

# **Aisin A650E 5 Speed Special instructions Ver 3.3B**

This firmware and software can be set up with a little bit of knowledge and understanding in mechanical and electrical functions. Different ratios in the drive train do make a big difference in line pressure settings and also the gear profile settings. Also to achieve off-road settings, engine braking in lower gears needs to be fine-tuned.

Note that the TPS sensor used is the one on the throttle body servo motor and not the one on the cable side of the throttle body. The throttle also needs to be modified to become a normal Drive by Cable Throttle. Alternatively you can use the drive by wire module from Spitronics which is still currently under development.

The A650E Transmission has a direct clutch for 2<sup>nd</sup> gear and accumulators for the other gears. This means that the main line pressure Graph 1 is applied directly via a control solenoid on the second gear clutch. The control solenoid will apply a certain amount of the line pressure which is adjusted on Graph 2.

Graph 1 will adjust the main line pressure of the transmission. Because this action is inverted for safety in limp mode, it means that the higher the graph the lower the line pressure will be. The reason for this is that in case of solenoid failure the line pressure will be high to prevent the clutches from slipping and be damaged in limp mode.

Graph 2 will adjust the shift pressure from 1<sup>st</sup> to 2<sup>nd</sup> gear. If there is a momentarily slip between shifts or no second gear, it means the pressure is too low. You need to raise the graph at that TPS setting. If the shift is harsh it means the pressure is too high. You need to lower the graph at that TPS setting. If you can't get enough firmness in the shift you may need to raise the main line pressure by lowering the line of graph 1 at that TPS setting.

Graph 3 will adjust the pressure when shifting from 2<sup>nd</sup> gear to 3<sup>rd</sup> gear to achieve a smooth shift. If there is a momentarily slip between shifts it means the pressure is too low. You need to raise the graph at that TPS setting. If the shift is harsh or it means the pressure is too high. You need to lower the graph at that TPS setting. If you can't get enough firmness in the shift you may need to raise the main line pressure by lowering the line of graph 1 at that TPS setting. Note that line 3 will always be slightly higher than line 2 but not too high otherwise 2<sup>nd</sup> and 3<sup>rd</sup> will try to engage at the same time resulting in engine brake action.

Note that the TPS settings for the lockup clutch must be set 0% and 100%.

Lockup TPS High	<input type="text" value="100"/>		(%)
Lockup TPS Low	<input type="text" value="0"/>		(%)

## **Tuning Tips**

Begin with the A650E start up map supplied by Spitronics and make sure that all the sensor calibrations are done and are operating correctly. This will be important especially for TPS, RPM Speed and Oil temperature. These sensors will influence how the pressures and shift times are applied.

To calibrate the speed setting you may need to lift the vehicle from the ground and compare the TCU speed to the speedometer. Then later do a fine calibration on the road. If the speedometer is dependent on the TCU then you will have to calibrate it on a quiet road with a GPS. See speed calibration in the software under active sensors.

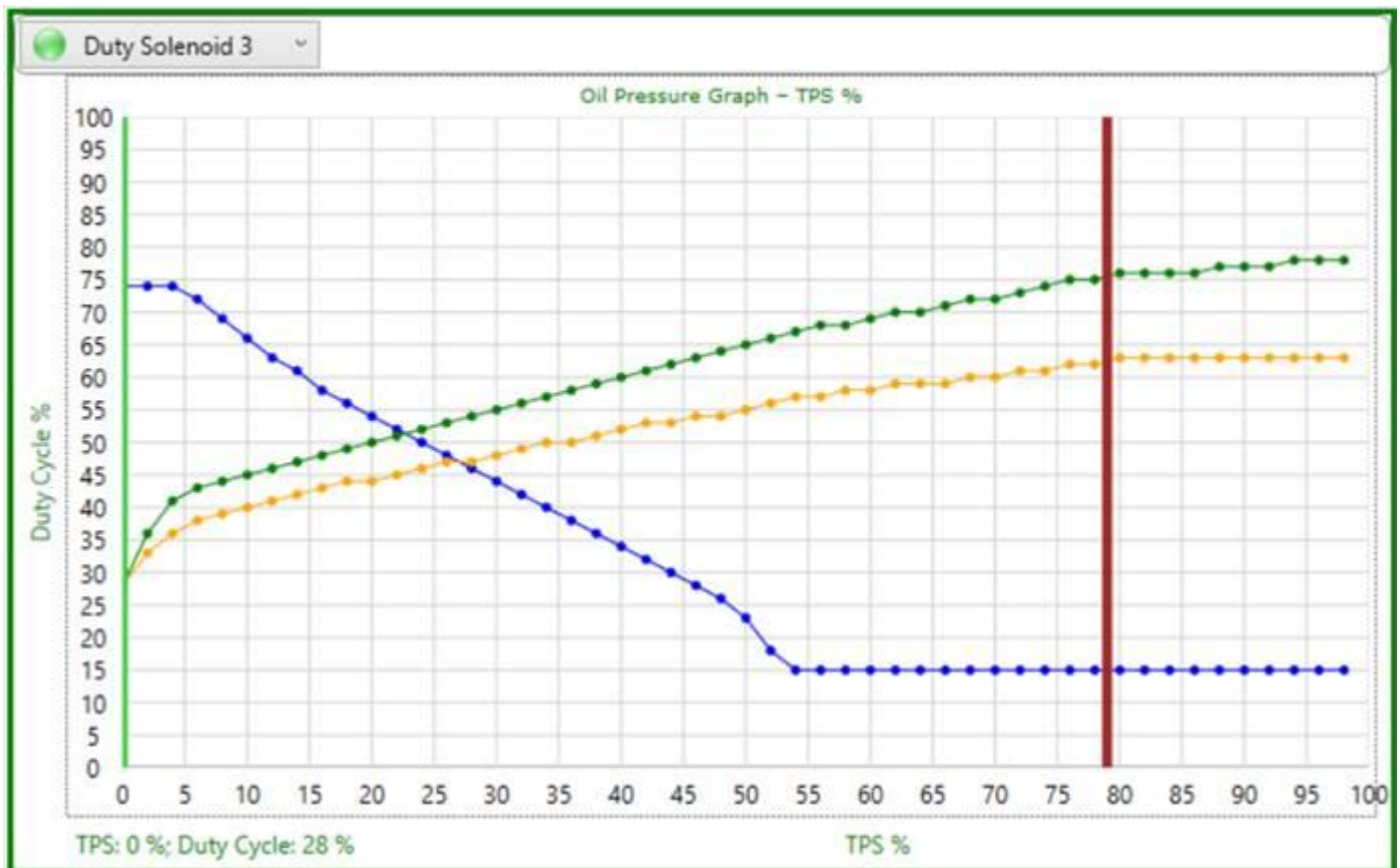
**NB. If at any time a gear slips immediately back off the throttle and increase the pressures according to the manual. These clutches are very small and could damage easily.**

Do not be afraid to play with the settings to see what the effect is. This way you will understand the operation of the TCU. Always start with the light load settings and if it feels like the clutches is slipping release the throttle and adjust the pressures.

## Graphs

Start with graph 1 and feel the shift firmness between 3<sup>rd</sup> & 4<sup>th</sup> and also 4<sup>th</sup> & 5<sup>th</sup> gears. The reason is that you need to determine a line pressure first which will then be applied to the lower gears. Make sure that the transmission is now on operating temperature. It should be from 50°C to 70°C

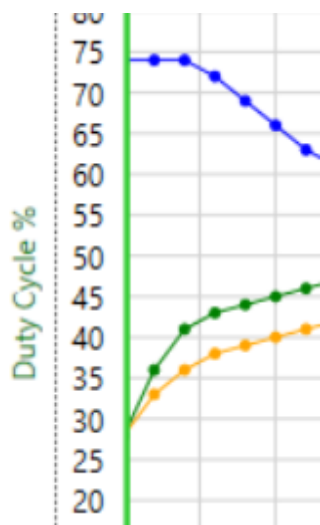
Now start with 1<sup>st</sup> to 2<sup>nd</sup> gear at a very light throttle like 5%. If it is a hard shift lower the graph 2 line at that TPS value. If it sounds as it slips or does not get 2<sup>nd</sup> gear and the software indicates 2<sup>nd</sup> raise the graph till it shifts to 2<sup>nd</sup> gear. If it shifts acceptable go to 3<sup>rd</sup> gear. The graph 3 line should be around 10% to 15% higher than the graph 2 line. Notice if there is a slip between the shifting process raise the line till it connects firmly. If the shift is too harsh lower the line slightly and test again. If this pressure is too high it will try to engage 2<sup>nd</sup> and 3<sup>rd</sup> gear simultaneously causing the engine to loose RPM as the transmissions will try to lock up. If you cannot get a firm shift it means the main line pressure is too low at that TPS value. Decrease graph 1 line slightly and test again. Now increase the throttle by 10% or more and adjust it the same as above. Repeat the process till you are at 100% TPS value. The graph should have a profile like below.



## Gear Profiles

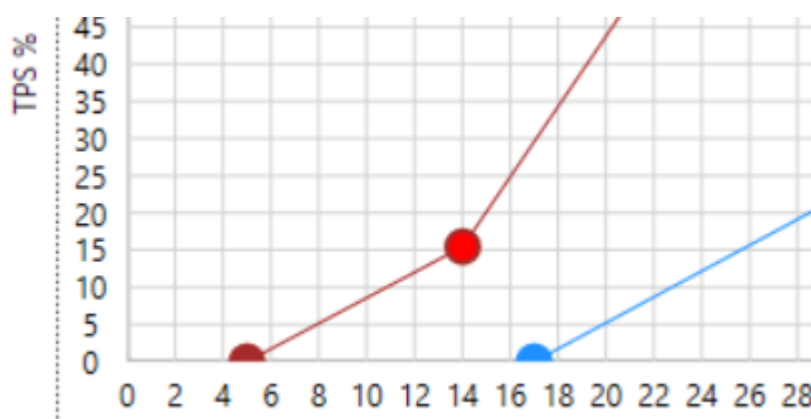
Again see the tuning part in the manual for setting up the profiles. The A650E transmission has free-wheel clutches in 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> gear when the shifter is in the Drive position. This is a safety feature should a sensor or TCU fails during driving and the TCU does an accidental shift to a lower gear. For off-road braking you need to put the shifter in 2<sup>nd</sup> or 1<sup>st</sup> position to achieve engine braking. Note that 2<sup>nd</sup> the engine braking is achieved by the applied line pressure to the clutch. Note on the picture below how the line pressure is dropped at 0% TPS. This will release the clutch and freewheel 2<sup>nd</sup> gear. The moment the throttle increase in TPS value, the pressure will be up and 2<sup>nd</sup> will engage in positive drive. Drop it just far enough so that total free wheel is achieved. If

you de accelerate from 3<sup>rd</sup> gear and 2<sup>nd</sup> is engaged, it must not have engine braking at close throttle. If you can feel 2<sup>nd</sup> engage or see a slight RPM increase, reduce both the 2<sup>nd</sup> and 3<sup>rd</sup> graph values.



Another thing to keep in mind here is to reduce the speed and RPM for shifting to 2<sup>nd</sup> when you reduce speed with the vehicle. Do the following adjustments.

### 3<sup>rd</sup> Gear



This engine idles at 700 RPM. As you can see the brown bottom dot is at 500 RPM which means the TCU will not shift down on RPM. This is set like that because the free wheel clutch will let the engine idle even if you are going at 50 Km/h. so to get it to shift to second set the gear down speed low.

Gear down speed  (Kph)

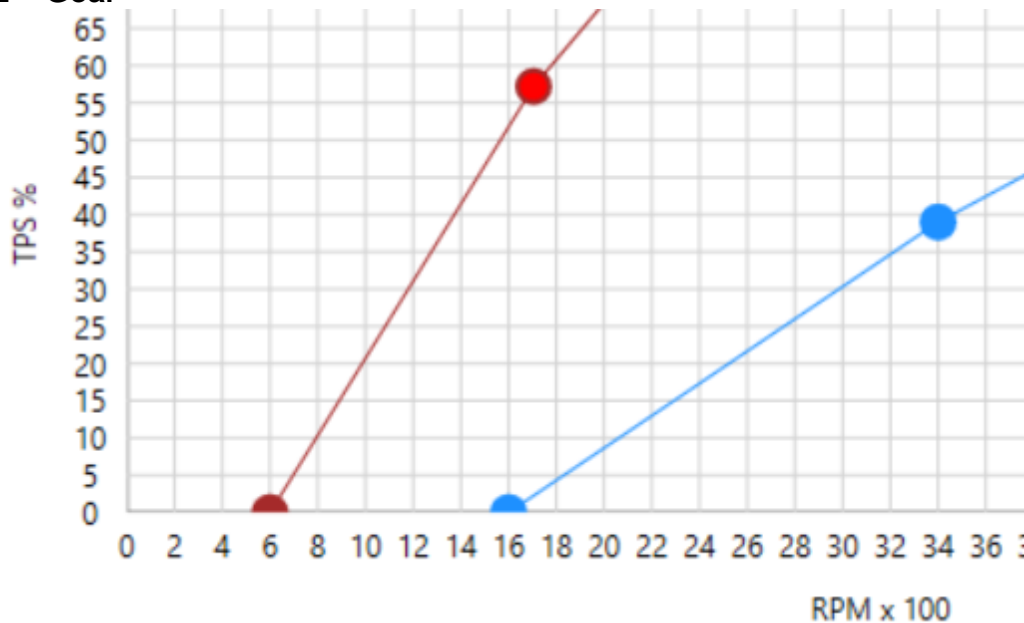
Also note the middle brown dot is set at 15% TPS and 1400 RPM. Should you accelerate fast it will engage the 2<sup>nd</sup> quickly while power is still low. Then the harsh kickback will be reduced. You can also set the speed limit so that any downshift above this speed will not be permitted.

Kick Down Speed  (Kph)

Note that this system does have a feature with Ver 3.5A ECU software to retard the timing of to soften the shift process. It does not control the fly by wire throttle so if you press the accelerator the TCU cannot reduce the power too much for a smooth shift. The shift from 3<sup>rd</sup> to 2<sup>nd</sup> and from

2<sup>nd</sup> to 1<sup>st</sup> may be very harsh because the engine is powerful. However the shift will come quick and without delay from the TCU. Set the profiles so that it does not kick back to 1<sup>st</sup>. Also from 3<sup>rd</sup> to 2<sup>nd</sup> must be set at low speed and low rpm.

## 2<sup>nd</sup> Gear



Again notice that the low brown dot is below RPM idle setting. This means that this profile will not downshift on RPM value but on speed. Set the gear down speed very low as this engine can use second gear for pull-off if you did not come to a complete stand-still.

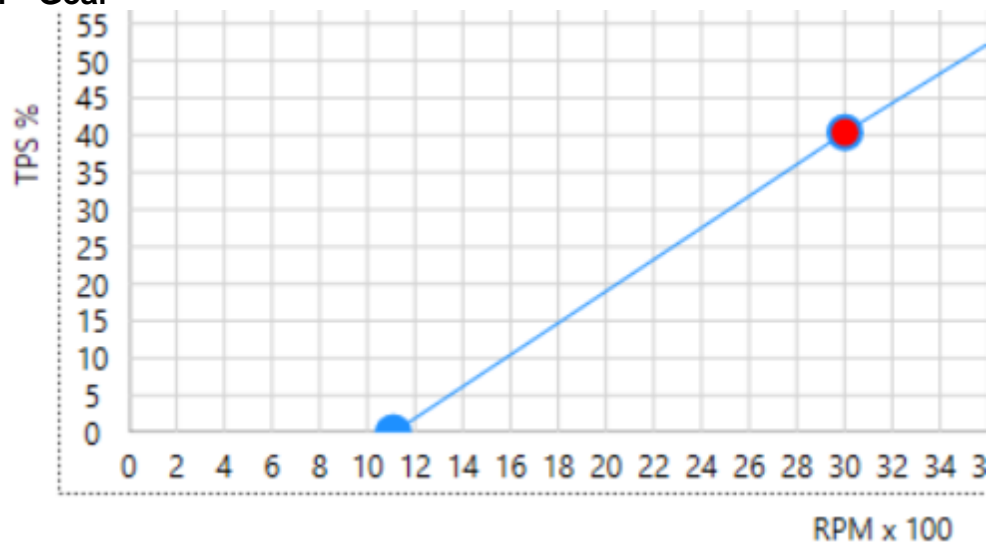
Gear down speed  (Kph)

Note also that the brown line goes up steep so a kickback to first will only occur when the throttle is blipped. You can also prevent kick back with the kick down speed setting.

Kick Down Speed  (Kph)

Remember to drop the line pressures as discussed at closed throttle.

## 1<sup>st</sup> Gear



1<sup>st</sup> gear is straight forward, set it up to select second gear quickly as the engine has enough power in second to accelerate. Then the amount of energy put on these clutches are reduced and the

wear and tear will be minimum. Important to note is than the gear down speed in 1<sup>st</sup> is actually a gear up speed and it must be higher in value than the 2<sup>nd</sup> gears gear down speed.

Gear up speed  (Kph)

This will prevent hunting between 1<sup>st</sup> & 2<sup>nd</sup>.

## Oil Temperature Compensation

For the A650E transmission oil temperature is critical due to the direct clutch system. We use the settings in oil temperature graph to lower the oil pressure applied to the 2<sup>nd</sup> gear when it is cold. It will also raise the pressure when it is hotter than normal. This will prevent harsh or slipping clutches. First tune the transmission at normal operating temperature till you are satisfied with the shift times and load settings. Start with the graph on the zero line. When the transmission is cold and second gear is harsh, decrease the graph line till the shift feels acceptable. When the transmission temperature goes above operating temperature, then the pressure must be raised to achieve a smoother shift. Never make it too soft. The graph should look like below.

