here. The colder temperature values have to be tested or estimated.

IAC-closed rpm value (-2000 .. 2000) Rpm								
Coolant temp(Deg C) Attr:30.00%								
	-30.0	-20.0	-10.0	0.0	10.0	20.0	30.0	80.0
	0	59	118	177	236	295	354	650

Figure 4 - IAC-closed rpm value, the 80 degrees value tested and other estimated

Then put in 5000 in **Idle speed table**, record the maximum rpm it will idle on. Be careful since you are idling at 8 degrees, also make sure it is using 8 degrees and not using **Main ignition timing**. In my case the engine idled at 3050 rpm, so the **IAC-Proportion range** 3000-600 = 2400 rpm. This is the value you put in the **IAC-Proportion range** at full operation temperature. The colder temperature values have to be tested or estimated

IAC-proportion range (32 .. 8160) Rpm								
Coolant temp(Deg C) Attr:30.00%								
	-30.0	-20.0	-10.0	0.0	10.0	20.0	30.0	80.0
	1600	1792	1920	2016	2112	2176	2208	2400

Figure 5 – IAC-Proportion range, the 80 degree value tested and other estimated

Then you can zero out the **IAC-minimum opening** table, a good IAC tuning do not need this.

IAC-minimum opening (0.0 .. 100.0) %								
Coolant temp(Deg C) Attr:30.00%								
	-30.0	-20.0	-10.0	0.0	10.0	20.0	30.0	80.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 6 – IAC-minimum opening

Then it is time to tune menu **IAC Tuning**

IAC Tuning	
Parameters	Value
1	IAC Actuator type USER DEFINED
2	Vacuum limit GPC Disabled
3	IAC Dead band 40 Rpm
4	Slow adapt rate 900
5	Slow adapt (no F/B) 600
6	IAC Dynamic comp 30
7	IAC Stall saver 2.0 %
8	IAC extra fuel 10.0 %
9	IAC position, 0 rpm 0.0 %
10	IAC dither Disabled

Figure 7 – IAC Tuning

Set **IAC Actuator type** to **USER DEFINED**, this is the clue to get a low adaption.

Vacuum limit GPC is set to disabled here but for the ones that want to limit vacuum can use it.

IAC Dead band is important for a stable idle, a good starting point is 40-50 rpm, if the rpm error is within this set band it will not correct the idle error.

Slow adapt rate is the gain for the control loop, higher value will make the corrections bigger. This value is used in the calculation for the valve and uses the rpm as feedback. A good starting value is 900-1200.

Slow adapt rate (no F/B) is also gain but do not use rpm as feedback, if this value is increased the control loop will quicker get to set idle but may overshoot. So a higher value here takes it quicker to set idle but also makes it more unstable. A good starting value is 600-800.

IAC Dynamic comp is the filter in the control loop, a smaller value makes the idle more stable and makes smaller changes to the valve. Try different values here and use the one that is stable but still fast. A good value is 20-30 as starting point.

IAC Stall saver is the extra % fuel needed.

IAC extra fuel is the throttle opening needed to get the IAC-Proportion range found above. Test this with IAC valve closed (set 50 rpm in idle speed table), then open the throttle until engines idles at the same rpm found above, my case 3050 rpm and I need to open the throttle 10 % for this. Make sure you still have a flat ignition table in my case 8 degrees. So I put in 10 % here.

IAC position 0 rpm how many percent you want to open at zero rpm. I have 0 here.

IAC dither Dither, is a signal processing technique, and a method of extending dynamic range by first perturbing (dithering) then averaging. May increase the resolution but I do not use it here.

Now it is time to tune **IAC Actuator O/P cal**, this axis are good starting point.

In this table the X-axis corresponds to the percentage of the **IAC-Proportion range + IAC-closed rpm value**. So 50 % on x-axis are (50% of range 2400) + rpm closed 650 = 1850 rpm. So if you put in 1850 in my case the SM4 will move the IAC valve to 50 % then start adapting with the settings from **IAC tune** until it runs on 1850 rpm. So in the cell 50 % we need to put in the actual valve opening required to run 1850 rpm at zero adaption. There are a slight offset due the control loop, around 12 % on range and + 100 rpm on closed rpm.

IAC Actuator O/P cal (0.0 .. 100.0)							
Battery voltage(Volts)	IAC valve posn(%)						
	0.0	6.3	12.5	25.1	49.8	100.0	
14.00	0.0	37.3	43.1	51.0	59.6	100.0	

Figure 8 – IAC Actuator

Here is one step to quickly get close in the table, you can jump directly to step 2 if you prefer.

Step 1 in callibrating **IAC Actuator O/P cal**.

If you got same axis as I below; 0, 6.3, 12.5, 25.1, 49.8, 100.0
Range are 2400, closed position 650 rpm.

Calculating approx $\% \times 2400 + 650$

0 % = 650 rpm,

6.3 % = 800 rpm

12.5 % = 950 rpm

25.1 % = 1250 rpm

49.8 % = 1850 rpm

Assign then a GPC output to your IAC valve, use the H-bridge if three wire, then press + / - untill you get the setpoints, 800 rpm, 950 rpm, 1250 rpm, 1850 rpm, write down the duty cycle required to archive the idle rpm. Remember to still have a flat ignition table.

Then put in this values in the **IAC Actuator O/P cal** table. You now have a good starting values for fine tuning the table to get very low adaption changes when you enter different idle speed values.

Step 2

The axis 25 % are 25 % of 2400 + 650 = 1250 rpm, so here we put in the value needed for the engine to idle at 1250 rpm with zero adaption.

The 12,5 % axis are 950 rpm, and 6,3 % axis are approx 800 rpm.

The following axis work fine to start with, and you will need to find the number required so the engine idles at set rpm with zero adaption. Put in different values in **Idle speed table** and go

back here and adjust table so adaption stays low or around zero. Make sure your fans or AC is not engaged, if fans starts wait until they have stopped and keep on adjusting table until adaption is kept to zero at different idle speeds. Do this adjustments until you are sure the adaption stays around zero, be patient since this is the key for stable idle.

When table is ready you should be able to put in any desired idle speed and engine will instant run at that rpm with zero adaption! Remember this is done with ignition timing flat and in my case 8 degrees. Now you have worked out the characteristics of your IAC valve. Some do use the Y-axis for voltage compensating, mostly it is not needed.

If you are using fans, watch the adaption when fan turns on, and adjust the **Fan1 On extra IAC** and **Fan2 On extra IAC** so adaption stays zero. Do same with the AC if used. If you are using an automatic transmission you can have a switch when drive or reverse are put in. You can use the AC function if not used to add the extra IAC % for this.

If the engine hunts/oscillates check the main fule table around idle and adjust if necessary, also you can adjust the dynamic comp in IAC tune to make it stable, try to get it stable before putting back the **Idle ignition**.

When stable it is time to put back the **idle ignition**, you can import the table from the previous saved cal file by opening the **idle ignition** table, the go to menu **Edit-Window > Export/Import/Print > Read from external file** > select the cal file you saved earlier and press enter for importing the hole table. (Works with fuel & timing tables also).

Now you should have a rock stable idle control!

Quick Idle setup

Quick Idle is a way to "fake" the settings to quickly setup an idle control where the Fans and AC will idle up. If used with **Idle Ignition Timing** you will have a stable idle but not any adaption or throttle follower.

First Install and enable the valve in menu **M1 / O/P setup**, see above for this.

Then set **IAC-closed rpm value** to 2000 rpm all over table, this makes the control logic are trying to lower the Idle to the **IAC-minimum opening** table

IAC-closed rpm value (-2000 .. 2000) Rpm								
Coolant temp(Deg C)	Diff:2000				Attr:30.00%			
	-30.0	-20.0	-10.0	0.0	10.0	20.0	30.0	80.0
	*2000	*2000	*2000	*2000	*2000	*2000	*2000	*2000

Figure 8 – IAC-closed rpm value

Put in your wanted idle ignition so the timing is flat.

Then start from cold engine and type in the needed value to keep the engine at the desired rpm, when engine gets warmer adjust all values until warmed up.

Then you can test with your fans and/or AC and add the extra percentage needed to keep the same rpm. Make sure you have same target idle set in Idle speed table so the idle ignition timing will work.

Put back the idle ignition values, or import them as mentioned above.

IAC-minimum opening (0.0 .. 100.0) %								
Coolant temp(Deg C)	Diff:40.0				Attr:30.00%			
	-30.0	-20.0	-10.0	0.0	10.0	20.0	30.0	80.0
	*40.0	*37.6	*35.3	*32.9	*30.6	*27.8	*25.1	*12.2

Figure 9 – IAC-minimum opening