Ford
Electronic Engine Control (EEC)
Tuning Notes

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Accelerator Pump

Overview

In the RUN and UNDERSPEED modes, whenever the rate of change of throttle angle exceeds a minimum value, acceleration enrichment fuel is delivered until the manifold filling effect is completed (LOAD stops increasing). The fuel is delivered at a rate determined by AEFUEL.

AE fuel is delivered synchronous with the base fuel pulse. AEFUEL is added into the FUELPW calculation

Parameters

accelerator_pump_multiplier
This is a global accelerator pump multiplier.

accelerator_pump_fuel
This is a table of throttle rate vs. coolant temp for fuel to be added in during an accelerator pump shot.

accelerator_pump_BP_mulitiplier
This value is a multiplier of the accelerator pump shot based on barometric pressure.

Adaptive Strategy

Overview

See fuel section for more detail on the adaptive strategy.

Parameters

adaptive_min_ACT_to_allow_adaptive_learning

adaptive_max_ACT_to_allow_adaptive_learning

This the min and max values of the air temp in which you will allow the PCM to learn/adapt. If you have a blower car with the air temp sensor moved, the max value probably needs to be raised to around 200F or slightly higher.

adpative_correction_max_allowed_learned

adpative_correction_min_allowed_learned

Sets the min or max amount of adaptive learning. The numbers are based on a base value of 0.50. Numbers below 0.5 are leaner. Numbers above 0.5 are richer. A good value for minimum is .1 (this would allow a correction of .5-.1 or 40% correction) and a good value for maximum is .9.

adaptive_control_switch

turns off adaptive control if set to 0

fuel_adaptive_table

A positive number is this table means you will allow learning at that speed and load point after that much time has elapsed. A negative number means you do NOT allow learning, but instead apply a correction to that cell. If the cell has –11 in it, that means you apply the correction that was learned in cell 11, row 1 column 1.

fuel_adaptive_WOT_sw

These are only used in trucks. Many trucks will stay closed loop at WOT. This can be seen when their fuel_open_loop function and/or the TP_for_WOT are set very high making it impossible to satisfy these criteria and thus staying closed loop. This will cause the engine to stay closed loop at WOT. To make engine run open loop at WOT, a must for supercharged applications, both the above functions have to change as well as fuel_open_loop_switch must be set to zero and fuel_adaptive_WOT_sw must also be set to zero.

Alternator

Parameters

alternator_WOT_cutout_TP
For vehicles with an EEC controlled alternator, this is the throttle position at which the alternator will be disabled for more power.

alternator_WOT_turnon_TP
For vehicles with an EEC controlled alternator, this is the throttle position at which the alternator turns back on after being shut off for WOT operation.

alternator_WOT_voltage_turn_on
For vehicles with EEC controlled alternators, this is the voltage at which the alternator will turn back on at WOT.

Barometric Pressure (BP)

baro_pressure_max

baro_pressure_min

This are the min and max BP values that the EEC will calculate.

On a blown car the BP calculation will not be correct so both of these values should changed to around 27 to prevent learning false BP's.

On a fairly stock N/A car, these can be left alone. On a heavily modified N/A, they should be set to 27 like a blown car.

BP_sensor_sw

This is a software switch to shut off the BP sensor. A value of 0 shuts off the BP sensor.

Canister Purge

Overview

Canister Purge refers to the solenoid and valve combination that is located in the line between the intake manifold and the carbon canister. When the solenoid is energized the valve opens, allowing the flow of vapors from the canister to the intake manifold.

The strategy enables canister purge during various engine operating modes. These modes are calibration items. Typical calibrations will enable purge when these conditions are met:

1) Fuel control is in the desired mode. The calibrator can choose between purging during closed loop only or during both open loop and closed loop.
2) The engine has warmed up.
3) The engine has not overheated.
4) The 'Not at Closed Throttle' delay has been met.

The strategy includes a feature to prevent the rich surge that may occur on purge turn on. When the purge is enabled the output is cycled on and off at a 10Hz frequency with a variable duty cycle. The duty cycle ramps up to slowly introduce the canister vapors.

Parameters

canister_hp

This is a switch to shut off the canister purge hardware. Making this a 0 will disable the entire purge system. This is only available on older models.

Electric Fan Control

Overview

The electric fan provides additional air circulation for engine cooling purposes under circumstances where an engine-driven fan is inadequate, i.e., low vehicle speed or unusually high engine temperatures. To minimize accessory load on the engine, the fan is always turned off during CRANK Mode.

The EEC controls the state of the cooling fan. The fan may be operated at either high or low speed. The strategy controls the state of the fan via two outputs as shown in the truth table below.

The cooling fan is turned on at low speed if:

1) The engine temperature is higher than normal (approximately 216 deg F);

2) The A/C is ON and the vehicle speed does not provide enough natural airflow (approximately 43 MPH).

The cooling fan will turn on at high speed if:

1) The engine temperature is higher than desirable (approximately 230 deg F) and the fan has been operating at low speed.

2) ECT sensor is out of specification.

The cooling fan will turn off if:

1) The driver demand is high (WOT type Mode as defined by A/C Cutout Strategy); or
2) The A/C clutch is not cycling rapidly; OR
3) Vehicle speed is high enough to provide enough airflow for engine cooling. provided the engine coolant temperature is not too high.

	CPU OUTPUT (Software)		EEC OUTPUT (Hardware)	
FAN STATE	EDF	HEDF	EDF	HEDF
Off	1	0	On	Off
Low speed	0	0	Off	Off
High speed	0	1	Off	On
Not Used	1	1	On	On --> NOT USED

Note: OFF = 12V (Referenced to ground)
ON = <1V (Referenced to ground)

Parameters

low_speed_fan_off_ect
This is the coolant temp to turn the low speed off.

low_speed_fan_on_ect
This is the coolant temp to turn the low speed on.

low_speed_fan_MPH_to_turn_off
This is the MPH that the low speed fan turns off, meaning there is enough air flow to cool the engine without the low speed fan being turned on.

low_speed_fan_MPH_to_turn_back_on
This is the MPH, that when slowing down, the low speed will be allowed to turn back on.

high_speed_fan_off_ect
Temp to turn off the high-speed fan.

high_speed_fan_high_load_temp_to_turn_on
Temp to turn on the high-speed fan for heavy loads.

high_speed_fan_on_ect
Temp to turn on the high-speed fan.

high_speed_fan_high_load_load_to_turn_on

high_speed_fan_high_load_RPM_to_turn_on

high_speed_fan_high_load_VS_to_turn_on
These three values can control the high speed fan to turn on sooner, based on the driving situations.

HIGH_SPEED_FAN_MIN_HIGH_LOAD is the calculated engine load that must be exceeded, along with three other parameters to bring on the high speed fan sooner.

HIGH_SPEED_FAN_MIN_RPM_FOR_HIGH_LOAD is the engine RPM that must be exceeded, along with three other parameters to bring on the high speed fan sooner.

HIGH_SPEED_FAN_MAX_VS_FOR_HIGH_LOAD is the vehicle speed the vehicle must be no faster than, along with three other parameters to bring on the high speed fan sooner.

If the above three criteria are met, the high speed fan will come on if the coolant temp is greater than HIGH_SPEED_FAN_ON_HIGH_LOAD.

fan_high_speed_ect_off
Temp to turn off high-speed fan.
(lower temps for on off equally, ie if you lower fan off by 20 degrees make sure you lower the fan on by 20 as well. Most cars have a hysteresis of 4 degrees but it's better to lower everything the same)

fan_high_speed_ect1_on

Temp to turn on high-speed fan for heavy loads.

fan_high_speed_ect2_on

Temp to turn on high-speed fan.

fan_low_speed_ect_off

This is the coolant temp to turn the low speed off.

fan_low_speed_ect_on

This is the coolant temp to turn the low speed on.

fan_min_low_speed_on_time

This is the minimum amount of time that the low speed fan is allowed to be.

desired_coolant_temp_fan

This is the desired coolant temp when a vehicle is equipped with a variable speed fan, like a Mark 8 or some newer vehicles.

Engine and EEC Specific

Parameters

clock_speed

Processor clock speed

Engine_displacement

Engine_displacement_(L*.0234394)

This value is the displacement of ONE cylinder times .000044256. This is a conversion to get the mass of air at standard temperature and pressure of one cylinder. When changing engine size it's easier to ratio this value up and down by the difference in displacement rather than calculate it.

For Example, this value on a 4.6L engine is .0015531. If you stroked this motor to 298 CID, you'd take 298/282 and multiply this by .0015531 to get a value of .001641.

firing_order

This is the firing order of the engine.

firing_order_to_injector_number

This is the number in the firing order and its corresponding injector number.

manifold_volume_(liters)

This is the volume of the intake manifold in liters. This is used as part of an accelerator pump logic in the newer cars.

Minimum_pip_period_V6

Minimum_pip_period_V8

Minimum_pip_period_I4

The preferred method of rev limiting on older vehicles, like Mustangs was to shut off the fuel when a PIP signal was recieved, sooner than a calibrated value for a V8.
This is a time in clock tics.

To calculate this value for an EEC-IV car, take 25,000,000 divided by (one half the number of cylinders time max RPM), or 25,000,000/(1/2 number of cylinders times max RPM).

To calculate this value for an EEC-V car, take 11,250,000 divided by (one half the number of cylinders time max RPM), or 11,250,000/(1/2 number of cylinders times max RPM).

number_of_cylinders

This is the number of cylinders in the engine.

MIL_light_sw

This disables the check engine light. If you set this to 0, the light will never come on for any code. The codes will still be set, but light will not come on.

obdII_MIL_switch

obdII_tst-switch

If you want to make it so the EEC does not run all of the OBDII tests, you can change the obdII_tst_switch . The recommended value for this is 18. The obdII_MIL_switch determines which OBDII tests will turn on the check engine light.

Exhaust Gas Recirculation (EGR)

Overview

The EGR (Exhaust Gas Recirculation) system does two things. One it reduces emissions of oxides of nitrogen and second it will improve fuel economy. There are only a few parameters for EGR control.

The first is the ability to shut the EGR completely off, EGR_TYPE_SWITCH. If this switch is set to zero (0), then the EGR system used is the old style sonic EGR found on older 5.0L engines. If the switch is set to one (1) then it uses a feedback pressure sensor to determine EGR flow, most modular engines use this switch. If this switch is set to two (2), then this shuts off the EGR system.

There is a table of engine RPM and load that determines how much EGR is desired to be flowing into the engine at those points, EGR_FLOW_RATE_SEA_LEVEL and EGR_FLOW_RATE_ALTITUDE. There are only a few reasons to change the flow rate of the EGR system. If you install cylinder heads that have a dramatically different burn rate in the combustion chamber, like FRPP 2V heads, you will need to reduce the EGR flow to prevent the engine from bucking. The EGR flow rate should be reduced in increments of about 2% each time to prevent this from happening.

Some vehicles that use a Bullitt intake manifold, will also suffer from a slight bucking condition due to excessive EGR. On these vehicles, it is also recommended to reduce the amount of EGR flow.

Totally shutting off EGR will not gain any power since the EGR system is shut off wide-open throttle. But, by eliminating the hot exhaust gas from flowing into the engine, the temperature of the intake manifold and cylinder heads can be reduced and power can be gained from the engine running cooler.

Sonic Exhaust Gas Recirculation

The Sonic Exhaust Gas Recirculation (EGR) system offers a high degree of flexibility. The chief benefit is improved drive and fuel economy. The abilities are:

1. EGR flow can be precisely varied depending upon engine operating conditions.
2. Spark advance can be precisely adjusted to compensate for the actual EGR flow.

The Sonic EGR system consists of:
1. Sonic EGR valve
2. EGR valve position (EVP) sensor
3. Electronic Vacuum Regulator (EVR)

The EGR valve controls the flow of exhaust gases to the intake manifold. The pintle valve and seat assembly are designed such that EGR flow is proportional to pintle position. Further, the output of the EVP sensor is directly proportional to the pintle position. This design allows direct calculation of EGR flow.

The EGR valve is operated by manifold vacuum. The EVR:

1. Applies vacuum to the EGR valve (increases EGR flow).

2. Holds in existing EGR valve vacuum (maintains EGR flow).

3. Vents EGR valve vacuum to atmosphere (decreases EGR flow).

The strategy enables EGR during various engine operating modes. These modes are calibration items. Typical calibrations will enable EGR when these conditions are met:

1. Time since start is greater than a calibration value.
2. Engine is in part throttle mode.
3. Current EGR valve position is not less than the fully closed position.

Sonic Exhaust Gas Recirculation

The PFE EGR system was developed as a subsonic alternative to the Sonic EGR system. The PFE EGR provides a projected reliability improvement over the Sonic system while still providing the flexibility and spark compensation characteristics of Sonic EGR.

Like the Sonic EGR subsystem, PFE EGR precisely regulates the EGR flow according to calibrated Tables and fox functions. However, the PFE EGR strategy uses pressure (EPT) as the feedback signal rather than pintle position (EVP). The PFE_EGR system consists of:

1) Tapered pintle ported EGR valve.
2) Downstream pressure sensor (EPT).
3) Control orifice.
4) Electronic Vacuum Regulator (EVR).

Since PFE EGR is a subsonic flow system, the EGR flow is proportional to the pressure drop across a sharp-edged orifice (PE - DP). PE, the upstream pressure, is calculated by the software. DP, the downstream pressure, is measured by means of a piezo-resistive transducer (EPT). The EGR valve itself operates as the downstream pressure regulator. When the valve is closed, the downstream and upstream pressures are equal. As the valve opens, the downstream pressure decreases due to the influence of the intake manifold vacuum.

Fig. 1

```
       Control            EGR
       Orifice            Valve
         |                  |
         V                  V
       --------------------------------------------
         |                 \   /
         |                  \ /     Intake
  PE, "H20     DP, "H20      \/     Manifold
         |                   /\      Vacuum
         | Control chamber  /  \
         |                 /    \
      --------------------------------------------
```

The EEC operates the EGR valve by outputting a variable duty cycle to the EVR. The EVR applies a vacuum signal, which is proportional to the duty cycle, to the EGR valve. The frequency of the duty cycle ranges from 90-180 Hz. The operation of the EVR is described near the end of this Chapter.

The strategy enables EGR during various engine operating modes. These modes are calibration items. Typical calibrations will enable EGR when the following conditions are met:

1) Time since start is greater than a calibration value.
2) Engine is in part throttle mode.

Parameters

egr_flow_rate_altitude

egr_flow_rate_sea_level

This is the percent of EGR that is desired to have flowing into the engine at the given speed and load (volumetric efficiency) point. Normally you would not have to change this, but some newer vehicles run a large amount of EGR and this can cause some slight surging or bucking during cruise. This can happen in some engines if the amount of EGR is above 10%. To prevent this reduce the amount of EGR to no more than 10% in any table. When switching to different burn rate combustion chamber, like SVO 2V heads over the production head, you may have to reduce the amount of EGR that is desired.

egr_multiplier

You can reduce the amount of EGR by just changing this value.
Making this value .8 means the desired EGR will just be multiplied by .8, or 80% of desired.
This is just an easier way reduce the amount of EGR.

egr_spark_adder

Adds spark based on EGR flow rate.

egr_type_switch

This is a switch to change the EGR type.

0 = is a sonic type EGR system (used on most older 5.0L's).
1 = is a delta PFE system, used on most 4.6L's.
2 = shuts off the EGR system

Fuel

Overview

Like spark there are a few versions of fuel control. They are very similar to each other. Air-fuel ratio is calculated in Lambda rather than actual A/F ratio. All this means is the output of the fuel tables is referenced to 14.64:1 air fuel ratio. A lambda of 1.0 is 14.64:1 A/F ratio, a lambda of .82 is .82 times 14.64 or 12:1 A/F ratio. This is important to remember since there are multipliers of A/F ratio. A smaller multiplier, say less than 1, makes the engine richer and a multiplier greater than 1 makes the commanded A/F ratio leaner. For example, if you were running .9 commanded lambda, and had a multiplier of .9, the commanded lambda would be .9 time .9 or .81 which is just under 12:1 A/F ratio.

The older software versions use a table of RPM and ECT to determine the desired A/F ratio, Fuel_open_loop and then this is multiplied by a WOT multiplier based on RPM, fuel_WOT_multipy and multiplied by a function based on ACT, fuel_ACT_multiply. Now, neither of these WOT fuel multipliers are used until you reach what the EEC thinks is WOT. This point is either a single scalar for throttle position or a function of RPM and the output being what throttle position to call WOT. Both the scalar and the function have the same name, TP_for_WOT.

Most software uses a fuel_base_table, which is RPM and load based. The output of this table is also multiplied by a WOT multiplier based on RPM, fuel_WOT_multipy and multiplied by a function based on ACT, fuel_ACT_multiply.

The newer software still uses a fuel_base_table, but rather than load on the Y-axis it uses throttle position on the Y-axis. Also, there is no longer a fuel_WOT_multipy based on RPM or a fuel_ACT_multiply based on ACT. So, you must use the fuel_base_table to change the commanded A/F ratio.

Now, if the engine is cold, it does not use the fuel_base_table for what A/F ratio to run. If the coolant temp is below fuel_ECT_to_switch_base_table, then is uses a cold start table. That cold start table is not included in this software to change, since there should be little reason to change it. Many cars have this temp set at around 180F, which means if you put in a colder thermostat, it may not run off the fuel_base_table for open loop fuel. That is why it's important to check and change this value. If the coolant gets above fuel_ECT_to_switch_base_table, and then cools below fuel_ECT_to_clear, it will switch back to the cold start tables.

This is how WOT A/F ratio is determined. Next is how you get to open loop conditions.

Depending on the software, there are two ways to get into open loop fuel. One is throttle position. fuel_open_loop is a function of RPM on the X-axis and throttle position to go open loop on the Y-axis. Once you reach that throttle at that RPM, it will go open loop. The newer software only has this function.

Some of the older software uses a scalar to go open loop, this scalar is TP_for_WOT. In some software there is also a function called TP_for_WOT, they both do the same thing one is just a function of RPM and the other is just a single TP point for WOT. Once this value is achieved then open loop fuel is commanded.

Some software may have both the TP_for_WOT and the fuel_open_loop function. In these cases you will have to change both.

The main reason for wanting to change the throttle position to go open loop at is on blown cars. Once you begin to develop boost, you will want to enter open loop fuel control to avoid getting any knock.

Now, in the older software, you can go open loop based on load and time. There is a function of engine RPM vs. Load, open_loop_load_RPM and open_loop_load_ECT. If you are at that engine RPM or that ECT, and you exceed the load timer, Time_to_delay_open_loop_RPM or Time_to_delay_open_loop_hys or time_to_delay_open_loop_ECT, (you will only have one of these timers) then you will go open loop fuel control.

In the new software (typically 2002 and up) these functions to go open loop are changed to a table, open_loop_delay, of RPM on the X-axis and what gear the EEC thinks the transmission is in, on the Y-axis. The output of this table is the time delay to go open loop. There is no load input in this table though. Then there is a scalar, also called open_loop_delay that allows a ramp from closed loop fuel to open loop fuel control. This timer should be set very low.

Now, why go to open loop fuel based on load. Again, this is more for blown cars where you can make boost at a throttle position lower than TP_for_WOT or fuel_open_loop, and you want to go open loop when that happens.

This logic is similar to the lugging mode of the old software, prior to 1994. Here is a review of what was explained earlier.

If you are at a high enough load, fuel_load_enable_lug_mode, for this amount of time, fuel_time_at_load_lug_mode, and are between these two ECT temps, fuel_lug_mode_min_ECT and fuel_lug_mode_max_ECT, then you will go open loop A/F control and you take the A/F ratio that comes out of the base table and multiply it by this function, fuel_lug_mode_multiplier, of RPM vs. Fuel multiplier.

Adaptive Fuel

Fuel injected systems may exhibit vehicle to vehicle steady state A/F ratio errors due to normal variability in fuel system components.

The adaptive fuel strategy attacks this problem by memorizing the characteristics of the individual fuel system being used. This memorized information is used to predict what the system will do based on past experience.

The ability to predict fuel system behavior improves both open loop and closed loop fuel control. As an example, the memorized information can be used on cold starts to achieve better open loop fuel contol before the EGO sensor reaches operating temperature.

The chief benefit of the adaptive fuel strategy will be to reduce the effects of product variability in the field.

The memorized or adaptive information is stored in table form in the Keep Alive Memory (KAM). KAM is continuously powered by the vehicle battery even when the vehicle is shut off. As a result, the table is not lost on vehicle shutdown.

Basically when the EEC is closed loop, it will learn the correction it needs to keep the engine at 14.64:1 A/F ratio. It learns values in a table that has engine RPM on the X axis and Load on the Y-axis. The table is 10 columns and 8 rows, so there are 80 cells. There is a table for each side of the engine, so each side learns on it's own. There are minimum temps that you have to meet to allow learning, but with a few exceptions, none of these need to change.
A lot of cars, let's use the Mustang as an example, in production form, only allow learning in a few cells and then apply that correction to the rest of the cells. I think the Mustangs only learn in about 4-8 cells and then apply that correction everywhere else. From a production standpoint, this is an OK strategy. You are assuming you have flowed enough MAF, airbox and clean air tubes, to develop a good average air meter transfer function. So, any change from this must be the result of an air meter or injector shift, and thus you can shift the entire fuel curve based on only a few points.

Now, once the guy changes the MAF and moves it around, that nice transfer function no longer applies. So, you try to develop one on the dyno using a wideband sensor. Are you as accurate as the factory, no, but it's decent.

The problem is if you don't change the way the adaptive fuel applies its correction, you could end up with some real problems. If it's too rich in the cells you are learning in, A Mustang typically only learns at like 1500 rpm, .4 load) then you apply a correction at WOT to take fuel out. A few days later, the car knocks and that's bad.

There is one adaptive table that needs to be changed, fuel_adaptive_table. A positive number is this table means you will allow learning at that speed and load point after that much time has elapsed. A negative number means you do NOT allow learning, but instead apply a correction to that cell. If the cell has -11 in it, that means you apply the correction that learned in cell 11, row 1 column 1.

Many times the table is not normalized to use the entire 80-cell table, but rather a small part of it. I recommend changing the normalizers to use the entire table. Typically I'd make the RPM go from 750 to 4350 (you won't be closed loop much past 4350 RPM) from cell 0 to cell 9 and change load to go from 0 in cell 0 to .9 in cell 7. This gives a good balance of learning in all cells.

For working on the dyno, it is recommended that you disable the adaptive fuel so you when you are trying to dial in the air meter transfer function, you are not using correction that it has learned. In the 1996 and up software there is a switch you can set to zero to disable learning fuel correction, adaptive_control_switch.

In addition, there are minimums and maximums that you allow to be learned in the cells. In most applications the factory has it setup to learn 25% correction either way. Once you start changing air meters and things like that, it becomes difficult to verify that each cell is correct. So, it is recommended to open up min and max allowed learned to .1 for the minimum and .9 for maximum. The min and max values are adaptive_control_maximum and adaptive_control_minimum.

The following is a list of miscellaneous fuel values that can be changed and why.
fuel_min_inj_pulse_width

When changing fuel injectors to larger injectors, this value needs to be lowered. The easiest thing is to lower this value to zero to ensure you don't get an overly rich condition when you change injectors.

```
Special idle
adaptive cells ---->|-42 -42 -42 -42 -42 -42
                    |
                 7  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
                    |
                 6  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
                    |
                 5  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
                    |
                 4  |-42 -42  20 -42 -42 -42 -42 -42 -42 -42
 NORMALIZED         |
  ENGINE         3  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
  LOAD              |
 (LOAD)          2  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
                    |
                 1  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
                    |
                 0  |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42
                    -----------------------------------------------
                      0   1   2   3   4   5   6   7   8   9
                    NORMALIZED
                    ENGINE SPEED
                        (N)
```

Returnless Fuel Control

In an electrical returnless fuel system vehicle the returnless system actually controls the pressure drop across the fuel injector. It does NOT control fuel rail pressure. The sensor on the fuel rail has a manifold vacuum/boost line hooked to it that feeds in the pressure in the manifold. The sensor is mounted to rail so the output of the sensor is actually the pressure drop across the injector. The flow of a fuel injector is dependent on the pressure drop across the fuel injector.

So, the EEC is closed loop on the fuel pressure drop across the fuel injector as measured from the sensor. If the pressure is too low, it increases the voltage to the fuel pump to get it back to where it should be. If the pressure is too high, then it lowers the voltage.

There is a lot of things that can be done with the electronic returnless fuel system. If the fuel injectors are too small for the application, pressure drop across the fuel injector can be raised to make the injector flow higher. This is done via this function, fuel_pump_pressure_diff, which has an X, input of # mass per fuel injection event and the output on the Y-axis is the desired pressure drop across the fuel injector. The X values are fairly small. If you think about it, if you have an injector that has a flow rate of 30 #/hr and you have a fuel injection pulsewidth of .010 seconds, the flow rate per injection is 30 times 3600 (to convert #/hr to #/sec) and then multiply this by .010 seconds, the mass of fuel injected per that even is .0000833#.

Fuel pressure drop across the injectors can also be modified based on air temp from the ACT sensor, via fuel_pump_pressure. The X-axis input is ACT and the Y-axis output is the desired fuel injector pressure drop. This is important to change if you move the air temp sensor after the blower/intercooler to make sure you don't start running higher pressures than you need to be. There may be good reason to just raise the fuel pressure drop at higher air temps. If the motor has a blower and sees high temps, you can increase the fuel injector flow rate when it sees the higher air temp, thus only increasing the flow of the injector when air temp is high. For most blown applications with the air temp after the blower, you should make the Y-axis all 40's.

There is then a Proportional, Integral, and Derivative controller for the fuel pump to maintain the desired pressure. This is also known as a PID controller. The proportional term tries to take a step to getting the desired outcome (fuel pressure) to where it needs to be if there is an error. However, the proportional term can never really get to a point where there is no error since it takes steps. So, there is a point where the proportional controller does nothing, once the error is low enough. If set too high, the proportional term can cause instability in fuel pressure as it jumps back and forth around the desired pressure.

The integral controller tries to force the error (the amount you are away from where you want to be) to zero, so there is no error.

The derivative term tries to slow the system down to keep it from going unstable.

Let's give an example. Let's say you want fuel pressure to be at 40 psi, but it's at 50. The proportional term will give a step correction toward 40 psi by lower the voltage to the pump. Let's say this results in a pressure drop of 43 psi. Now, if the proportional term took another step, it would end up at too low of pressure, less than 40 psi, and overshoot the target. So, the proportional term stops when it gets to 43 psi (3 psi of error). Now the integral term tries to take this error of 3 psi to zero psi by more slowly changing the fuel pump voltage, by lowering it, until it sees 40 psi.

These fuel pressure gains, how big of a step in pressure it can make each time is changeable. fuel_pump_P_gain is the proportional gain. A good value for this, if you've changed the fuel pump is .15-.20 units. fuel_pump_I_gain is the integral term. A good value for this is .02-.04 units. And finally, fuel_pump_D_gain is the derivative gain. It is recommended to make this value zero. If fuel pressure is too unstable, meaning fluttering during cruise, or taking too long to get to the target value, then the P and I gain should be tweaked to make this OK.

The final player in the returnless fuel system is fuel_pump_voltage_table. This is a base table of what the fuel pump voltage should start at to be pretty close in pressure, based on Fuel flow and desired rail pressure. If you change the fuel pump, this table will change. Now, the EEC learns what voltage it needs to be at to get the fuel pressure it wants, so this table is only used upon an EEC reset. There are some recommended table values for this table.

Fuelinj_high_slp_mult_for_deltaP, fuelinj_low_slp_mult_for_deltaP

These are multipliers to the fuel injector high and low slopes based on the pressure drop across the injector as measured by the sensor on the fuel rail. When pressure is high, above 40 psi, the multiplier is greater than one giving a larger injector flow rate due to the higher pressure. If the multiplier is less than one, it gives a lower injector flow rate due to lower pressure.

There is logic to turn the check engine light on if fuel pressure is lower than it's suppose to be. The following is how this works.

First the rate of fuel pressure change has to be a certain value or less. This rate is fp_max_rate_of_change_to_test. It is recommended to set this value high, to around 50. Even if the pressure is dropping it is still desirable to run the test. If the rate criteria is met, then it checks for the actual fuel pressure. The actual pressure must be under fp_below_pressure_to_test, to look for pressure. If these two criteria are met, the test can run to check for low fuel pressure. For the light to turn on, fuel pressure must be fp_error_buffer below fp_below_pressure_to_test for fp_time_below_pressure_for_error time to turn the light on. Basically if actual pressure is fp_below_pressure_to_test minus fp_error_buffer, and the rate of fuel pressure change is less than fp_mx_rate_of_change_to_test psi per second, then you must be below the above pressure for fp_time_below_pressure_for_error and the light turns on.

Cranking Fuel

Crank fuel is very simple. In most applications crank fuel is a function of engine coolant temp and the output is the actual pulse width you want the fuel injectors to have during crank, CRANK_FUEL_PULSEWIDTH. In addition to this, there is a function for idle speed duty cycle during crank, CRANK_ISC_DUTY_CYCLE. The combination of the two of these allows you to change the cranking A/F ratio. More ISC duty cycle makes a leaner crank; less ISC duty cycle makes a richer crank. The same applies for the pulse width values; more pulse width is a richer mixture during crank.

Newer software uses a desired lambda ratio during crank, rather than a cranking duty cycle. This new function, CRANK_LAMBDA, takes into account fuel injector size and flow characteristics. In this version of software there is usually no need to change the commanded lambda during crank.

Parameters

base_fuel_table

Sets the A/F ratio, in lambda, in either open loop mode and/or at WOT. Older PCMs use the TP_FOR_WOT value, while newer models use the FUEL_OPEN_LOOP_TP function to determine when to go open loop. This value is lambda, not A/F ratio. So a value of 1 represents 1 times 14.64 for a A/F ratio of 14.64. A value of .82 means .82 times 14.64 for a commanded A/F ratio of 12:1.

fuel_open_loop

A function of RPM on the X-axis and throttle position to go open loop on the Y-axis. Once you reach that throttle at that RPM, it will go open loop. The newer software only has this function.

Some of the older software uses a scalar to go open loop, this scalar is TP_for_WOT. In some software there is also a function called TP_for_WOT, they both do the same thing one is just a function of RPM and the other is just a single TP point for WOT. Once this value is achieved then open loop fuel is commanded.

Some models may have both the TP_for_WOT and the fuel_open_loop function. In these cases you will have to change both.

fuel_open_loop_switch

These are only used in trucks. Many trucks will stay closed loop at WOT. This can be seen when their fuel_open_loop function and/or the TP_for_WOT are set very high making it impossible to satisfy these criteria and thus staying closed loop. This will cause the engine to stay closed loop at WOT. To make engine run open loop at WOT, a must for supercharged applications, both the above functions have to change as well as fuel_open_loop_switch must be set to zero and fuel_adaptive_WOT_sw must also be set to zero.

fuel_open_loop_VS_CL

fuel_open_loop_VS_SH

Not in all models, but this is a vehicle speed that once reached will make the car run open loop fuel all the time. There is no need for this and both these values should be set to 125.

fuel_time_to_switch_base_table

Switch to fuel_base_table after this time expires

Crank_fuel_pulsewidth

Just what it sounds like, the fuel pulsewidth in cranking mode as a function of coolant temp.Reduce the pulsewidth by the same percentage as the injector change.
(19 to 42 pound injectors = 19/30=.63 reduce the pulse width by 63%

crank_lambda

This is the desired A/F ratio during crank in lambda.
There is no longer a crank fuel pulse width, just a desired A/F ratio during crank.

desired_pressure_drop_across_injectors

The left column has input of # mass per fuel injection event and the output on the Y-axis is the desired pressure drop across the fuel injector. This can be raised to increase the flow rate of the injectors as long as the fuel pump can supply enough pressure. See fuel description for details.

fuel_injector_pressure_drop

This is the desired pressure drop across the fuel injector on a mechanical return less system. This value has no impact on a electronic return less system.
If this value is not 39 psi, then the injector flow rates may take into account this higher pressure drop, meaning a 30# injector may need a different value depending on how values are setup.

high_speed_fuel_enrichment

This allows more fuel to be added to the engine based on vehicle speed. This is a multiplier of commanded lambda, or A/F ratio.
A smaller number puts in MORE fuel when at the given speed.
A larger number puts in LESS fuel when at the given speed.

WOT_fuel_multiplier

Multiplies commanded open loop fuel, at WOT, by this amount.
A smaller number puts in MORE fuel when at WOT, at that RPM.
A larger number puts in LESS fuel when at WOT, at that RPM.

WOT_fuel_multiplier_for_ACT

Multiplies commanded open loop fuel, at WOT, by this amount based on the air temp.
A smaller number puts in MORE fuel when at WOT, at that ACT.
A larger number puts in LESS fuel when at WOT, at that ACT.

fuel_cutout_switch

This is a switch to disable any injector shut off, thus eliminating the rev limiter. Setting this to 1 results in no rev limiter. This is only used in a few rare cases where the correct rev limiter cannot be found, like the '99-01 Cobras and some Focus's.

fuel_ECT_to_clear

temperature (ect) at which to switch back to startup fuel mode as the engine cools

fuel_ECT_to_switch_base_table

stable engine temp at which to switch from startup fuel to fuel_base_table. Startup fuel is not included in the software as there is little reason to ever change it.

fuel_high_speed_enrichment

This allows more fuel to be added to the engine based on vehicle speed. The X-axis is vehicle speed and the Y-axis is a fuel multiplier. This should be changed so that all the Y values, or multipliers are 1.

Fuel Pump

Parameters

fuel_pump_ACT_pressure

Fuel pressure drop across the injectors can also be modified based on air temp from the ACT sensor, via fuel_pump_ACT_pressure. The X-axis input is ACT and the Y-axis output is the desired fuel injector pressure drop.

fuel_pump_prop_gain

is the proportional gain. A good value for this, if you've changed the fuel pump is .15-.20 units. See fuel description for details.

fuel_pump_integral_gain

is the integral term. A good value for this is .02-.04 units. See fuel description for details.

fuel_pump_derivative_gain

is the derivative gain. It is recommended to make this value zero. If fuel pressure is too unstable, meaning fluttering during cruise, or taking too long to get to the target value, then the P and I gain should be tweaked to make this OK.

fuel_pump_max_rate_of_change_to_test

fuel pressure rate of change must be below the value for MIL test. See fuel description for details.

fuel_pump_pressure_diff

has an X, input of # mass per fuel injection event and the output on the Y-axis is the desired pressure drop across the fuel injector. See fuel description for details.

fuel_pump_pressure_error_for_MIL

turn on MIL if fuel pressure test is below this value - fuel_pump_error_buffer. Test conditions must first be met. See fuel description for details.

fuel_pump_below_pressure_to_test

fuel pressure must be below this value to start MIL test

fuel_pump_error_buffer

subtracted from fuel_pump_pressure_error_for_MIL. See fuel description for details.

fuel_pump_system_type

type of fuel system

fuel_pump_voltage_table

This is a base table of what the fuel pump voltage should start at to be pretty close in pressure, based on Fuel flow and desired rail pressure. If you change the fuel pump, this table will change. Now, the EEC learns what voltage it needs to be at to get the fuel pressure it wants, so this table is only used upon an EEC reset. There are some recommended table values for this table.

Idle Speed Control (ISC)

Overview

In general, the ISC system is designed to regulate the duty cycle to an air bypass solenoid as necessary to obtain the desired engine speed for all idle operating conditions (base idle, hi-cam, various accessory loads) and provide for a dashpot action. Predicted airflows for the different load states at idle are adaptively corrected to minimize the impact of hardware variability. Acceptable quality on engines utilizing a speed density determined air mass requires a coupling of the ISC logic with both fuel (adaptive fuel, transient fuel, special AM filtering routine) and spark control strategies.

ENGINE CRANK MODE

Entry/exit conditions for this mode are defined in the engine mode select logic of the strategy book. In engine crank mode, the ISC duty cycle (ISDTY) is a function of temperature at start, TCSTRT. If the time between PIP signals exceeds two seconds, it is assumed that the operator is not cranking and the duty cycle is set to 0%.

DASHPOT PRE-POSITION MODE

In engine run/underspeed mode and when operating at part or wide open throttle, the ISC system is placed in dashpot pre-position mode. In this mode the ISC duty cycle is incremented a calibratible amount in anticipation of a required dashpot action. Proper dashpot operation is essential on systems having speed density fuel controls in order to avoid tip-in/tip-out stalls and HC (Hydrocarbon) spiking on decels.

DASHPOT MODE

In engine run/underspeed mode and having just transitioned from part to closed throttle, the system is placed in ISC dashpot control mode. The length of time the ISC system will remain in dashpot control is both hardware/strategy dependent (some applications have VSS; some manual transmission applications have gear and clutch switches) and calibration dependent. Regardless of the length of time required to enter RPM control, as long as closed throttle operation is maintained the amount of airflow specified by the dashpot pre-position (see dashpot pre-position logic) is decremented at a constant rate until exhausted (until DASPOT = 0).

For normal entry into Closed Loop (C/L) RPM control, the following conditions must be satisfied:

If VSS hardware used it must indicate a speed less than MINMPH.
If a manual trans. with gear/clutch switches, must indicate neutral.

Note: Although the system can provide acceptable function without the above-mentioned hardware, either item will increase reliability in production. The vehicle speed sensor has calibration benefits outside of ISC (lean Cruise control, etc.) and should be considered when specifying system assumptions for future applications utilizing ISC.

Regardless whether the above hardware is used, normal entry into RPM control requires that actual engine speed be less than or equal to (DSDRPM + RPMCTL) and that throttle position be less than or equal to (RATCH + DELRAT).

DASHPOT LOCKOUT OF RPM

The following discussion will attempt to describe entry into C/L RPM control through the lock-out logic (ISCFLG = 2).

In a normal deceleration the dashpot bleed time will be short relative to the vehicle coastdown time. As soon as engine speed drops low enough, the ISC system should enter RPM control. However, due to hysteresis in the bypass valve, over specification of idle airflow requirements prior to adaptive ISC learning, and/or ISC learning in an unusually high state of engine load (400 psi A/C head pressure, etc.), the ISC actuator may pass too much air at the specified idle duty cycle to allow normal entry in RPM control. When this condition occurs the system will remain in dashpot control until it can recognize that it should, in fact, be in RPM control.

CALIBRATION HINTS

This task is easy should you have a VSS or a manual calibration with gear/clutch switches. If this hardware is not present, then it is difficult to differentiate between a constant deceleration (as in a coast down a mountain) and a true locked-out of idle condition. Most of the logic in the Dashpot and RPM lockout Mode Selection deals with recognition of distinguishing features of each.

To differentiate between deceleration and idle, the rate of change in RPM is first evaluated over a calibrated period of time (ISCTM). If the speed has remained within a specified deadband (NDIF) for this time period, a second check is performed to compare LOAD with a calibrated LOAD value (LOWLOD for A/C off; LOWLOD + ACLOD for A/C on). The assumption is that all idle LOAD values, (including green engine, altitude effects, etc.) will be greater than this calibration parameter; and all true deceleration conditions, including the same variability's, will yield lower LOAD. To avoid incorrect interpretation of the LOAD value, great care must be taken in selecting the correct LOWLOD value.

If the ISC system were locked in dashpot control and both the rate of engine speed change and LOAD criteria were satisfied, the strategy would then be forced into C/L RPM control with ISCFLG indicating 2. This state would be present until the speed fell below the normal entry point. The adaptive ISC would learn the required correction, assuming sufficient time at idle, and subsequent dashpot to RPM control transitions should follow a normal entry path.

Logic controlling the dashpot pre-position airflow is intended to increase the ISC duty cycle during part/WOT operation. Strategy determines the rate at which ISC valve flow increases/decreases in part/WOT operation, as well as the maximum allowed pre-position airflow. Adequate pre-position airflow (DASPOT) is essential prior to entering the dashpot control mode in order to avoid HC (Hydrocarbon) spiking and/or deceleration stalls. The calculated pre-position airflow increment is added to an adaptively-corrected idle flow requirement (DESMAF) prior to output of the ISC duty cycle. Pre-position airflow (DASPOT) is a function of the difference between a filtered throttle position (DSTPBR) and a throttle position equal to the Closed Throttle breakpoint (RATCH + DELHYS). This value is clipped to zero as a minimum, if this difference becomes a negative value. DELHYS should be set equal to DELTA + HYSTS (Closed Throttle breakpoint). DASPOT can be clipped to DASMIN as a minimum if vehicle speed is high enough to prepare for declutch.

During Closed throttle mode, the DASPOT airflow is "bled off" by decrementing it. This action smooths the transition into RPM control by gradually eliminating the DASHPOT contribution to the idle airflow, DESMAF. The bleed rate is determined by FN879, unless clipped to DASMIN. When vehicle speed falls below DASMPH, normal bleed off will resume.

The EEC has a desired idle speed it wants the engine to be at in either park or neutral. It takes this RPM and uses these functions, isc_Drive_idle_air and isc_Neutral_idle_air, to determine how much air is needed to get the engine to idle at that RPM. It then takes that amount of air and determines the ISC duty cycle it needs to get that much air into the motor. These functions are what it uses determine how much air to put into the motor. If you change the load on the engine at idle, add a supercharger or change camshafts resulting in having less idle vacuum, then the amount of air to make the engine idle will probably change.

The EEC does learn and adjust for some of this but if the change made is too great, then it cannot and it will cause either stalling or idle surging issues. How to determine how much air is going into the motor will be explained later. These functions are desired RPM on the X axis and air in #/min on the Y-axis.

Parameters

isc_idle_speed_drive

isc_idle_speed_neutral

This is the desired idle speed in drive or neutral. There is a maximum clip on drive idle speed. If you try to set this higher than around 800 rpm (depending on the vehicle) the EEC will not command a higher idle speed in drive.

isc_rpm_adder_A/C_drive

isc_rpm_adder_A/C_neutral

This is the idle rpm adder for when the A/C clutch is applied when in either drive or neutral. There are separate adders for drive or neutral.

isc_rpm_adder_for_A/C

This is the amount of idle rpm to add when the A/C clutch is applied, and it does not matter if the vehicle is in drive or not.

isc_dashpot_gain

This is air that is added in via the idle speed control valve when at part throttle. When shifting a manual trans if the engine flares when the clutch is depressed, reducing this value helps reduce this flare.

isc_dashpot_preposition

This is the minimum amount of dashpot to have at a given throttle position.

isc_Daspot_clip_1, isc_Daspot_clip_2, and isc_Daspot_clip_3
This is the minimum amount of air that is allowed through the idle speed valve when the vehicle is moving. If a car coasts down too slow, you can lower this value, or if the car has shuffle during coastdowns, then you can increase this number in all the functions.

isc_dashpot_decay_rate

This is a decay rate when transitioning from the amount of air added at part throttle via isc_dashpot_gain down to the clip values from above. A smaller number makes this decay slower, a larger number makes it decay faster.

isc_daspot_clip_1

isc_daspot_clip_2

isc_daspot_clip_3

This is the minimum amount of air that is allowed through the idle speed valve when the vehicle is moving. If a car coasts down too slow, you can lower this value, or if the car has shuffle during coastdowns, then you can increase this number in all the functions.

isc_air_flow_T/B

This is the amount of air that flows through the throttle body, in #/min, across the throttle plate.

isc_duty_cycle_adder

This is a global adder to idle speed valve duty cycle.

isc_duty_cycle_multiplier

This is a global multiplier for the duty cycle on the ISC valve.

isc_idle_speed_drive

isc_idle_speed_neutral

This is the desired idle speed in drive or neutral. There is a maximum clip on drive idle speed. If you try to set this higher than around 800 rpm (depending on the vehicle) the EEC will not command a higher idle speed in drive.

crank_ISC_duty_cycle

Idle speed control valve duty cycle during crank.

IMRC

Parameters

imrc_hardware_present

This is a hardware switch to turn off the IMRC's. Setting this to zero shuts off the complete IMRC function.

imrc_opening_rpm

This controls the RPM to open the IMRC at as a function of engine speed. At the engine speed in the X column, the IMRC's would open if you were at the Y column in TP or greater.

imrc_open_hi_value

imrc_open_low_value

This determines when the IMRC's are considered open. If you are above imrc_open_hi_value in A/D counts from the sensor, it is considered open. If you are open and then they close to imrc_open_low_value, they are considered not open.

imrc_closed_hi_value

imrc_closed_low_value

This determines when the IMRC's are considered closed. If you are below imrc_closed_low_value then the IMRC's are considered closed. If they are opening, once they get above imrc_closed_hi_value, they are no longer considered closed.

Load_w/IMRC

Load_w/o_IMRC

Depending on the software, you will either have Load_w/o_IMRC and Load_w/IMRC or you'll just have Load.

Injectors

Parameters

fuel_injector_breakpoint

This is the point at which the PCM will switch from the low slope to the high slope for the fuel injectors.

For 50# injectors use .0000x.
For 42# injectors use .0000x.
For 36# injectors use .0000x.
For 30# injectors use .0000x.
For 24# injectors use .0000x.
For 21# injectors use .0000x.
For 19# injectors use .0000x.
For 14# injectors use .0000x.

The above values should be very close but may vary from the actual file that you have loaded. This is not an error, these values are just good recommendations.

fuel injector slope low

Take the size of injector you are using and multiply it by 1.15 to get a good starting point for low slope

fuel injector slope High

Enter the size of injector you are using- raise or lower this if you see a global rich or lean condition. It is the best way to get the majority of fuel tuning accomplished but you can only go up to 55 before it starts losing some of it's affect.

Injector slope, or flow rate. These values are in # per second of fuel flow. If you want to convert these to # per hour you would just multiply these values by 3600.

For 50# injectors use .0x High Slope and .0x Low Slope.
For 42# injectors use .0x High Slope and .0x Low Slope.
For 36# injectors use .0x High Slope and .0x Low Slope.
For 30# injectors use .0x High Slope and .0x Low Slope.
For 24# injectors use .0x High Slope and .0x Low Slope.
For 21# injectors use .0x High Slope and .0x Low Slope.
For 19# injectors use .0x High Slope and .0x Low Slope.
For 14# injectors use .0x High Slope and .0x Low Slope.

The above values should be very close but may vary from the actual file that you have loaded. This is not an error, these values are just good recommendations.

fuel_injector_minimum_pulse_width

The Minimum injector pulse width allowed. This should set to a value when the injector is still in its linear range.

For 50# injectors use .00x.
For 42# injectors use .00x.
For 36# injectors use .00x.
For 30# injectors use .00x.
For 24# injectors use .00x.
For 21# injectors use .00x.
For 19# injectors use .00x.
For 14# injectors use .00x.

The above values should be very close but may vary from the actual file that you have loaded. This is not an error, these values are just good recommendations.

fuel_injector_comp_batt_volt

This is a compensator for fuel missed due to the injector turning on or off based on battery voltage.

Battery voltage \ Injector Size	50	42	36	30	24	21	19	14
15								
14								
13								
12								
11								
10								
8								
6								
0								

fuel_inj_high_slope_multiplier_fodeltaP

fuel_inj_low_slope_multiplier_fordeltaP

multiplier to the fuel injector high or low slopes based on the pressure drop across the injector as measured by the sensor on the fuel rail. When pressure is high, above 40 psi, the multiplier is greater than one giving a larger injector flow rate due to the higher pressure. If the multiplier is less than one, it gives a lower injector flow rate due to lower pressure.

fuel_min_inj_pulse_width
minimum injector pulsewidth, set it to 0 (decrease min pulse by same percentage as injector change)

injector_comp_batt_volt
This is a compensator for fuel missed due to the injector turning on or off based on battery voltage.

injector_delay
This is an RPM and load table for fuel injector timing based on engine RPM and Load in crankshaft degrees.

Injector_fuel_breakpoint
This is the point at which the EEC will switch from the low slope to the high slope for the fuel injectors.

injector_slope
injector_slope_hi
injector_slope_low
injector slope, or flow rate. These values are in # per second of fuel flow. If you want to convert these to # per hour you would just multiply these values by 3600. There is a separate document of all the different injector flow values.

injector_timing_vrs_ECT
This is a global modifier to move the fuel injector timing as a function of engine coolant temp.

Knock Sensor

Parameters

borderline_knock_table

This is the spark to prevent the engine from knocking when running 14.64:1 A/F ratio, and is typically setup for around 200F coolant and 75F inlet air temp. This table is typically determined using 87-octane gas unless the car was designed for premium then it should have been used with 92-octane gas. The X-axis of this table is engine RPM and the Y-axis of this table is calculated engine load (volumetric efficiency).

knock_sensor_max_rpm

The maximum RPM to use the knock sensor to retard timing

On some engines, the knock sensor will become active at higher RPM, even though there is no knock really happening. This can be used to disable the knock sensor at higher RPM.

knock_sensor_min_rpm

The minimum RPM to use the knock sensor to retard timing

knock_sensor_min_ECT

The min coolant temp to use the knock sensor to retard timing

knock_sensor_min_load

This the minimum calculated engine load (volumetric efficiency) that the knock sensor will be allowed to be active.

knock_sensor_advance_limit

Maximum amount of advance allowed if knock is not detected.

knock_sensor_advance_rate

a rate at which you can control how fast timing is added, in seconds per degree. You need to very careful not to have the advance rate faster than the retard rate or timing will be added in faster than it can be taken out and the engine will knock.

knock_sensor_retard

Maximum amount of retard allowed if knock is detected from the knock sensors.

knock_sensor_retard_rate

a rate at which you can control how fast timing is removed, in seconds per degree. You need to very careful not to have the advance rate faster than the retard rate or timing will be added in faster than it can be taken out and the engine will knock.

Knock_sensor_thers_cyl_1

Knock_sensor_thres_cyl_0

Knock_sensor_thres_cyl_2

Knock_sensor_thres_cyl_3

Knock_sensor_thres_cyl_4

Knock_sensor_thres_cyl_5

Knock_sensor_thres_cyl_6

Knock_sensor_thres_cyl_7

signal to noise tables for the knock sensors. There is a table for each cylinder in the firing order, Knock_sensor_thres_cyl_0, where the 0 is the first cylinder in the firing order, 1 would be the second, etc. A smaller number in these tables reduces the sensitivity of the knock sensor for that cylinder. A larger number makes it more sensitive to knock.

knock_sensor_switch

Switch to turn off or on the knock sensor.

0 = The vehicle does not have this feature, or shuts off the PCM input of this feature.
1 = The vehicle has this feature and the PCM will attempt to use this input.

knock_sensors_number_of

number of knock sensors. Set to 0 to disable knock retard.

Mass Air Function (MAF)

Parameters

maf_maximum_AD_counts

This is the highest A/D count, coming in from the MAF that the PCM will acknowledge.
If the MAF voltage gets beyond this, then it assumes the MAF has failed and switches to a table of RPM and throttle position to get engine volumetric efficiency. When it reaches this point the PCM switches to LOAD_W/FAILED_MAF or LOAD_W/FAILED_MAF_W/IMRC_OPEN.

This is the highest A/D count, coming in from the MAF that the EEC will acknowledge. If the maf voltage gets beyond this, then it assumes the MAF has failed and switches to a table of RPM and throttle position to get engine volumetric efficiency. When it reaches this point the EEC switches to Load_w/o_IMRC / Load_w/IMRC / Load.

maf_minimum_AD_counts

This is the lowest A/D count, coming in from the MAF that the PCM will acknowledge.
If the maf voltage gets below this, then it assumes the MAF has failed and switches to a table of RPM and throttle position to get engine volumetric efficiency. When it reaches this point the PCM switches to LOAD_W/FAILED_MAF or LOAD_W/FAILED_MAF_W/IMRC_OPEN.

maf_transfer_function

This is the air meter transfer function. This is the most critical item that must be correct in order to make the car run correctly. You need to adjust the air meter transfer function to get the AFR that you are asking for.

This is the air meter transfer function. There are three versions of the MAF transfer function.
On the older vehicles, prior to 1996, the X column was in voltage. Starting in 1996 the X column became A/D counts. A/D counts is just voltage in a different form. If you take A/D counts, divide it by 1024 and multiply it by 5, you get voltage.

The Y column of the MAF transfer function was # mass of air per clock tic. Starting in the late 1990's, they started changing to # per minute of air. Mustang's changed in 2002.

As the clock speed changed from year to year, the same air meter ends up with different transfer functions. There are clock speeds of 18, 21 and 24 MHz that will require different transfer functions.

This is the most critical item that must be correct in order to make the car run correctly. You need to adjust the air meter transfer function to get the A/F ratio that you are asking for.

aircharge_WOT_multiplier

This MUST be set to 1.9 on all cars, especially on newer models. This will basically limit the airflow that the EEC thinks is going into the engine and cause the engine to run very lean. The importance of changing this on the newer vehicles cannot be stressed enough.

Normalizer

Overview

These functions are what is called a normalizer for specific tables. A table has two axis on it, and X on the bottom and a y on the side. The axis of the table determine what all the values in that row or column correspond too.

For example, the top row in a spark table may be a load (volumetric efficiency) a .9. So all the spark values in that row are for a load (volumetric efficiency) of point. As you go from left to right the RPM changes, but the load (volumetric efficiency) stays the same. The same is true for the columns in the table.

If you want to change the values that a row or column corresponds too, you have to change these normalizing functions. The right column is the row or column number that the data on the left corresponds to. The numbering starts at zero and goes up from there. So for a table that has 10 columns, they would be numbered 0 - 9.

It is helpful to change these tables when making a calibration for a supercharged vehicle and the load (volumetric efficiency) that the vehicle will actually see will exceed what the table is set too.

Oxygen Sensors (O2) & Cats

Parameters

rear_O2_heater_bank1_downstream

rear_O2_heater_bank2_downstream

rear_O2_heater_downstream

rear_O2_heaters_downstream_switch

In some cases just setting the REAR_O2_SENSOR_SWITCH will not shut off the rear O2 sensors or the REAR_O2_SENSOR_SWITCH is not in that model.

Sometimes the PCM will still do an electrical check on the heaters in the rear O2 sensors. By making these values zero, it will shut off the rear heaters.

heater_bank1_downstream

heater_bank2_downstream

In some cases just changing the above configuration will not shut off the rear O2 sensors totally. Sometimes the EEC will still do an electrical check on the heaters in the rear O2 sensors. By making both of these values zero, it will shut off the rear heaters.
lightning truck change from 247 to 246 to turn off

hego_configuration

Setting this to zero disables the rear O2 sensors.

Switch_for_cat_temp_ctl

Switch_for_flange_temp_ctl

These are switches that override the commanded A/F ratio and add extra fuel to keep the catalytic converters cool. If you have ever ran an '01 Cobra or newer GT and seen A/F ratio drop at the end of the dyno run, this is why. The EEC thinks the cats are too hot and take over fuel control. It is recommended to shut both of these switches off.

Rev and Torque Limits

Parameters

rev_limit

Used in older software as well, just a single rev limit value.

rev_limit_0_off

rev_limit_0_on

These are the normal pairs of limiters in most software, set them where you want the limiter to be at.

rev_limit_1_off

rev_limit_1_on

rev_limit_2_off

rev_limit_2_on

These are used in certain applications to limit engine speed with other criteria are met. If the calculated engine oil temp is too high (like in some Cobras) then these are the limiters that are used in these areas.

rev_limit_half_fuel_off

rev_limit_half_fuel_on

Used in older software to shut off half of the fuel injectors.

rev_limit_neutral_0_off

rev_limit_neutral_0_on

These are for neutral, but some manual transmission vehicles use these limiters all the time.

rev_limit_off_tics

rev_limit_on_tics

Used in older cars where the limiter is done as a function of clock tics rather than actual engine speed. Clock tics can be converted to engine speed if the clock speed is known.

rev_limit_shaft_vs_torque

This is a function, just make the Y-axis of this function all 1's and use one of the scalar limiters as the rev limiter.

rev_limit_torque_off

rev_limit_torque_on

This is the engine speed to begin to use the function rev_limit_shaft_vs_torque.

rev_limit_torque_ratio

Minimum torque ratio to use when in rev limit control, set to 1.

rev_Minimum_pip_period_V6

rev_Minimum_pip_period_V8

The preferred method of rev limiting on the older Mustangs was this value for a V8. This is a time in clock tics, where if a pulse from the distributor wheel comes in this soon or sooner (again, in clock tics), the fuel is shut off to the injectors.

Security (PATS)

Paramters

PATS_disable_switch

This switch controls the anti-theft system.
A value of one (1) will disables the anti-theft system.
A value of zero (0) allows the anti-theft system to function.

p0136sw

p0138sw

p0141sw

p0156sw

p0158sw

p0161sw

p0605sw

PATS_definite/maybe

PATS_disable_SW

This switch disables the anti-theft system. If you set this to a one, it disables the anti-theft system. A zero allows the anti-theft system to function.

Shocks

Parameters

adjustable_shock_pulse_HP

This turns on or off pulse controlled adjustable shocks.

Spark

Overview Pre 94

In the older versions of spark control it is much simpler but nowhere near as powerful. When you are at WOT there are separate functions that add up to the total spark delivered to the engine. The main function is WOT_SPARK. This is RPM on the X axis and spark on the Y-axis. There are then 3 modifiers to this spark value. WOT_SPARK_BP_ADDER is a function of Barometric pressure on the X axis and amount of spark to add or subtract on the Y-axis. WOT_SPARK_ECT_ADDER is an adder or subtractor for spark at WOT based on engine coolant temp and WOT_SPARK_ACT_ADDER is an adder or subtractor for WOT spark based on inlet air temp.

So, for WOT, the final spark calculation looks like this.
Final spark = WOT_SPARK + WOT_SPARK_BP_ADDER + WOT_SPARK_ECT_ADDER + WOT_SPARK_ACT_ADDER
As a side note TP_FOR_WOT is what determines when you switch to part throttle spark to WOT spark mode.

The part throttle spark is very simple. It is just an RPM vs. Load table and the output of that table is the spark that is commanded. This table is SPARK_SEA_LEVEL. The only other adder to this part throttle spark is PART_THROTTLE_SPARK_ADDER_FOR_ECT, this adds spark at part throttle based on engine coolant temperature and Load.

When at closed throttle in this version of spark, the commanded spark is just SPARK_AT_CLOSED_THROTTLE, which is RPM vs. Spark. This is then modified based on coolant temp with, SPARK_AT_CLOSED_THROTTLE_ADDER_FOR_ECT. There is a modifier for idle spark based on BP called IDLE_SPARK_ADDER_FOR_BP that modified the spark at idle based on barometric pressure.

There are global adders for spark for the older version of spark, GLOBAL_SPARK_ADDER_FOR_WOT is just for WOT, GLOBAL_SPARK_ADDER_FOR_PART_THROTTLE is a global adder for part throttle and GLOBAL_SPARK_ADDER_FOR_CLOSED_THROTTLE is a global adder for closed throttle.

Overview Post 93

The following section explains the spark calculation for most 1994 and newer cars. There is a table called spark_base_table. This table should represent MBT spark. The spark required to make the most torque (MBT stands for Maximum Brake Torque). You may find in some obscure EEC's (mainly trucks), that this table is set all 60's or 40's to make it effectively useless. This table is RPM on the X axis (fn016) and load on the Y axis (fn012).

So, now there is a table called spark_borderline_det_table. This should be the spark to prevent the engine from knocking when running 14.64:1 A/F ratio, and is typically setup for around 200F coolant and 75F inlet air temp. This table is usually derived using 87-octane gas unless the car was designed for premium then it should have been used with 92-octane gas. This table uses the same X and Y-axis as the borderline table.

Then there is a table called spark_add_af_ratio. This is a table with RPM on the X axis and commanded A/F ratio, in lambda, on the right axis. This table is used when the engine is running open loop fuel. If you are richer than 14.64:1, then the engine can usually tolerate more spark before it knocks. This table is designed to add in more spark when running richer than 14.64:1. With the recent emissions levels lowering, this table is also used to modify spark when you are leaner than 14.64 on cold starts and what not.

To modify spark based on coolant temp there are two items to use. One is spark_retard_ECT_multiplier, which is RPM on X axis and Load on the Y-axis and the other is spark_retard_for_ECT, which is a function of coolant temp on the X column and some number in the Y column. The way this works is that you take the RPM and load that you are running at that point, and look up and retrieve the value out of spark_retard_ECT_multiplier. You then take this number and multiply it by the value in the Y column of spark_retard_for_ECT based on the coolant temp you are running at that time. The two of these multiplied together is the modification of spark based on coolant temp. It can be either positive or negative.

To modify spark based on air temp, it's pretty much the same as ECT. There is a table called spark_retard_ACT_mulitplier that is RPM vs. load and then one of two different types of values for the one tied to ACT, spark_retard_for_ACT is either a table based on ACT on the Y axis and RPM on the Y axis or it is just ACT on the X axis and retard multiplier on the Y axis. This is why you want to move the air temp sensor on blown cars. You can change spark based on the outlet air temp.

If a vehicle has IMRC's, then there are two other tables to deal with. One is spark_imrc_add_base_spark. This is spark that gets added to spark_base_table to reflect a change in the MBT spark when the IMRC's are open. The other is spark_imrc_add_bdrline_spark. This reflects a change in the borderline spark for IMRC's.

Both of these values for IMRC's get added to their respective tables. Spark_imrc_add_base_spark gets added to spark_base_table and spark_imrc_add_bdrline_spark gets added to the spark_borderline_det_table.

The final piece to this puzzle in the spark stuff is the octane pin function, spark_octane_plug_retard. This is just a blanket adder or subtracter from the spark values and is either a scalar, function or table depending on the year.

Now here is what happens with all of the above.

spark_borderline_det_table + spark_imrc_add_bdrline_spark + spark_add_af_ratio + (spark_retard_ECT_multiplier X spark_retard_for_ECT) + (spark_retard_ACT_multiplier X spark_retard_for_ACT) + spark_octane_plug_retard

This result ends up with a total spark value. This value is then compare to spark_base_table + Spark_imrc_add_base_spark and then the LOWER of the two values are taken to be delivered to the engine.

The knock sensor then modifies this final value if the engine is equipped with knock sensors. There are a few more parts to the spark puzzle. There is a table called spark_MBT_table, which is used in the torque calculation to determine how close the engine is running to MBT spark. If a vehicle is equipped with IMRC's then this impacts MBT spark. To compensate for this, spark_imrc_add_mbt_spark is used to add timing to the spark_MBT_table for IMRC's when they are open.

In the newer applications, starting around 2002, the spark_base_table disappears and is no longer used. The comparison back to base spark is not done. The rest of the spark values are calculated the same as above, but there is no comparison back to a base table and picking the lower of the two.

The base and borderline tables have RPM on the X axis and Load on the Y-axis. Load is nothing more than engine volumetric efficiency. The production naturally aspirated engines will have a max load in the spark tables of around .9 or 90%. On a forced induction application volumetric efficiency will become greater than 1.0. To adjust for this, the load axis on the spark tables should be changed to allow values to go up to around 1.5 or 1.6. This way when the engine starts to build boost and volumetric efficiency goes above 100%, the spark tables, if calibrated correctly, will automatically remove spark as load goes up.

To change the breakpoints on any of the tables, look at the table itself and there will be the name of the normalizers for the axis on those tables at the top of the table. They typically begin with X_normalize_???? Or Y_normalize_??? Followed by some letter/number combination of the name. You can go to the bottom of the list of values and you should see these values.

To get peak power out of a N/A car, the best thing to do is just take the spark_base_table and cut and paste it into the spark_borderline_det_table. This will give you the spark to make the most power based on dyno work that was performed by the OEM. The only other thing to change with this method is to make sure it will still allow spark to be retarded with hotter air temp and coolant temp. If you look at the calculation above to determine final spark, before it's compared to spark_base_table, you'll notice that if you put the spark_base_table into the spark_borderline_det_table and then add spark in for A/F ratio, ACT or ECT, the output of that equation will always be greater than spark_base_table. So, to still allow spark to be retarded for some conditions, eliminate all the positive values from spark_add_af_ratio, spark_retard_for_ECT, and spark_retard_for_ACT. This now allows the engine to run off of the best spark for most power, but still allow spark retard for coolant temp and air temp. Now when applying this logic to a 2002 GT that does not have a spark_base_table then you just simply take the spark_MBT_table and paste this into the spark_borderline_det_table. The tables are really kind of redundant.

You cannot do this on a supercharged engine. You cannot put MBT spark in everywhere and expect the air temp sensor to be able to compensate for it. In these cases you will need to lower the spark_borderline_det_table to compensate for the spark requirements.

In this version of spark there are two other parameters of interest, spark_adder_global and spark_multiplier_global. These values allow you to override the above calculations and just add in spark to the final calculation. It does not check it against the base table; it just adds it to the final amount. The spark_multiplier_global multiplies the final spark value by whatever that multiplier is.

The following section explains how the spark is calculated in older vehicles.

Overview Pre 94

In the older versions of spark it is much simpler but nowhere near as powerful. When you are at WOT there are separate functions that add up to the total spark delivered. The main function is spark_at_WOT. This is RPM on the X axis and delivered spark on the Y-axis. There are then 3 modifiers to this spark value. Spark_adder_WOT_w/BP is a function of Barometric pressure on the X axis and amount of spark to add or subtract on the Y-axis. Spark_adder_ECT_WOT is an adder/subtracter for spark based on engine coolant temp and spark_adder_ACT_WOT is an adder/subtractor for WOT spark based on inlet air temp.

So, for WOT, the final spark calculation looks like this.

Final spark = spark_at_WOT + Spark_adder_WOT_w/BP + Spark_adder_ECT_WOT + Spark_adder_ACT_WOT

As a side note tp_for_WOT is what determines when you switch to these values. This is explained later.

The part throttle spark is very simple. It is just an RPM vs. Load table and the output of that table is the spark that is ran. This table is spark_sea_level.

There is another sea level spark table that is spark_sea_level_2. This table is used under the following conditions. Remember in the previous version of spark that there was an adder when it was in open loop A/F control? Well, this is similar. If you are at a high enough load, fuel_load_enable_lug_mode, for this amount of time, fuel_time_at_load_lug_mode, and are between these two ECT temps, fuel_lug_mode_min_ECT and fuel_lug_mode_max_ECT, then you will go open loop A/F control and you take the A/F ratio that comes out of the base table (explained later) and multiply it by this function, fuel_lug_mode_multiplier, of RPM vs. Fuel multiplier and then you switch to the other spark table, spark_sea_level_2. This allows you to change spark based on a high load condition.

When at closed throttle in this version of spark, spark is just spark_closed_throttle, which is RPM vs. Spark. This is then modified based on coolant temp with, spark_closed_throttle_adder. There is a BP idle spark retard function which is spark_BP_idle_retard, which his just amount of timing to remove at a given barometric pressure.

There are global adders for spark for the older version of spark, spark_adder_WOT is just for WOT, spark_adder_part_throttle is a global adder for part throttle and spark_adder_closed_throttle is a global adder for closed throttle.

There are altitude spark tables for both versions of spark. These tables are rarely used and do not need to be modified or changed unless a car is at altitude. If a car is at altitude, it will use the altitude tables above a given barometric pressure. In general if you make the spark_altitude the same as either the spark_borderline_det_table or the spark_sea_level, there will not be a problem.

The final aspect of spark is tip in spark retard. To help prevent tip in knock the EEC retards spark at tip in. Depending on the version of software there are three different ways to accomplish this. In the older versions of software there is a just a scalar, spark_min_for_tip-in_retard. This controls the absolute value of spark, BTDC that you allow the EEC to retard to. In combination with these, there is a maximum amount of change of spark that is allowed, spark_max_tip_retart. The first value is the absolute value of spark to allow the engine to run at, spark_max_tip_retart, is the amount of spark that is allowed to be retarded from the regular calculation.

The next version of software has a table for tip in spark retard, spark_retard_tip_in that is a function of RPM on the X-axis vs. Load on the Y-axis. The output of this table is just the amount of spark to retard at that speed and load point.

The final version of tip in retard is the newest version, which is a table of RPM on the X-axis and ACT on the Y-axis. The output of this table is the amount of spark to retard, in degrees, in change per cylinder air charge. This table is spark_tip_in and can be identified based on the very large values as outputs of the table.

Typically, on most combinations, if you get the rest of the tables set up correctly tip in spark retard is not needed.

If a vehicle is equipped with knock sensors, here is how that works.

In the older software, there is basically just fixed limit of retard that you cannot do anything with, other than change the amount that the sensor is allowed to remove. This is a scalar value and is called, knock_sensor_retard. Along with this there is a switch that turns the knock sensor on. If you are unsure if a vehicle has a knock sensor or not, you can look at knock_sensor_hardware_present or knock_sensors_number_of. If either of these is something other than zero, then the vehicle has knock sensing hardware. If you want to disable the knock sensors, then you just set the above values to zero.

In the newer software, the amount of retard allowed by a knock sensor is a table of RPM and Load, knock_sensor_retard. This is the amount of retard that the sensor is allowed to have in those speed and load points.

Also, some of the newer software will allow the knock sensor to advance timing if it is not detecting knock. This is a table of speed and load as well, knock_sen_advance_limit.

Then there is a rate at which you can control how fast it removes timing and how fast it puts it back in. These rates are knock_sensor_retard_rate and knock_sensor_advance_rate. These are in seconds per degree. You need to very careful not to have the advance rate faster than the retard rate or timing will be added in faster than it can be taken out and the engine will knock.

Finally there are signal to noise tables for the knock sensors. There is a table for each cylinder in the firing order, Knock_sensor_thres_cyl_0, where the 0 is the first cylinder in the firing order, 1 would be the second, etc. A smaller number in these tables reduces the sensitivity of the knock sensor for that cylinder. A larger number makes it more sensitive to knock.

Knock_sensor_min_load
This the minimum calculated engine load that the knock sensor will be allowed to be active.

Overall, knock sensors on blown engines are not very reliable and the noise of the blower could cause false knock detection. Be very careful on blown engines of trying to use an aggressive knock sensor setup.

Parameters

WOT_spark
This is the amount of spark for the engine to use at WOT.
The following equation shows how final spark at WOT is determined.
WOT_SPARK + WOT_SPARK_BP_ADDER + WOT_SPARK_ACT_ADDER + WOT_SPARK_ECT_ADDER + GLOBAL_SPARK_ADDER_FOR_WOT = Final Spark at WOT

PATS_disable_switch
This switch controls the anti-theft system.
A value of one (1) will disables the anti-theft system.
A value of zero (0) allows the anti-theft system to function.
An adder/subtractor for WOT spark based on inlet air temp, ACT.

WOT_spark_ECT_adder
An adder/subtractor for WOT spark based on engine coolant temp, ECT.

WOT_spark_BP_adder
An adder/subtractor for WOT spark based on barometric pressure, BP.

global_spark_adder_for_closed_throttle
Adds spark when the closed throttle flag is set, meaning the throttle position is less than TP_FOR_PT.

global_spark_adder_for_part_throttle
Spark adder for part throttle. This value is added to all part throttle values.

global_spark_adder_for_WOT
Adds spark at WOT to the final calculated value.

global_spark_adder
Adds this amount of spark after final calculation is completed. Use this to add or subtract without conditions.

global_spark_multiplier
Multiplies final spark by this amount

high_speed_spark_retard
Amount of spark to retard when at high speed

spark_add_af_ratio
This is a table with RPM on the X axis and commanded A/F ratio, in lambda, on the right axis. This table is used when the engine is running open loop fuel. If you are richer than 14.64:1, then the engine can usually tolerate more spark before it knocks. This table is designed to add in more spark when running richer than 14.64:1. With the recent emissions levels lowering, this table is also used to modify spark when you are leaner than 14.64 on cold starts and what not.

spark_adder_ACT_WOT
An adder/subtractor for WOT spark based on inlet air temp.

spark_adder_closed_throttle
adds spark when in closed throttle mode

spark_adder_ECT_WOT
An adder/subtracter for spark based on engine coolant temp

spark_adder_part_throttle
spark adder fo rpart throttle

Spark_adder_with_Octane_pin
amount of spark to add when octane pins is installed

spark_adder_WOT
adds spark at WOT

spark_adder_WOT_w/BP
A function of Barometric pressure on the X axis and amount of spark to add or subtract on the Y-axis.

spark_altitude
--spark_altitude_table
Not generally used, unless BP is extremely low (high altitude). If BP is less than 26, this table is used. Replaces spark_boderline_detonation or spark_altitude, depending on model
(when you set the spark table values- the lowest value in any table will be the value that gets used at any given load and rpm point)

spark_at_WOT
This is RPM on the X axis and delivered spark on the Y-axis, used in WOT mode.
spark_at_WOT + Spark_adder_WOT_w/BP + Spark_adder_ECT_WOT + Spark_adder_ACT_WOT = Final Spark at WOT

spark_base_table
This table should represent MBT spark. The spark required to make the most torque (MBT stands for Maximum Brake Torque). You may find in some obscure EEC's (mainly trucks), that this table is set all 60's or 40's to make it effectively useless. This table is RPM on the X axis (fn016) and load on the Y axis (fn012).

spark_borderline_det_table
This should be the spark to prevent the engine from knocking when running 14.64:1 A/F ratio, and is typically setup for around 200F coolant and 75F inlet air temp. This table is usually derived using 87-octane gas unless the car was designed for premium then it should have been used with 92-octane gas. This table uses the same X and Y-axis as the borderline table.

spark_closed_throttle
spark value when TP inducates closed throttle mode

spark_closed_throttle_adder
sparl added to spark_closed_throttle

spark_cold_idle_retard
amount of spark to retard fo rcold idle

spark_EGR_adder
adds saprk based on EGR duty cycle

spark_global_adder
add this amount of spark after final calculation

spark_global_multiplier
multiplies final spark by this amout

spark_high_speed_retard
amount of spark to retard when at high speed

spark_idle_subtractor

spark_imrc_add_base_spark
spark_imrc_add_bdrline_spark
spark_imrc_add_mbt_spark
If a vehicle has IMRC's, then there are two other tables to deal with. One is spark_imrc_add_base_spark. This is spark that gets added to spark_base_table to reflect a change in the MBT spark when the IMRC's are open. The other is spark_imrc_add_bdrline_spark. This reflects a change in the borderline spark for IMRC's. Both of these values for IMRC's get added to their respective tables. Spark_imrc_add_base_spark gets added to spark_base_table and spark_imrc_add_bdrline_spark gets added to the spark_borderline_det_table.

spark_max_tip_retard
is the amount of spark that is allowed to be retarded from the regular calculation.

spark_MBT_table
Is used in the torque calculation to determine how close the engine is running to MBT spark (makes the most torque)

spark_MBT_table_ECT_comp
spark_min_for_tip-in_retard
This controls the absolute value of spark, BTDC that you allow the EEC to retard to.

spark_octane_plug_retard
This is just a blanket adder or subtracter from the spark values and is either a scalar, function or table depending on the year, added or subtracted if the octane plug is pulled.

spark_part_throttle_adder
spark_retard_act_multiplier
To modify spark based on air temp, it's pretty much the same as ECT. There is a table called spark_retard_ACT_mulitplier that is RPM vs. load and then one of two different types of values for the one tied to ACT, spark_retard_for_ACT is either a table based on ACT on the Y axis and RPM on the Y axis or it is just ACT on the X axis and retard multiplier on the Y axis. This is why you want to move the air temp sensor on blown cars. You can change spark based on the outlet air temp.

spark_retard_ect_multiplier
To modify spark based on coolant temp there are two items to use. One is spark_retard_ECT_multiplier, which is RPM on X axis and Load on the Y-axis and the other is

spark_retard_for_ECT, which is a function of coolant temp on the X column and some number in the Y column. The way this works is that you take the RPM and load that you are running at that point, and look up and retrieve the value out of spark_retard_ECT_multiplier. You then take this number and multiply it by the value in the Y column of spark_retard_for_ECT based on the coolant temp you are running at that time. The two of these multiplied together is the modification of spark based on coolant temp. It can be either positive or negative.

spark_retard_for_act
To modify spark based on air temp, it's pretty much the same as ECT. There is a table called spark_retard_ACT_mulitplier that is RPM vs. load and then one of two different types of values for the one tied to ACT, spark_retard_for_ACT is either a table based on ACT on the Y axis and RPM on the Y axis or it is just ACT on the X axis and retard multiplier on the Y axis. This is why you want to move the air temp sensor on blown cars. You can change spark based on the outlet air temp.

spark_retard_for_ect
To modify spark based on coolant temp there are two items to use. One is spark_retard_ECT_multiplier, which is RPM on X axis and Load on the Y-axis and the other is spark_retard_for_ECT, which is a function of coolant temp on the X column and some number in the Y column. The way this works is that you take the RPM and load that you are running at that point, and look up and retrieve the value out of spark_retard_ECT_multiplier. You then take this number and multiply it by the value in the Y column of spark_retard_for_ECT based on the coolant temp you are running at that time. The two of these multiplied together is the modification of spark based on coolant temp. It can be either positive or negative.

spark_retard_tip_in
spark_sea_level
The part throttle spark is very simple. It is just an RPM vs. Load table and the output of that table is the spark that is used.

spark_sea_level_2
This table is used under the following conditions. If you are at a high enough load, fuel_load_enable_lug_mode, for this amount of time, fuel_time_at_load_lug_mode, and are between these two ECT temps, fuel_lug_mode_min_ECT and fuel_lug_mode_max_ECT, then you will go open loop A/F control and you take the A/F ratio that comes out of the base table (explained later) and multiply it by this function, fuel_lug_mode_multiplier, of RPM vs. Fuel multiplier and then you switch to the this spark table, spark_sea_level_2. This allows you to change spark based on a high load condition.

spark_temp_load_increase
spark_tip_in
A table of RPM on the X-axis and ACT on the Y-axis. The output of this table is the amount of spark to retard, in degrees, in change per cylinder air charge. This table is spark_tip_in and can be identified based on the very large values as outputs of the table.

Speed Limiter And Axel Ratio

Overview

There are many different types of rev limiters and speed limiters. It varies based on the type of vehicle and the model year of the vehicle.

There are several rev limiters in most of the software. These are usually just a turn on point, the RPM at which to start limiting the engine RPM and then a turn off point, the point at which to no longer start limiting the RPM. These should be set to the engine RPM point at which you would like the rev limiter to become active. There are too many different types of limiters to list them all here in an explanation. The description box at the bottom of the screen has a description of the specific limiter that you click up on. Most limiters are RPM based, but there are some that are based on clock tics. How to calculate the correct number of clock tics is located in the description box.

In many newer applications the rev limiter also uses a function that allows torque to be reduced slowly rather than just the normal on/off limiters. These are functions, REV_LIMIT_RPM_VRS_TORQUE, that are engine speed in the left column and the percent of engine torque to allow in the right column.

If done correctly, the EEC can be setup such that it has a two-step limiter for launching a manual transmission vehicle. In order to accomplish this several things have to be changed. First, you must set REV_LIMIT_SPEED_TO_EXIT_NEUTRAL_LIMITER to the vehicle speed that you want to exit the neutral limiter at. The lowest you can set this is ½ MPH (.5) so that once the EEC sees any vehicle speed; it will exit the neutral limiter and switch to the regular limiter. Also the TRANS_LOAD_SWITCH must be set one (1). If the TRANS_LOAD_SWITCH is set to zero it will always force a neutral state and never leave the neutral rev limiter. With these two values set correctly, you can then use the REV_LIMIT_NEUTRAL_0_ON as the engine RPM you want the EEC to control in neutral.
In older applications, mainly EEC-IV but some early EEC-V, the rev limiter was a single value that was in clock tics based on the number of cylinders the engine had, MINIMUM_PIP_PERIOD_x#, where x# is either I4 for a 4 cylinder engine, V6 for a 6 cylinder engine or V8 for an 8 cylinder engine. The explanation as to how to calculate the number of clock tics for what you want the limiter set at is in the description box when you click on the item. In many cases this is used as the only rev limiter, even though there may be other limiters in the software.

There are also two other scalars in the new applications that control the rev limiter as well, REV_LIMIT_TORQUE_ON and REV_LIMIT_TORQUE_OFF. This is the engine RPM at which another rev limiter will kick in to limit engine RPM. When it does us this limiter, it uses REV_LIMIT_MIN_TORQUE_RATIO at the minimum amount of percent of full torque that it will allow the engine to have. If this value is .75, then it will control the engine to a minimum of 75% of its full torque.

Finally there is one last rev limiter value. This value is very powerful and should only be used if necessary. This value prevents the fuel injectors from being shut off under any circumstances. So the rev limiter would be totally eliminated. This value is called NO_FUEL_CUTOUT_SWITCH and setting to a value of one (1) will eliminate the rev limiter.

Like the rev limiter, there are many different speed limiters in vehicles. Most of these limiters are either based on vehicle speed in MPH, driveshaft speed in RPM, or engine speed in top gear. For an explanation of each different limiter value, use the description box at the bottom of the page.

Parameters

rev_limit_on
rev_limit_off
Set this to where you want the rev limiter to be at.

rev_limit_0_off
rev_limit_0_on
Set this/these values to where you want the regular rev limiter to be at.

rev_limit_1_off
rev_limit_1_on
rev_limit_2_off
rev_limit_2_on
These are used in certain applications to limit engine speed with other criteria are met. If the calculated engine oil temp is too high (like in some Cobras) then these are the limiters that are used in these areas. In most cases these values should be set above the regular rev limiter.

rev_limit_neutral_0_off
rev_limit_neutral_0_on
These are for neutral, but some manual transmission vehicles use these limiters all the time.

rev_limit_off_tics
rev_limit_on_tics
This is the rev limiter in clock tics rather than actual engine speed.
To calculate this value, take 25,000,000 divided by (one half the number of cylinders time max RPM), or 25,000,000/(1/2 number of cylinders times max RPM).

rev_limit_RPM_vs_torque
This is a function, just make the Y-axis of this function all 1's and use one of the scalar limiters as the rev limiter.

rev_limit_speed_to_exit_neutral_limiter
This is the vehicle speed to no longer use the neutral rev limiter on a manual trans. Setting this value low, about 1 MPH, allows the function of a two step box by limiting the RPM at launch and then switching when it sees vehicle speed.

rev_limit_torque_off
rev_limit_torque_on
This is the engine speed to begin to use the function rev_limit_shaft_vs_torque.

rev_limit_min_torque_ratio
Minimum torque ratio to use when in rev limit control, set to 1.

shift_light_on_above_this_rpm
No matter the conditions, the shift light will turn on when this RPM is reached. This can be used on vehicles with shift lights active, to indicate to the driver when to shift.

speed_limit
This is speed limiter also used in older software.

speed_limit_1_off
speed_limit_1_on
speed_limit_2_off
speed_limit_2_on
Point to turn or off the speed limiter.

speed_limit_on
speed_limit_off
Speed_limit_set_high is the point at which the speed limiter will turn on.

speed_limit_output_shaft_off
speed_limit_output_shaft_on
This limiter is used to limit the speed of the driveshaft.
It kicks in once this driveshaft RPM is met. To eliminate set to 15000.

speed_limit_stage_1_off
speed_limit_stage_1_on
speed_limit_stage_2_off
speed_limit_stage_2_on
These values are one of the items that control the speed limit of the vehicle. To remove the speed limiter, set these to the maximum value allowed

speed_limit_stage-3
This is a speed limiter based on transmission driveshaft speed. Set this to 15000.

speed_limit_VS_vs_torque
This is a speed limiter based on vehicle speed and the amount of torque to run. To eliminate this limiter, set the entire right column to zeros.

Tire_Revs_per_mile
This is the number of tire revolutions in one mile. Most Mustang tires are around 810 revs/mile.

Tire_Revs_per_mile
This is the tire revolutions in one mile. There is a excel spreadsheet to calculate this value based on tire size.

speed_limit
These are speed limiter also used in older software.

speed_limit_1_off
speed_limit_1_on
speed_limit_2_off
speed_limit_2_on
These are speed limiters in older software.

speed_limit_clear_low
speed_limit_max
These are speed limiter also used in older software.

speed_limit_output_shaft_cl
speed_limit_output_shaft_sh
The above limiter is used once this driveshaft RPM is met. To eliminate set to 15000.

speed_limit_reverse
Some vehicles have a speed limiter in reverse. To eliminate set the Y-axis to all 1's.

speed_limit_shaft_vs_torque
This is a limiter based on driveshaft speed vs. torque. Set the Y-axis to all 1's to eliminate.

speed_limit_stage-1_off
speed_limit_stage-1_on
speed_limit_stage-2_off
speed_limit_stage-2_on
These are RPM based vehicle speed limiting values. To make the speed limiter go away, set these values to 15000.

speed_limit_stage-3
This is a speed limiter based on transmission driveshaft speed. Set this to 15000.

speed_limit_VS_vs_torque
This is a limiter based on vehicle speed to eliminate set the Y-axis to all 1's.

speed_limit1_clear_low
speed_limit1_set_high
speed_limit2_clear_low
speed_limit2_set_high
speed_limt_set_high
This limiter is used once this vehicle speed is achieved. Setting these to 250 will eliminate the speed limiter.

axle_ratio
This is the axle ratio that the car has in it. Change this to the correct axle ratio.

axle_ratio_f
axle_ratio_i
These are used for traction control, setting axle_ratio_f, will disable traction control forever and will never be able to be switched on.
(scott's tuning note, set axle_ratio_i to 5 to disable)

nov_vid_sw
In order for the EEC to use the tire_revs_per_mile and axle_ratio for tire size and axle ratio, this switch MUST be set to zero or it will NOT use the values you enter.

Supercharger

Parameters

supercharger_bypass
This is a software switch to disable the supercharger bypass on the newer vehicles like a Lightning or a Cobra. A value of 0 disables the bypass.

0 = The vehicle does not have this feature, or shuts off the EEC control of this feature.

1 = The vehicle has this feature and the EEC attempt to control this function.

Thermactor

Overview

Thermactor air refers to air added to the exhaust gas mixture from the belt driven thermactor air pump. The computer controls two solenoids to create three mutually exclusive air states:

Thermactor Air State	TAB Solenoid	TAD Solenoid
Upstream	on	on
Downstream	on	off
Bypass	off	off
Bypass	off	on

TAB - Thermactor Air Bypass (AM1)
TAD - Thermactor Air Divert (AM2)

Upstream refers to air added at or near the exhaust ports. This is done to provide better oxidation of the exhaust gas mixture when a richer exhaust gas mixture is anticipated. It is not possible to operate in closed loop fuel control while air is introduced upstream (the EGO sensor may always indicate a lean condition).

Downstream refers to air added to the catalyst mid-bed. Downstream air is compatible with closed loop fuel control and is the normal thermactor air state.

Bypass refers to the condition in which no thermactor air is added to the exhaust gas mixture. This feature is used primarily to protect the catalyst from over-temperature conditions.

Parameters

thermactor_switch

This tells the PCM if the vehicle has a thermactor air system, or secondary air system.

0 = The vehicle does not have this feature, or shuts off the EEC control of this function.
1 = The vehicle has this feature and the EEC attempt to control this function.

Throttle Position (TP)

Parameters

TP_for_PT
This is the throttle position that is used to exit idle control and enter part throttle mode.

TP_for_WOT
This is the throttle position that it uses to enter WOT throttle mode.

Timers & Delays

open_loop_delay
In the new software (typically 2002 and up) these functions to go open loop are changed to a table, open_loop_delay, of RPM on the X-axis and what gear the EEC thinks the transmission is in, on the Y-axis. The output of this table is the time delay to go open loop. There is no load input in this table though. Then there is a scalar, also called open_loop_delay that allows a ramp from closed loop fuel to open loop fuel control. This timer should be set very low.

time_disable_AC_at_WOT
This is the time to disable the converter clutch at WOT. There are many applications that do not disable the A/C clutch when at WOT.

Time_to_delay_open_loop
Time_to_delay_open_loop_ECT
Time_to_delay_open_loop_hys
Time_to_delay_open_loop_RPM
In the older software, you can go open loop based on load. There is a function of engine RPM vs. Load, open_loop_load . If you are at that engine RPM , and you exceed the load timer, Time_to_delay_open_loop_RPM or Time_to_delay_open_loop_hys or time_to_delay_open_loop_ECT, (you will only have one of these timers) then you will go open loop fuel control.

warm_up_time
This is a function of start up coolant temp on the x axis and time to reach warm_up_ECT. If this temp, warm_up_ECT is not reached in this time, then the check engine light is turned on.

Transmission

SHIFT LIGHT

There are three values that can be changed for a shift light. One is a switch that allows the light to be enabled or disabled. Setting TRANS_TYPE to zero, from one will disable the shift light completely.

If you would rather change how it comes on there are two values that can be manipulated to accomplish this. One is a function, SHIFT_LIGHT_TURN_ON_POINT that is load in the left column and RPM in the right column. At the load in the left hand column, you will turn the light on once you reach the RPM in the right column that corresponds to that load. You can set all the RPM values in the right hand column to something very high, and then set SHIFT_LIGHT_ON_ABOVE_THIS_RPM to a single RPM value to activate the shift light. This setup only allows the shift light to come on once the RPM in the above scalar is reached.

SHIFT/LOCK SCHEDULE

The shift schedule is pretty straightforward. There are functions for each up-shift and down-shift, TRANS_SHIFT_SCHEDULE_xy where xy is the shift. These are throttle position relative to closed throttle vs. what speed to shift at. You must make sure that the pair of shift curves does NOT cross. For example, you cannot have the 1-2 and 2-1 shift curves cross. If they do, the trans will most likely just shift back and forth at a fairly high frequency in the range that they cross and this is not good. It is recommended to graph the shift schedules when changing them to ensure they do not cross.
It is also recommended that you keep the existing shift schedule for that vehicle and just modify it. Making a whole new schedule is very difficult and probably won't work right no matter how good you think you are at tuning.

The same applies to the torque converter lock schedule; make sure they don't cross. The names for the shift and lock schedules are TRANS_CONVERTER_LOCK_x and TRANS_CONVERTER_UNLOCK_x, where x is the gear that that function is mapped to. At WOT; a locked up torque converter WILL transmit more torque to the wheels than an open converter, period. So, it is recommended to have the converter locked at WOT in all gears. Some of the older 5.0L Mustangs with AODE's had the torque converter locking at light throttle in 2nd gear to increase fuel economy. It is recommended to eliminate this to improve the driveability of the car. To eliminate this, just raise the MPH points so that they are very high at lower throttle positions and it will no longer lock. You can then step the curve down at heavy throttle positions so that it is allowed to lock up at WOT to improve power to the wheels.

At WOT, the Trans shifts based of one of two things, whichever one happens first. Either the vehicle speed that is in the shift schedule functions or the WOT engine speed scalars, TRANS_WOT_SHIFT_RPM_xy, where xy is the shift that that scalar controls, like 12. What this means, in most cases, is that this is where the shift is COMMANDED and not where it will occur. In some transmissions it can take up to one second to fill the on coming clutch. If the engine is accelerating at 1000 RPM per second (not unusual for 1st gear with a 3.73 axle ratio) that means that from the commanded of the shift to the actual shift point, the RPM will increase by 1000 rpm. So, if you set the TRANS_WOT_SHIFT_RPM_12 to 5000 rpm, the shift will occur around 6000 rpm. This is important to know when setting up WOT shift points.

The actual shift points in the schedule may not be the actual shift points in the vehicle at that throttle position if the axle ratio was changed. Please see the description on AUTO_TRAN_GEAR_RATIO for an explanation on how this works.
There are also some delay timers that prevent the torque converter from locking up right after a shift, either upshift or downshift. These timers can be used to prevent the engine speed from dropping too much after a WOT shift. The timers are shift specific and follow the format TIME_TO_DELAY_CONV_LK_AFTER_xy, where xy is the shift that the converter clutch lockup is delayed after.

Automatic Transmission

First I'll cover how pressure gets calculated.

There is something in the trans function called TV pressure, this is a throw back to when there was a TV rod from the throttle to a valve in the trans, and TV stands for Throttle Valve. There is an electric solenoid that controls TV pressure. TV can also be called EPC, Electronic Pressure Control. TV pressure acts on the main regulator valve to change line pressure. Line pressure, in most Ford transmissions, equals 1.6 times TV pressure plus 40. All trans speak is done in TV pressure.

There are two components to TV pressure, they are called torque input and user input. Torque input pressure is calculated based on some inputs (which I'll cover in a minute) and user input is user controlled (that's you).

When you are not shifting, TV pressure is just the output of a Y=mX+b slope, where m is a calibrated slope and b is an intercept. X is the calculated torque that the EEC thinks the engine is making, multiplied by the torque ratio of the torque converter based on the speed ratio that you are at . So, for example, lets say the slope is .2 (typical numbers are in the .1-.4 range) and the intercept is -4 (typical numbers are in the -20 to 10 range) and you are making 200 ft-lbs of torque. You take 200*.2-4 or 36 psi TV pressure. Now, most transmission have a minimum clip for pressure when you are not shifting so you cannot run the trans below a certain pressure. From the above example you can see why making sure the EEC calculates the correct torque is important. The b value in the equation, or intercept is trans_pressure_offset_x_gear, where x is the gear you are in at that time. The slope value, of m term in the equation, is trans_nonshift_slope_x, where x is the gear that you are in at that time.

Now when you are shifting, it's a little different. It has a separate set of slopes for each upshift and downshift. Other than unique slopes the torque input part of shifting pressure is the same, other than where it gets it's torque from... These slopes are trans_upshift_slope_x where x is the gear you are shifting into and trans_downshift_slope_x where x is the gear that you are shifting into.

When and engine is slowed down, during that transient, torque rises. This is why a car can get rubber on an upshift. That inertia from the engine results in a temporary rise in torque coming out of the transmission. When and engine is accelerated, the engine uses it's torque to accelerate itself, so torque actually drops during this transient. The EEC takes these into account.

During an upshift, the engine speed is going to drop, assuming no torque converter slip, by the ratio of the gear you are going to divided by the gear you are coming from. On a 1-2 shift in a 4R70W the ratio would be 1.55/2.84, or .55. So, if you are at 6000 rpm, the engine speed, again assuming no converter slip, would drop to 55*6000, or 3300 rpm. Now it never really drops this much since you are accelerating through the shift, the input shaft of the trans is coming up and there is converter slip, but you have to assume something. So, now it takes the amount the engine speed has to drop, 6000-3300 or 2700 RPM, and basically multiplies it by a value (this is not exactly what happens but for our discussion, let's say it is). The result of this calculation results in a torque value that gets added to the calculated engine torque, which is then multiplied by torque converter torque ratio for the total torque going into that shift. On a downshift the inertia term results in a negative torque, thus reducing pressure during a downshift.

So now you have an engine torque that gets an inertia torque added to it and then you determine an amount of static shifting TV pressure for the shift. The next part of shifting pressure is user input pressure.

There are several things that get added together to make the user input TV pressure number. I'll cover a few the more important ones.

There is a user input TV pressure table for each shift, trans trans_TV_pressure_xy where xy is the shift you want to change, like a 1-2 shift of a 2-3 shift. These tables are throttle position across the X-axis and vehicle speed across the Y-axis. The output of this table is the dynamic pressure for that shift. In some of the older software these are just functions of throttle position on the X-axis and added pressure on the Y-axis. There are things like blip pressures, stroke pressure, TV ramps, pressure profiling, and some other adders that all get added together to make the total dynamic TV contribution.

Now, user input TV is added to torque input shifting capacity TV to end up with total TV for the shift. In the tables, the far left column is used for all closed throttle shifts, both upshifts and downshifts.

If you want to make a shift firmer, just add pressure to the tables. The throttle position across the X-axis is A/D counts. Typically 750 is WOT for TP_REL, throttle position relative to closed throttle. The vehicle speed is ratio'd from the stock axle ratio divided by the axle ratio you have in there now.

During shifts, the EEC can reduce engine torque. This is done either via spark retard or shutting of fuel injectors. In most cases shutting this off makes the shifts firmer and the vehicle performance improves. On some of the E4OD and 4R100 transmission, if you disable the torque reduction the shifts get softer since the transmission does not have enough capacity to stop the oncoming clutch with the power its making. In these cases, you should reduce the amount of torque that is reduced during the shift. In the some software there are two ways to disable this torque reduction, setting trans_min_tp_for_torque_mod to 900 or setting trans_min_ECT_for_torque_mod to 250 will disable this reduction. In some versions of software there will be these two values plus two others that need to be set to 900, trans_min_tp_for_torque_mod_upshift and trans_min_tp_for_torque_mod_downshift.

If you do not want to shut off the torque reduction and just want to reduce it, then you can change the amount in the torque reduction tables. These tables are a percent of total torque you want the engine to have. A value of .8 means you want the engine to have 80% of its normal torque, or a 20% reduction. These tables are specific for each shift and are as follows, trans_tqmod_xy where xy is the shift you want to change. A 1-2 shift would be trans_tqmod_12.

The shift schedule is pretty straightforward. There are functions for each upshift and downshift, trans_shift_schedule_xy where xy is the shift. These are throttle position relative to closed throttle vs. what speed to shift at. You must make sure that the pair of shift curves do NOT cross. For example, you cannot have the 1-2 and 2-1 shift curves cross. If they do, the trans will most likely just shift back and forth at a fairly high frequency in the range that they cross.

It is also recommended that you keep the existing shift schedule for that vehicle and just modify it. Making a whole new schedule is very difficult and probably won't work right.

The same applies to the torque converter lock schedule, make sure they don't cross. At WOT, a locked up torque converter WILL transmit more torque to the wheels than an open converter, period. So, it is recommended to have the converter locked at WOT in all gears. Some of the older 5.0L Mustangs with AODE's had the torque converter locking at light throttle in 2nd gear to increase fuel economy. It is recommended to eliminate this to improve the driveability of the car. To eliminate this, just raise the MPH points so that they are very high and it will no longer lock. You can then step the curve down at heavy throttle positions so that it is allowed to lock up at WOT.

To also improve driveability of the vehicle, it is recommended to take the 3-4-shift schedule and paste it into the 3rd gear lock function, trans_converter_lock_3rd. This prevents the torque converter from locking in 3rd gear before the 3-4 shift and will generally improve the feel of the car when driving it.

At WOT, the trans shifts off of one of two things. Either the vehicle speed that is in the shift schedule functions or the WOT engine speed scalars, trans_wot_shift_xy, where xy is the shift, like 12. What this means, in most cases, is that this is where the shift is COMMANDED and not where it will occur. In some transmissions it can take up to one second to fill the on coming clutch. If the engine is accelerating at 1000 RPM per second (not unusual for low gear with a 3.73 ratio) that means that from the commanded of the shift to the actual shift point, the RPM will increase by 1000 rpm. So, if you set the trans_wot_shift_12 to 5000 rpm, the shift could occur 6000 rpm. This is important to know when setting up WOT shift points.

There is an excel spreadsheet to allow the graphing and calculation of shift points.

Now the tricky part. The vehicle speed in the shift functions is not always the actual vehicle speed that the speedometer shows. Here is why.

First there is a parameter called N/V, say N over V (this actually shows up on the dynojet software right before you click OK, to a graph with all the values on it). This is the engine speed (N) over the vehicle speed (V) of the vehicle in direct drive ratio of the trans (typically 3rd gear in a 4 speed trans). A typical 3.27 axle ratio Mustang has an N/V of 44.5, meaning that in 3rd gear (with an auto) for every 44.5 increase in engine RPM, you get a 1 MPH increase in speed.

Now, the transmission shift schedule is setup for a certain N/V, this is called trans_Base_N/V_of_Vehicle. There is another value on some older cars called trans_4_times_NVBASE. This value will either be 4 times or 10 times the trans_Base_N/V_of_Vehicle. You'll have to look at the production file to see if it's 4 times of 10 times. If you want to change trans_Base_N/V_of_Vehicle then you'll also need to change this values, if it's there, by either 4 or 10 times trans_Base_N/V_of_Vehicle.

Now, all the MPH's in the shift and lock schedules are based on this trans_Base_N/V_of_Vehicle. So, if you change the axle ratio what happens?

Assuming there is range in learning, and this will be covered later, it adjusts if you give it the right information. On, the cars where the EEC sends the vehicle speed info out to the cluster this means changing the axle ratio value in the software. On cars with vehicle speed sensors, this means changing the speedo gear so that the speedo reads correctly. This is important since the EEC always assumes that the vehicle speed is correct.

So, let's say you put a 3.73 axle in a Mustang that was setup for a 3.27. The MPH's in the shift and lock functions are ratio'd by the trans_Base_N/V_of_Vehicle divided by the current calculated N/V of the vehicle. The EEC is smart enough to calculate a new N/V based on the driveshaft speed (which it knows since it has a sensor to measure this) and then divides this by what it thinks the vehicle speed is. The EEC now treats this at the real N/V of the vehicle. In this example, the N/V of a 3.73 axle Mustang with production tire diameter, is about 50.5. So, it would take a ratio of 44.5 divided by 50.5 to get a ratio of .88. So, it now takes all the MPH's in the shift and lock functions and multiplies them by .88. So, if you had a shift setup to be at 50 MPH, with this axle change, it would be at 50 * .88 or 44 MPH. There is an Excel spreadsheet to calculate N/V and Tire Rev per Mile in the software package and a spreadsheet to plot the shift curves.

The min and max correction allowed can be changed. Trans_Min_learned_N/V is the min correction, set this to .75 and trans_Max_learned_N/V is the max correction, set this to 1.25.

There are a few other shift point values that are available to change.

Trans_2-1_pullin_max_speed
This is the speed to allow the trans to shift into low gear when the shifter is placed in manual 1.

Trans_3-2_pullin_max_speed
This is the speed to allow the trans to shift into 2nd gear when the shifter is placed in manual 2.

Trans_vs_o/d_cancel_override
Above this vehicle speed, if the OD cancel button is pressed so the driver has the vehicle in 3rd gear, the OD Off light will go out and the transmission will shift into 4th gear. Make this value 127.5

Trans_man_shift_12_limit
Above this RPM, the transmission will shift out of manual 1 and into second gear even though the shift was not moved. To prevent this from happening, set this RPM above the engine rev limiter.

Trans_Tm_Sequence_thru_3rd_P4
This is the time the EEC must be commanding 3rd gear before letting the trans shift into 4th gear. This value should be at least 1-1.5 seconds.

Trans_Tm_Sequence_thru_2nd_P4
This is the time the EEC must be commanding 2nd before it will command 3rd. This value can be lowered to zero but should be around .5 - 1.0 seconds.

Trans_Tm_Sequence_in_man1
On some older applications, when you put the shifter into manual low, it delays the engagement into low by a long time, even though you are below the trans_2-1_pullin_max_speed. Make sure this timer is at or near zero.

Trans_Tm_Sequence_in_man2
See above explanation of manual shifts into 1, this is the same thing but into position two.

There is also a way to unlock the torque converter based on how fast the throttle is moved in or out. This can cause the converter to unlock when the drive may not be expecting it too. It is recommended to make this none functional. Make trans_thrtl_rate_lowTP_in and trans_thrtl_rate_hiTP_in to values of 500 and make trans_thrtl_rate_lowTP_out and trans_thrtl_rate_hiTP_out to -500.

Shifting pressure was briefly mentioned before. There is either a function of TP vs. added pressure for each shift, or a table of TP on the X-axis and vehicle speed on the Y-axis for added pressure during the shift. These functions/tables are trans_TV_pressure_xy, where xy is the shift you want to add pressure too. For example, trans_TV_pressure_12 is added pressure for a 1-2 shift. Normally adding 10 psi to the 1-2 shifts makes them noticeably firmer. To get this same result on the 2-3 shift you need to add about 15 psi and for the 3-4 shift adding 10 has similar results. For maximum firmness at WOT, make the high TP columns near WOT, about 650+ TP, all 99's. This will ensure max pressure for WOT shifts.

In some of the newer transmissions, the EEC measures the time it takes the clutch to apply and then the shifting pressure adjusted so the time it takes the clutch to apply is within a target range. These target values are in tables like trans_Tagret_slip_time_xy, where xy is the shift that that table controls. The value in these tables are in milliseconds. To make a shift firmer, make these values smaller. I'd move them in 100-150 millisecond increments.

On some older software versions and applications, ramps were used to ramp pressure in or out during a shift. These ramps are trans_TV_Ramp_xyshift, where xy is the shift that pressure is being ramped into or out of. Just check these values to make sure there is not a large negative number in there. If there is, then as you try to add pressure, this will take the pressure back out. I'd make all these values zero or positive numbers.

When manually shifting from 1 to 2, to make the shift firmer on some cars, make trans_manual_12 zero. This changes the way pressure gets calculated during 1-2 shifts.

To make engagements faster there are two functions that control the pressure in the trans when the vehicle speed is zero. If you change the zero to low TP area of these functions, it will change the pressure the engagement is made on. These functions are trans_stall_curve_F for pressure into Drive and trans_stall_curve_R for pressure into Reverse. For pressure into drive, I'd make the value about 20 for a quick engagement and for reverse the value should be around 25.

Torque Converter Lockup feel/function.

The EEC controls the rate at which the torque converter can be ramped on. There are quite a few parameters to change. trans_Lockup_rate_w/high_TP controls the rate the converter locks when at high throttle positions. trans_Lockup_rate_after_upshift is the rate at which the converter locks after an upshift and trans_Lockup_rate_after_tip_in is the rate at which the converter locks up after a tip in from closed throttle or any other time not covered by the other two. Larger numbers are faster lockups. A stock converter can have these numbers increased by 50-100%. Different model years used different types of values in these scalars so don't be surprised from one vehicle to another that the numbers may be very different.

Aside from the above values that control lockup rate, the following also control the rate, trans_slip_rate, trans_slip_rate_low_TP and trans_slip_rate_shifts. To make the lockup under these conditions faster, make these values smaller. Good values for these to start with are around .2

Some vehicles allow steady state slip across the torque converter. This is bad, it just generates heat and no good can come from it. The following 3 tables determine how much steady state slip the converter will try to control to, trans_tqconv_slip_2nd, _3rd and _4th. Make the values in these tables zero's.

Some vehicles will also slip the converter for the A/C clutch apply, again no good can come of it. Setting the following two values to zero makes this go away, trans_ac_slip and trans_ac_slip_watchdog.

During shifts, the torque converter can also slip. The amount of slip during a shift is trans_Slip_during_shift. This value can be made either zero of 8 rpm.

trans_Min_Speed_Ratio_to_lock
This is a ratio of transmission input shaft speed divided by engine speed, to allow the converter to lock. If you are below this value the converter will not lock up. A good value for this is around .85.

trans_Tm_dealy_lockup_at_tipin
When coming in from closed throttle, this is a time delay to lock the converter. A good value for this is around 2 seconds.

trans_Tm_remained_locked_CT
This is a time to keep the converter locked at closed throttle.

There are several values for minimum transmission shifting pressure. They are specific for each gear and are for either power on (P/on), power off (P/off) or non-shifting. The none shifting values should all be around 30 to ensure enough line pressure to hold all the clutches on. The power off values should be around 10-20 psi and the power on values should be around 20 psi. These are trans_min_TV_P/off_into_1st, trans_min_TV_P/on_into_1st, and trans_min_TV_nonshift_1st. Are the values for 1st gear.

The 95 and 96 Mustang cars have no baro sensor and are prone to poor operation after extensive modification. They do respond well to tuning however.You may want to raise the speed limit on the Cobra and to do this, simply raise the speed limits all to 16000. (this value is driveshaft rpm) The Cobra is an easy car to pick up power on. Simply use the GT binary and edit it for the vehicle combination. The Cobra calibration has poor cold start and tip in hesitation, and the spark and fuel is configured in a less aggressive format than the GT calibration.
Another way to tune the 95 and 96 cars is to install a Pro-M Racing Power Improvement Harness. This allows you to install a 89-93 computer.

Parameters

1st_gear_ratio
2nd_gear_ratio
3rd_gear_ratio
4th_gear_ratio
5th_gear_ratio
6th_gear_ratio
rev_gear_ratio
Transmission gear ratios for the gear shown

2-1_pullin_max_speed
This is the speed to allow the Trans to shift into low gear when the shifter is placed in manual 1.

3-2_pullin_max_speed
This is the speed to allow the Trans to shift into 2nd gear when the shifter is placed in manual 2.

axle_ratio
This is the axle ratio that the car has in it. When this is changed, you MUST look at AXLE_RATIO_SWITCH. This switch MUST be set to zero to use the new axle ratio that is entered into this value. Change this to the correct axle ratio.

traction_control_switch
Setting the value to zero will permanently disable traction control and it will never come on again.

axle_ratio_switch
This MUST be set to zero to be able to change axle ratio or tire size. If it is set to one, then it will use the values programmed into the vehicle ID block from the factory.

torque_table
torque_table_friction
This is a pair of tables that is used by the EEC to calculate the amount of torque that the motor is producing. These tables are important in making the automatic transmission function correctly. A lot of the pressure in the transmission is determined by how much torque the engine produces. For an N/A motor, I would not change the torque table, for a blown motor, I'd use the tables that are recommended.

torque_truncation_table
There are only a few cars that this is used on. The 89-93 Automatic Supercoupes used this limit the torque into the transmission. In this case this is a table of RPM and Load and how much spark to retard. To eliminate this set this table to all zeros.

In the newer vehicles this is a 4-cell table that limits the torque in each gear. The 94/95 Supercoupes and Base V6 T-Birds used this to limit torque into the axle. To eliminate this, set these values to all 1000's.

tp_for_pt
This is the throttle position that it uses to exit idle control and enter part throttle mode.

tp_for_wot
This is the throttle position that it uses to enter WOT throttle mode.

trans_2-1_pullin_max_speed
This is the speed to allow the trans to shift into low gear when the shifter is placed in manual 1.

trans_3-2_pullin_max_speed
This is the speed to allow the trans to shift into 2nd gear when the shifter is placed in manual 2.

trans_4_times_NVBASE
trans_ac_slip
trans_ac_slip_watchdog
Some vehicles will also slip the converter for the A/C clutch apply, again no good can come of it. Setting the following two values to zero makes this go away, trans_ac_slip and trans_ac_slip_watchdog.

trans_auto_switch
This is used in some of the later software. If the vehicle has an automatic trans, this switch will be set to one. To eliminate the electronic automatic trans function, this needs to be changed to a zero.

trans_Base_N/V_of_Vehicle
rpm / speed

trans_converter_lock_1st
trans_converter_lock_2nd
trans_converter_lock_3rd
trans_converter_lock_4th
trans_converter_lock_5th
trans_converter_unlock_1st
trans_converter_unlock_2nd
trans_converter_unlock_3rd
trans_converter_unlock_4th
trans_converter_unlock_5th
controls lock and unlock points of torque convertor, based on TP and MPH. See trans description for details

trans_holes_in_OPS
When changing trans types on the newer vehicles, the speedo is driven off the output shaft in the trans and not a vehicle speed sensor. This defines the number of holes in the output shaft. Normally a 4R70W has 6 holes and most T5/T45 manuals have 12 holes. To make the speed right when changing transmissions, this needs to be changed to the correct values.

trans_load_type_switch
trans_strategy
trans_load_type_switch
These two determine what type of transmission the vehicle has in it. The main things to remember here are this; if you switched from an auto to a manual transmission, you need to make both of these values zero. To disable the shift light on some vehicles, make both of these values zero. If switching to a none electronic type automatic trans, make both of these values zero.

trans_lockup_rate_after_tip_in
trans_lockup_rate_after_upshift
trans_lockup_rate_w/high_tp
trans_lockup_rate_w/high_tp
The EEC controls the rate at which the torque converter can be ramped on. There are quite a few parameters to change. trans_Lockup_rate_w/high_TP controls the rate the converter locks when at high throttle positions. trans_Lockup_rate_after_upshift is the rate at which the converter locks after an upshift and trans_Lockup_rate_after_tip_in is the rate at which the converter locks up after a tip in from closed throttle or any other time not covered by the other two. Larger numbers are faster lockups. A stock converter can have these numbers increased by 50-100%. Different model years used different types of values in these scalars so don't be surprised from one vehicle to another that the numbers may be very different.

trans_man_shift_12_limit
Above this RPM, the transmission will shift out of manual 1 and into second gear even though the shift was not moved. To prevent this from happening, set this RPM above the engine rev limiter.

trans_manual_12
rpm at which to command a 1-2 shift

trans_Max_learned_N/V
maximum N/V correction factor

trans_min_ECT_for_torque_mod
minimum engine temp to enable spark retard on shifts

trans_Min_learned_N/V
minimum N/V correction factor

trans_Min_Speed_Ratio_to_lock
This is a ratio of transmission input shaft speed divided by engine speed, to allow the converter to lock. If you are below this value the converter will not lock up. A good value for this is around .85.

trans_min_tm_OSS_pulse
Set this to zero to prevent the transmission from downshift at very high speeds when it is not suppose to.

trans_min_tp_for_torque_mod
trans_min_tp_for_torque_mod_downshift
trans_min_tp_for_torque_mod_upshift
During shifts, the EEC can reduce engine torque. This is done either via spark retard or shutting of fuel injectors. In most cases shutting this off makes the shifts firmer and the vehicle performance improves. On some of the E4OD and 4R100 transmission, if you disable the torque reduction the shifts get softer since the transmission does not have enough capacity to stop the oncoming clutch with the power its making. In these cases, you should reduce the amount of torque that is reduced during the shift. In the some software there are two ways to disable this torque reduction, setting trans_min_tp_for_torque_mod to 900 or setting trans_min_ECT_for_torque_mod to 250 will disable this reduction. In some versions of software there will be these two values plus two others that need to be set to 900, trans_min_tp_for_torque_mod_upshift and trans_min_tp_for_torque_mod_downshift.

trans_min_TV_nonshift_1st
trans_min_TV_nonshift_2nd
trans_min_TV_nonshift_3rd
trans_min_TV_nonshift_4th
minimum TV pressure when not shifting

trans_min_TV_P/off_into_1st
trans_min_TV_P/off_into_2nd
trans_min_TV_P/off_into_3rd
trans_min_TV_P/off_into_4th
trans_min_TV_P/on_into_1st
trans_min_TV_P/on_into_2nd
trans_min_TV_P/on_into_3rd
trans_min_TV_P/on_into_4th
There are several values for minimum transmission shifting pressure. They are specific for each gear and are for either power on (P/on), power off (P/off) or non-shifting. The none shifting values should all be around 30 to ensure enough line pressure to hold all the clutches on. The power off values should be around 10-20 psi and the power on values should be around 20 psi. These are trans_min_TV_P/off_into_1st, trans_min_TV_P/on_into_1st, and trans_min_TV_nonshift_1st. Are the values for 1st gear.

trans_multiplier_NV
multiplier for NV

trans_od_cancel_override
trans_shift_schedule_12
trans_shift_schedule_21
trans_shift_schedule_23
trans_shift_schedule_32
trans_shift_schedule_34
trans_shift_schedule_43
trans_shift_schedule_45
The shift schedule is pretty straightforward. There are functions for each upshift and downshift, trans_shift_schedule_xy where xy is the shift. These are throttle position relative to closed throttle vs. what speed to shift at. You must make sure that the pair of shift curves do NOT cross. For example, you cannot have the 1-2 and 2-1 shift curves cross. If they do, the trans will most likely just shift back and forth at a fairly high frequency in the range that they cross.

trans_Slip_during_shift
During shifts, the torque converter can also slip. The amount of slip during a shift is trans_Slip_during_shift. This value can be made either zero of 8 rpm.

trans_slip_rate
trans_slip_rate_low_TP
trans_slip_rate_shifts
Aside from the above values that control lockup rate, the following also control the rate, trans_slip_rate, trans_slip_rate_low_TP and trans_slip_rate_shifts. To make the lockup under these conditions faster, make these values smaller. Good values for these to start with are around .2

trans_Stall_Curve_F
trans_Stall_Curve_R
To make engagements faster there are two functions that control the pressure in the trans when the vehicle speed is zero. If you change the zero to low TP area of these functions, it will change the pressure the engagement is made on. These functions are trans_stall_curve_F for pressure into Drive and trans_stall_curve_R for pressure into Reverse. For pressure into drive, I'd make the value about 20 for a quick engagement and for reverse the value should be around 25.

trans_strategy
trans_strategy and trans_load_type_switch
These two determine what type of transmission the vehicle has in it. The main things to remember here are this; if you switched from an auto to a manual transmission, you need to make both of these values zero. To disable the shift light on some vehicles, make both of these values zero. If switching to a none electronic type automatic trans, make both of these values zero.

trans_Tagret_slip_time_12
trans_Tagret_slip_time_13
trans_Tagret_slip_time_23
trans_Tagret_slip_time_25
trans_Tagret_slip_time_34
trans_Tagret_slip_time_45
In some of the newer transmissions, the EEC measures the time it takes the clutch to apply and then the shifting pressure adjusted so the time it takes the clutch to apply is within a target range. These target values are in tables like trans_Tagret_slip_time_xy, where xy is the shift that that table controls. The value in these tables are in milliseconds. To make a shift firmer, make these values smaller. I'd move them in 100-150 millisecond increments.

trans_thrtl_rate_hiTP_in
trans_thrtl_rate_hiTP_out
trans_thrtl_rate_lowTP_in
trans_thrtl_rate_lowTP_out
There is a way to unlock the torque converter based on how fast the throttle is moved in or out. This can cause the converter to unlock when the drive may not be expecting it too. It is recommended to make this none functional. Make trans_thrtl_rate_lowTP_in and trans_thrtl_rate_hiTP_in to values of 500 and make trans_thrtl_rate_lowTP_out and trans_thrtl_rate_hiTP_out to -500.

trans_Time_to_Stroke_Cnvcl
trans_Tm_dealy_lockup_at_tipin
When coming in from closed throttle, this is a time delay to lock the converter. A good value for this is around 2 seconds.

trans_Tm_remained_locked_CT
This is a time to keep the converter locked at closed throttle.

trans_Tm_Sequence_42
trans_Tm_Sequence_in_man1
trans_Tm_Sequence_in_man2
On some older applications, when you put the shifter into manual low, it delays the engagement into low by a long time, even though you are below the trans_2-1_pullin_max_speed. Make sure this timer is at or near zero.

trans_Tm_Sequence_thru_2nd_P4
This is the time the EEC must be commanding 2nd before it will command 3rd. This value can be lowered to zero but should be around .5 - 1.0 seconds.

trans_Tm_Sequence_thru_3rd_P4
This is the time the EEC must be commanding 3rd gear before letting the trans shift into 4th gear. This value should be at least 1-1.5 seconds.

trans_tqconv_slip_2nd
trans_tqconv_slip_3rd
trans_tqconv_slip_4th
Some vehicles allow steady state slip across the torque converter. This is bad, it just generates heat and no good can come from it. The following 3 tables determine how much steady state slip the converter will try to control to, trans_tqconv_slip_2nd, _3rd and _4th. Make the values in these tables zero's.

trans_tqmod_12
trans_tqmod_21
trans_tqmod_21
trans_tqmod_23
trans_tqmod_32
trans_tqmod_34
trans_tqmod_43
trans_tqmod_45
trans_tqmod_54
If you do not want to shut off the torque reduction and just want to reduce it, then you can change the amount in the torque reduction tables. These tables are a percent of total torque you want the engine to have. A value of .8 means you want the engine to have 80% of its normal torque, or a 20% reduction. These tables are specific for each shift and are as follows, trans_tqmod_xy where xy is the shift you want to change. A 1-2 shift would be trans_tqmod_12.

trans_tv_pressure_12
trans_tv_pressure_13
trans_TV_pressure_21
trans_tv_pressure_23
trans_tv_pressure_25
trans_tv_pressure_31
trans_tv_pressure_32
trans_tv_pressure_34
trans_tv_pressure_42
trans_tv_pressure_43
trans_tv_pressure_45
trans_tv_pressure_54
Shifting pressure . There is either a function of TP vs. added pressure for each shift, or a table of TP on the X-axis and vehicle speed on the Y-axis for added pressure during the shift. These functions/tables are trans_TV_pressure_xy, where xy is the shift you want to add pressure too. For example, trans_TV_pressure_12 is added pressure for a 1-2 shift. Normally adding 10 psi to the 1-2 shifts makes them noticeably firmer. To get this same result on the 2-3 shift you need to add about 15 psi and for the 3-4 shift adding 10 has similar results. For maximum firmness at WOT, make the high TP columns near WOT, about 650+ TP, all 99's. This will ensure max pressure for WOT shifts.

trans_TV_Ramp_12shift
trans_TV_Ramp_23shift
trans_TV_Ramp_34shift
On some older software versions and applications, ramps were used to ramp pressure in or out during a shift. These ramps are trans_TV_Ramp_xyshift, where xy is the shift that pressure is being ramped into or out of. Just check these values to make sure there is not a large negative number in there. If there is, then as you try to add pressure, this will take the pressure back out. I'd make all these values zero or positive numbers.

trans_vs_o/d_cancel_override
Above this vehicle speed, if the OD cancel button is pressed so the driver has the vehicle in 3rd gear, the OD Off light will go out and the transmission will shift into 4th gear. Make this value 127.5

trans_wot_shift_12
trans_wot_shift_23
trans_wot_shift_34
At WOT, the trans shifts off of one of two things. Either the vehicle speed that is in the shift schedule functions or the WOT engine speed scalars, trans_wot_shift_xy, where xy is the shift, like 12. What this means, in most cases, is that this is where the shift is COMMANDED and not where it will occur. In some transmissions it can take up to one second to fill the on coming clutch. If the engine is accelerating at 1000 RPM per second (not unusual for low gear with a 3.73 ratio) that means that from the commanded of the shift to the actual shift point, the RPM will increase by 1000 rpm. So, if you set the trans_wot_shift_12 to 5000 rpm, the shift could occur 6000 rpm. This is important to know when setting up WOT shift points.

trans_converter_lock_1st
trans_converter_lock_2nd
trans_converter_lock_3rd
trans_converter_lock_4th
trans_converter_lock_5th
trans_converter_unlock_1st
trans_converter_unlock_2nd
trans_converter_unlock_3rd
trans_converter_unlock_4th
trans_converter_unlock_5th
Controls lock and unlock points of the torque converter, based on TP and MPH. See trans description for details

trans_shift_schedule_12
trans_shift_schedule_21
trans_shift_schedule_23
trans_shift_schedule_32
trans_shift_schedule_34
trans_shift_schedule_43
trans_shift_schedule_45
There are functions for each up shift and downshift, trans_shift_schedule_xy where xy is the shift. These are throttle position relative to closed throttle vs. what speed to shift at. You must make sure that the pair of shift curves do NOT cross. For example, you cannot have the 1-2 and 2-1 shift curves cross. If they do, the Trans will most likely just shift back and forth at a fairly high frequency in the range that they cross.

Tagret_slip_time_12_shift
Tagret_slip_time_13_shift
Tagret_slip_time_23_shift
Tagret_slip_time_25_shift
Tagret_slip_time_34_shift
Tagret_slip_time_45_shift
In some of the newer transmissions, the PCM measures the time it takes the clutch to apply and then the shifting pressure adjusted so the time it takes the clutch to apply is within a target range. These target values are in tables like Tagret_slip_time_xy_shift, where xy is the shift that that table controls.
The values in these tables are in milliseconds. So 1 second is 1000 milliseconds.
To make a shift firmer, make these values smaller. It is recommended to move them in 100-150 millisecond increments.

trans_tv_pressure_12
trans_tv_pressure_13
trans_tv_pressure_21
trans_tv_pressure_23
trans_tv_pressure_25
trans_tv_pressure_31
trans_tv_pressure_32
trans_tv_pressure_34
trans_tv_pressure_42
trans_tv_pressure_43
trans_tv_pressure_45
trans_tv_pressure_54
This is the shifting pressure. There is either a function of TP vs. added pressure for each shift, or a table of TP on the X-axis and vehicle speed on the Y-axis for added pressure during the shift. These functions/tables are trans_TV_pressure_xy, where xy is the shift you want to add pressure too. For example, trans_TV_pressure_12 is added pressure for a 1-2 shift. Normally adding 10 psi to the 1-2 shifts makes them noticeably firmer. To get this same result on the 2-3 shift you need to add about 15 psi and for the 3-4 shift adding 10 has similar results. For maximum firmness at WOT, make the high TP columns near WOT, about 650+ TP, all 99's. This will ensure max pressure for WOT shifts.

trans_vs_o/d_cancel_override
Above this vehicle speed, if the OD cancel button is pressed so the driver has the vehicle in 3rd gear, the OD Off light will go out and the transmission will shift into 4th gear. Make this value 127.5

trans_wot_shift_rpm_12
trans_wot_shift_rpm_23
trans_wot_shift_rpm_34
trans_wot_shift_rpm_45
At WOT, the Trans shifts off of one of two things. Either the vehicle speed that is in the shift schedule functions or the WOT engine speed scalars, trans_wot_shift_xy, where xy is the shift, like 12. What this means, in most cases, is that this is where the shift is COMMANDED and NOT where it will occur. In some transmissions it can take up to one second to fill the on coming clutch. If the engine is accelerating at 1000 RPM per second (not unusual for low gear with a 3.73 ratio) that means that from the commanded of the shift to the actual shift point, the RPM will increase by 1000 rpm. So, if you set the trans_wot_shift_12 to 5000 rpm, the shift could occur 6000 rpm. This is important to know when setting up WOT shift points.

min_tp_for_torque_reduction_on_shifts
min_tp_for_torque_reduction_on_upshifts
min_tp_for_torque_reduction_on_sdownhifts
During shifts, the PCM can reduce engine torque. This is done either via spark retard or shutting of fuel injectors. In most cases shutting this off makes the shifts firmer and the vehicle performance improves.

On some of the E4OD and 4R100 transmission, if you disable the torque reduction the shifts will get softer since the transmission does not have enough capacity to stop the oncoming clutch with the power its making. In these cases, you should reduce the amount of torque that is reduced during the shift.

Volumetric Efficiency & Load

Parameters

volumetric_efficiency

This is only use on speed density vehicles like the original Lightning from the early/mid 1990's. This is engine speed vs. MAP and the output is engine volumetric efficiency.

open_loop_load

In the older software, you can go open loop based on load. There is a function of engine RPM vs. Load, open_loop_load . If you are at that engine RPM , and you exceed the load timer, Time_to_delay_open_loop_RPM or Time_to_delay_open_loop_hys or time_to_delay_open_loop_ECT, (you will only have one of these timers) then you will go open loop fuel control.

percent_load_switch

determines the Y axis for the fuel_base_table.