Toyota Tundra 5.7L 3UR-FBE

Flex Fuel

Supercharger Calibration Guide

Ver. 1.2.9.9

Table of Contents

Glossary

AFR	→ Air Fuel Ratio
Calibration	→ The process of configuring an instrument to provide a result for a sample within an acceptable range
ECU	→ Engine Control Unit
ECM	→Engine Control Module
MAF	→Mass Air Flow
PID	→Proportional Integral Derivative
RPM	→Revolutions Per Minute

1. Understanding Fuel Logic

The 3UR-FBE Engine fueling logic consists of an AlphaN - TPS + MAF and Fuel Density

The primary components of this strategy are

i. Ethanol blend concentration calculation (which can be effectively muted)
ii. The Throttle position in correlation to the calculated cylinder filling tables
iii. Volumetric Table enrichments
iv. The Mass Airflow - Gram per second Readings from the MAF Sensor
v. The current Target Lambda state (Stoic, Enrich, Catalyst Protection)

1.1. Ethanol blend concentration calculation

The Flex Fuel Tundra does not have an Ethanol content sensor. The Ethanol content is calculated through a series of recordings. The ECU records various fuel trims during different driving states to calculate what the effective amount of ethanol is in the fuel tank. This is done after each fuel tank refill.

When supercharging the 3UR-FBE, it is critical that fueling is accurate at all times. If your fuel trims are far enough off to cause a different calculation in ethanol, you may run overly rich or lean.

To disable ethanol content controls (or modify them) VF Tuner has provided several Ethanol content tables to do so. Please see our Ethanol content section regarding this

1.2. The throttle position in Correlation to the calculated cylinder filling tables

There are several Alpha-N based fueling strategies that the 3UR-FBE Calibration utilizes. One is enrichment tables per throttle position and cylinder. It also uses a calculated engine load variant plus individual cylinder trims. These tables are individual cylinder based TPS vs Engine speed Fuel enrichment tables. Under normal circumstances these tables do not really need modification. However they can be used to provide additional fueling where the MAF sensor and other methods cannot.

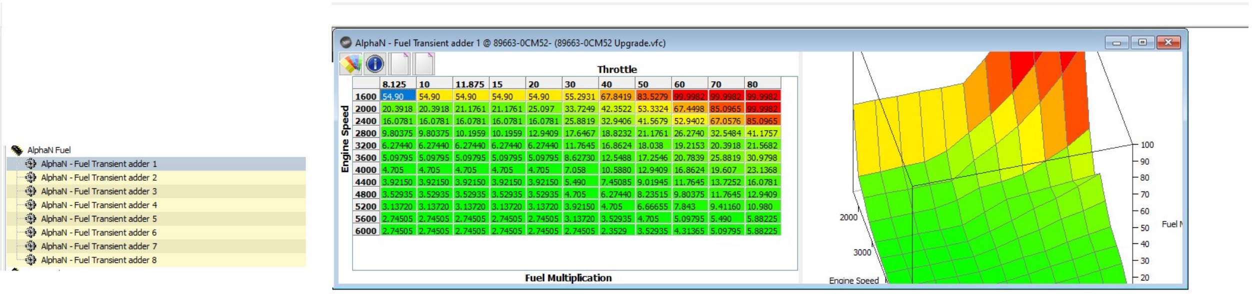


Fig 1.1 showing throttle position in Correlation to the calculated cylinder filling tables

1.3. Volumetric table enrichment's

The ECU uses a method for injector calculation based on a primary fuel density, modified for airflow. An example calculation is

(Airflow (Fuel Density x Mass Airflow Gram) Engine Load (Engine Load Fuel Multiplier)))

1.3.1. Injector Information

The ECU uses a base flow calculation which VF Tuner program has converted to an easier to work with value.

<u>NOTE</u>: The value is not true CC per minute! Please pay attention to this.
The ECU also has a minimum effective Pulse width (in milliseconds)

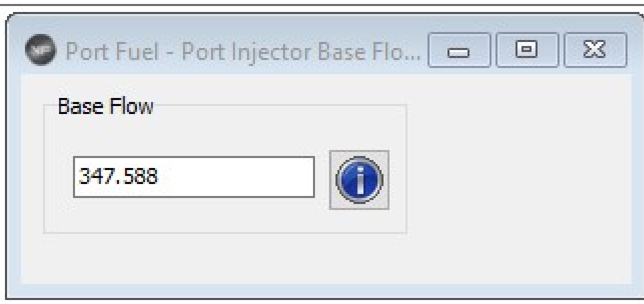


Fig 1.2 Showing Base Flow calculation

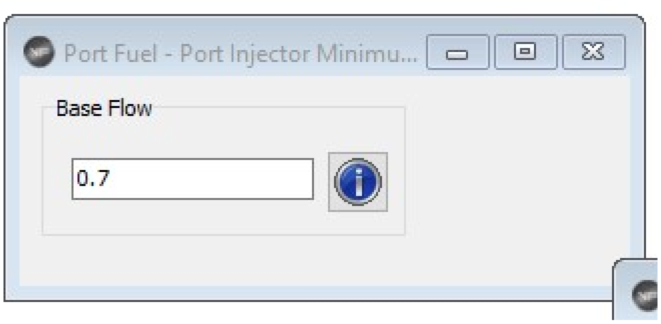


Fig 1.3 showing minimum allowed injector mS pulse

1.3.2. Toyotas Fueling logic

Toyota fueling logic also consists of fueling for engine load absolute. There are 2 tables, plus additional RPM based trigger points for table activation. These control when the ECU uses a HIGHER load calculation base and a LOWER load calculation base.

These tables effectively are the calibrations base load control strategy. Load is calculated through these primary tables. Example of how it works:

(Engine RPM * MAF flow * Engine Load multiplier value) = Total Engine load

Raising these values will increase Absolute engine load calculated, and resulting fuel demand.

Lowering the values will lower it.

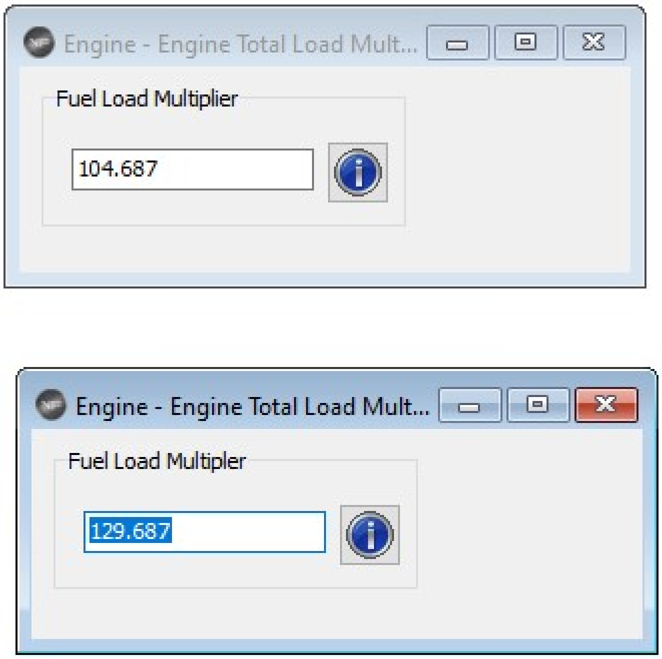


Fig 1.4 showing Engine total load Multiplier

There are RPM trigger points that activate or deactivate these tables (see "Engine" section in the table list)

- ✓ Overload = The calibration is now using the HIGH Load strategy
- ✓ Engine RPM for Overload Enable = When the ECU will use this strategy.
- ✓ Disable is when the Calibration will use the LOW Load Strategy.

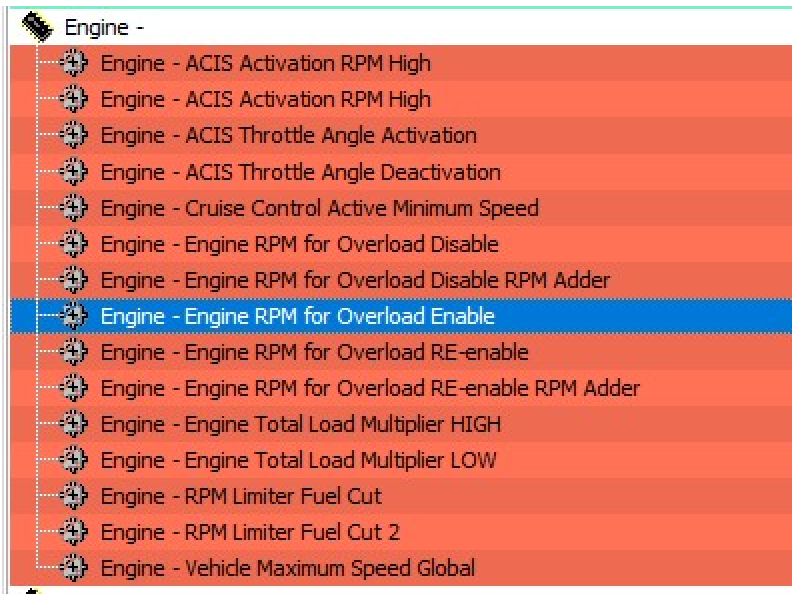


Fig 1.5 showing Engine Map PID

1.3.3. Fuel Multipliers

Toyotas 3UR-FBE engine calibration has 2 primary Fuel Multiplier tables.

These tables are used for trimming fuel based on engine load, engine speed, and Fuel Pump pressure mode.

i. Global Fuel - Load Based Injection Multiplier

This table effectively trims fuel for calculated engine load.

NOTE –

- The Tundra does not have a vacuum referenced Fuel Pressure Regulator and the ECM does not have a manifold pressure sensor. As a result of this, the Logic for fueling has this table that trims total fuel, multiplied by a value in this table.

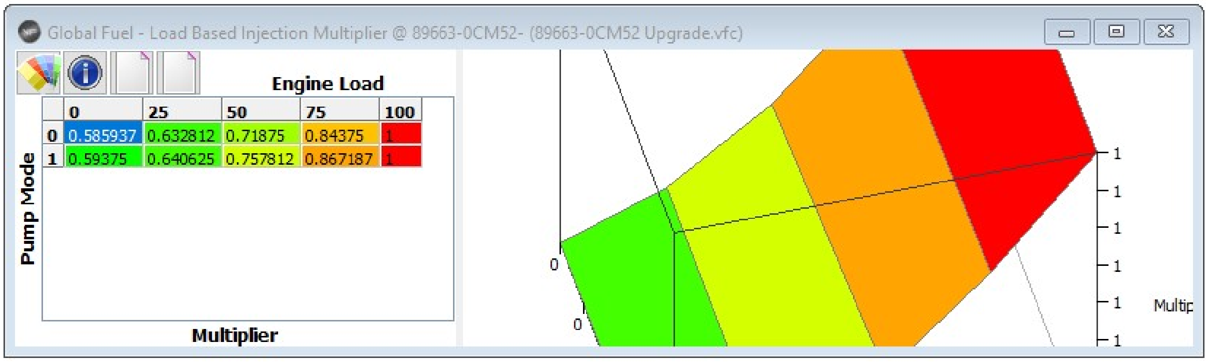
  Note: 1.0 = 100%.

- Increasing values in this table will increase the amount of total fuel injected.

  Note: 0.05 = 5%, 1.0 - 100%

ii. Global Fuel - Fuel Multiplier For Each Cylinder –

This table trims fueling for each individual cylinder at low load conditions when VE is not optimal and each cylinder is not achieving the same amount of cylinder filling for a given throttle position. This table is only referenced during Stoic / Target Lambda 1.0 conditions



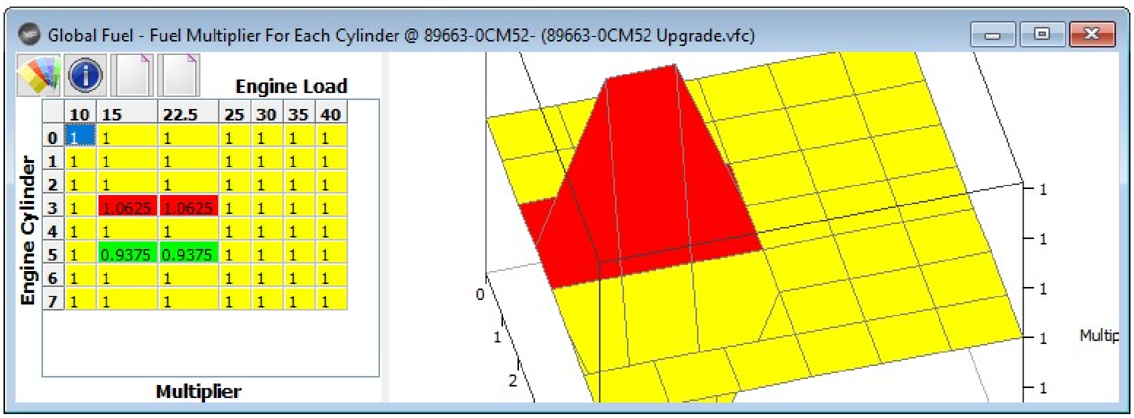


Fig 1.6 showing Fuel multiplier tables

1.3.4. The Mass Airflow - Gram Per second Readings from the MAF Sensor

The MAF sensor provides the ECU with a reading that is used to calculate the amount of air entering the engine (MAF G/sec). The method used is similar to the industry standard for airflow calculations on a hot-wire MAF. This can be used to correct fuel trims when your MAF reading / fuel trims are off

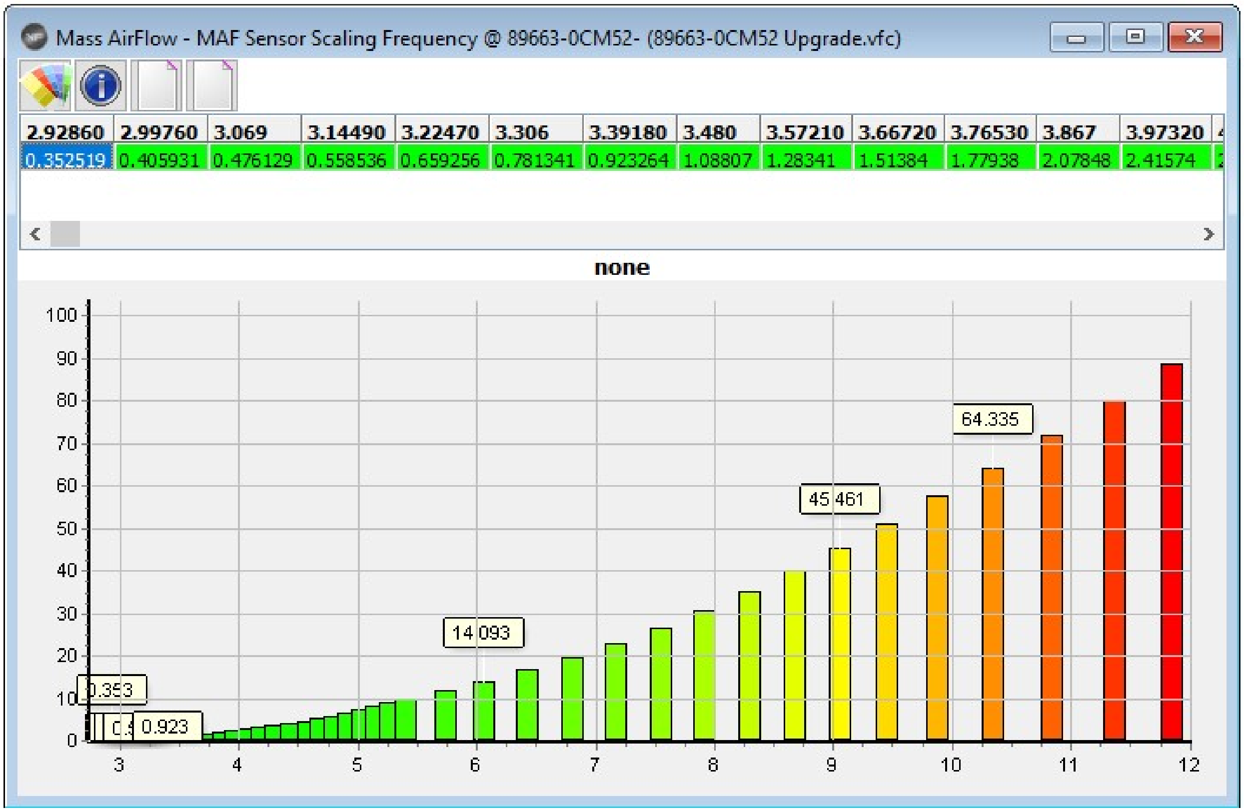


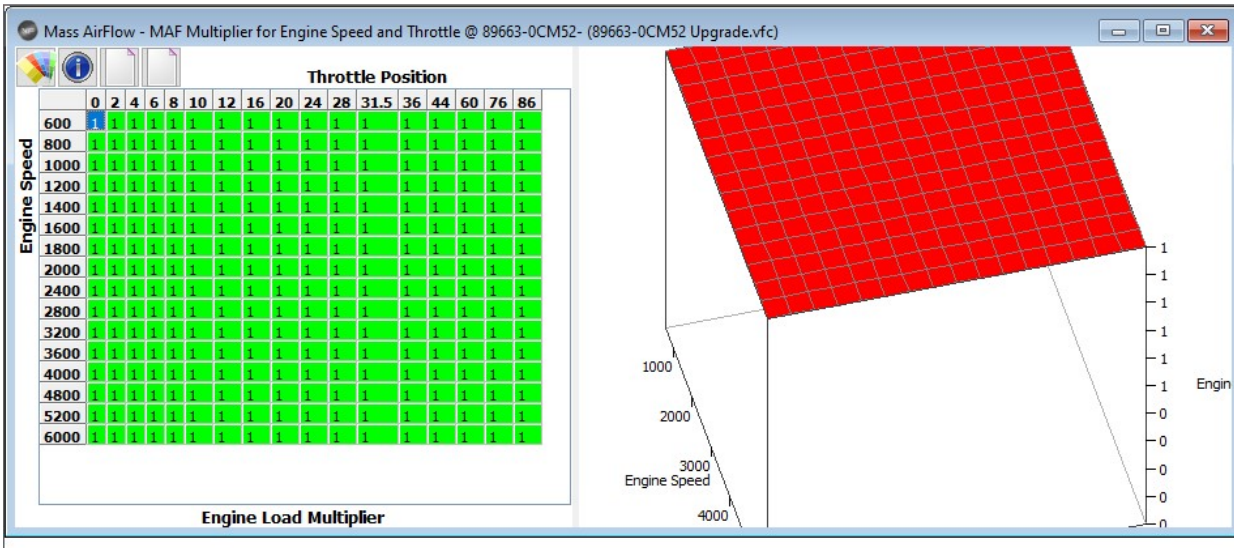
Fig 1.7 showing MAF sensor scaling frequency

1.4. Mass Airflow - MAF Multiplier for Engine Speed and Throttle

The ECU also provides 2 tables; Engine Hot and Engine Cold, which correct the Mass airflows reading. These tables multiply *(1.0 = 100%)* the total amount of MAF G/sec calculated.

Note:

- These tables are not referenced at high load and high RPM during acceleration conditions
- These tables are also not referenced during initial cold startup conditions
- These tables cannot be used to increase total G/sec calculation (limited to 655.35) when you Max out the MAF sensor



Engine Speed	0	2	4	6	8	10	12	16	20	24	28	31.5	36	44	60	76	86
600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
800	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1800	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2800	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4800	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Fig1. 8 showing Mass Airflow table

1.5. The current Target Lambda state (Stoic, Enrich, Catalyst Protection)

There are multiple conditions that affect target lambda. During **normal operation, closed loop, engine warm**, the target lambda will always be **14.59**. **This value is hard coded into the ECU and cannot be modified**

<u>Note</u>:

- VF Tuner has provided AFR Break - Point tables that provide some additional tuning capabilities for closed loop functions.
- These tables can modify target lambda in **CLOSED LOOP** and will achieve a different desired AFR.
- VF Tuner has also provided the tables that the ECU references to ignore close loop operation (Rich limits)
- Normally these tables do not need modification

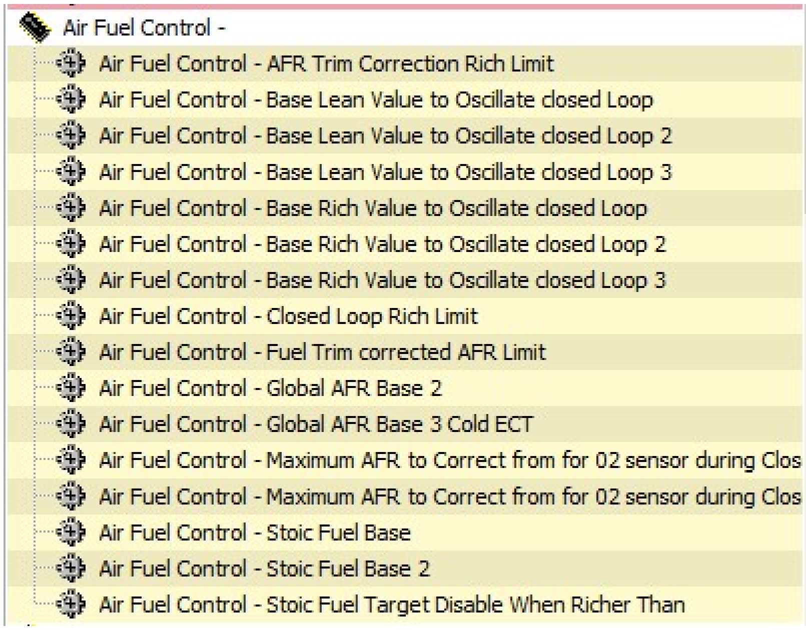


Fig 1.9 showing AirFuel Control

1.5.1. Enrichment Fueling - Base fueling

During acceleration the ECM provides enrichment fueling through 3 operations.

i. Catalyst temperature and corresponding enrichment factor,

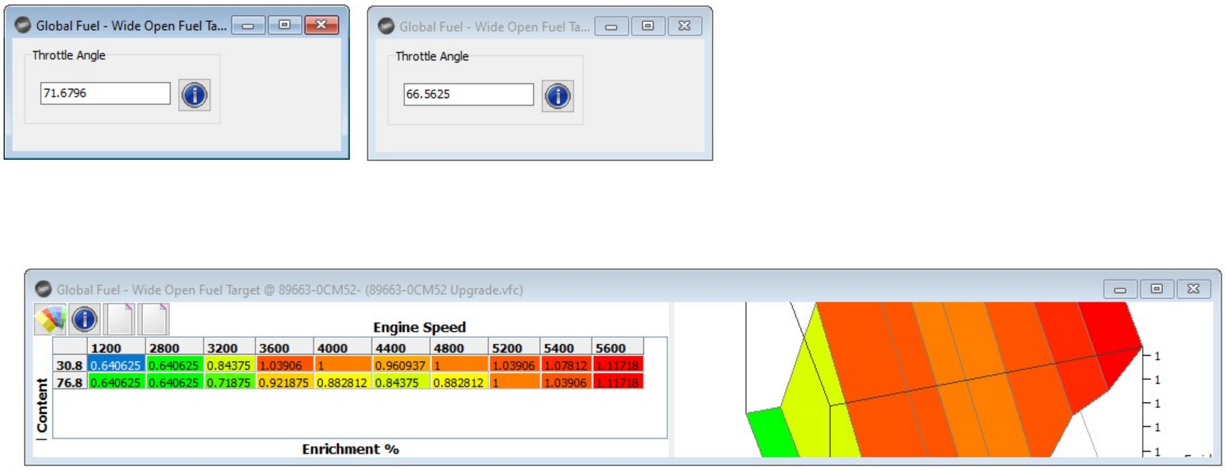
ii. Throttle position, and

iii. wide open fuel target

i. Global Fuel - Wide Open Fuel target.

This table is a target enrichment fuel factor that the ECU uses to ENRICH (richer than 14.6). This table is based on the Flex Fuel Tundras PUMP MODE (high Pump mode or Low Pump Mode). For easier tuning, we recommend setting these tables the same for supercharged applications

This table is only used when the Throttle Position (TPS) angle has reached the desired amount to activate the table: (*Global Fuel - Wide Open Fuel Target OFF/ON Thresholds*)



	1200	2800	3200	3600	4000	4400	4800	5200	5400	5600
30.8	0.640625	0.640625	0.84375	1.03906	1	0.960937	1	1.03906	1.07812	1.11718
76.8	0.640625	0.640625	0.71875	0.921875	0.882812	0.84375	0.882812	1	1.03906	1.11718

Fig 1.10 Showing Global Fuel - Wide Open Fuel Target

1.5.2. Catalyst enrichments

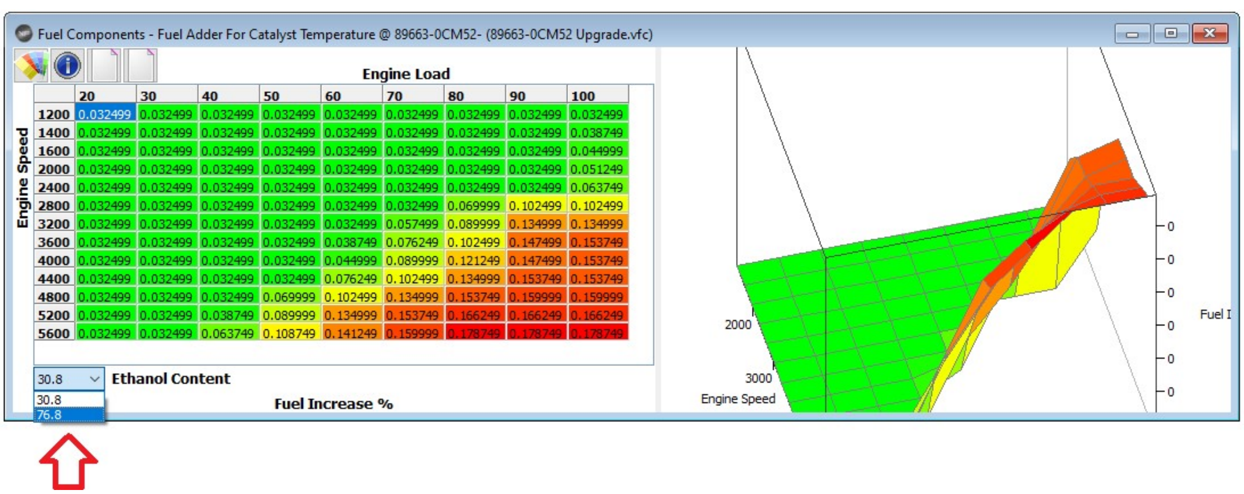
Additional fuel is provided based on catalyst calculated temperature (from the calculated temperature tables) and the 4D (4th Dimensional / Tri - Axis) Fuel enrichment tables.

i. Fuel Components - Fuel Adder for Catalyst Temperature

This table provides additional fueling, on top of all other fuel calculations, **ONLY DURING** non-stoic conditions (**target lambda richer than 14.6, Open loop, fault, etc. conditions)**

Note:

- This table is modified based on Ethanol content



Engine Speed	20	30	40	50	60	70	80	90	100
1200	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499
1400	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.038749
1600	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.044999
2000	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.051249
2400	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.063749
2800	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.069999	0.102499	0.102499
3200	0.032499	0.032499	0.032499	0.032499	0.032499	0.057499	0.089999	0.134999	0.134999
3600	0.032499	0.032499	0.032499	0.032499	0.038749	0.076249	0.102499	0.147499	0.153749
4000	0.032499	0.032499	0.032499	0.032499	0.044999	0.089999	0.121249	0.147499	0.153749
4400	0.032499	0.032499	0.032499	0.032499	0.076249	0.102499	0.134999	0.153749	0.153749
4800	0.032499	0.032499	0.032499	0.069999	0.102499	0.134999	0.153749	0.159999	0.159999
5200	0.032499	0.032499	0.038749	0.089999	0.134999	0.153749	0.166249	0.166249	0.166249
5600	0.032499	0.032499	0.063749	0.108749	0.141249	0.159999	0.178749	0.178749	0.178749

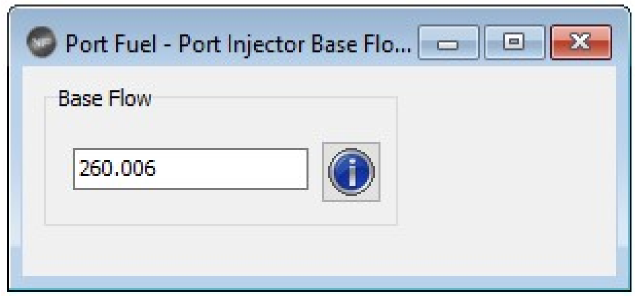
Fig 1.11 showing Fuel component –Fuel adder for catalyst temperature

2. Tuning - Injectors and Injector PW

Tuning the injectors and injector controls can be difficult. The stock injector control and measurement is done by calculation of airflow through the stock MAF and airbox. The stock injector size is not a direct CC Value either. If you have a supercharger, we have done a majority of this difficult injector tuning for you.

Use the value: 260 in the Injector size table (*insert picture, 260cc*).

Fig 2.1 showing Injector size table value



<u>NOTE</u>

- This value will only work optimally if you are using the stock airbox. Modified airboxes or intakes may require additional fuel trimming
- Normally the Injector minimum pulse width value does not need modified
- This value should get you very close to ideal and will allow the ECU to effortlessly target the required 14.6 during stoic target conditions allowing you to focus your time on WOT Tuning (wide open throttle)
- If your injectors have lag times provided you can input those in the table for injector lag times.

3. Flex Fuel Disable – Optional

Ethanol content calculations can get in the way of tuning. Especially since the ECUs method of calculating ethanol is not precise. The 3UR-FBE calibration uses a method of calculating content concentration through logging fuel trims and resetting the content value after every fill up.
We recommend disabling some, or all of these controls through the VF Tuner software. Some tables have the value needed to disable or modify them right in the table. We have also provided minimum and maximum content concentration values that can be calibrated. These tables can be found at the top under VFT EROM as they are tables provided EXCLUSIVELY through VF TUNER

Back to the top

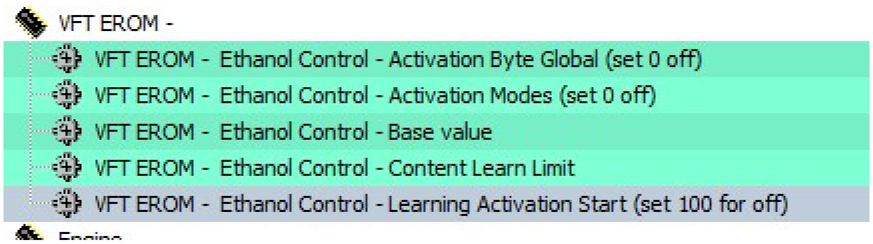


Fig 3.1 showing VFT EROM tables

In our example for ethanol content calculation, we tested with our tables set as follows:

- ✓ All zero activation table set to 0.
- ✓ Throttle set to 100 and maximum value allowed to calculate as 12%

  This means the ECU can calculate a value maximum to that of 12%

During logging and testing, we saw that regardless of drive cycle, even immediately after a flash, our base content value does not change.

Note:

- When filling up the tank the content value will reset, as seen in our datalog

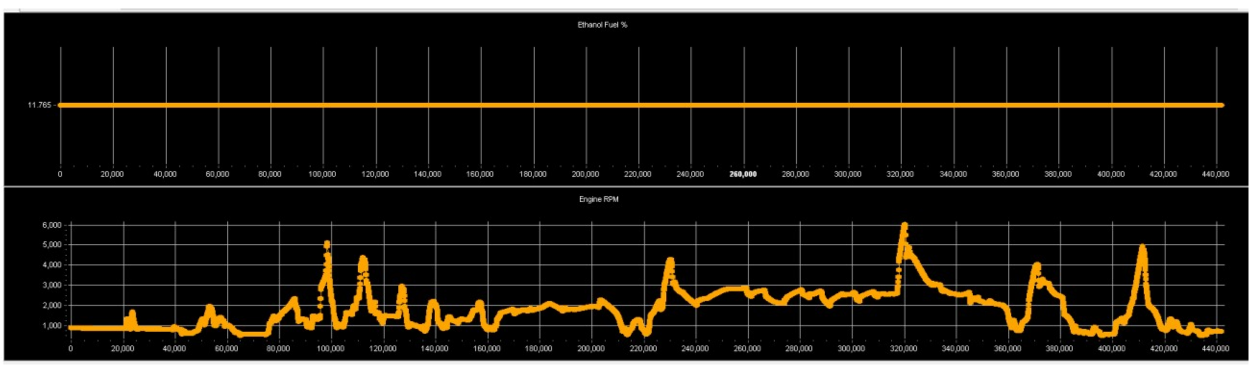


Fig 3.2 showing Logged Content Values during various driving

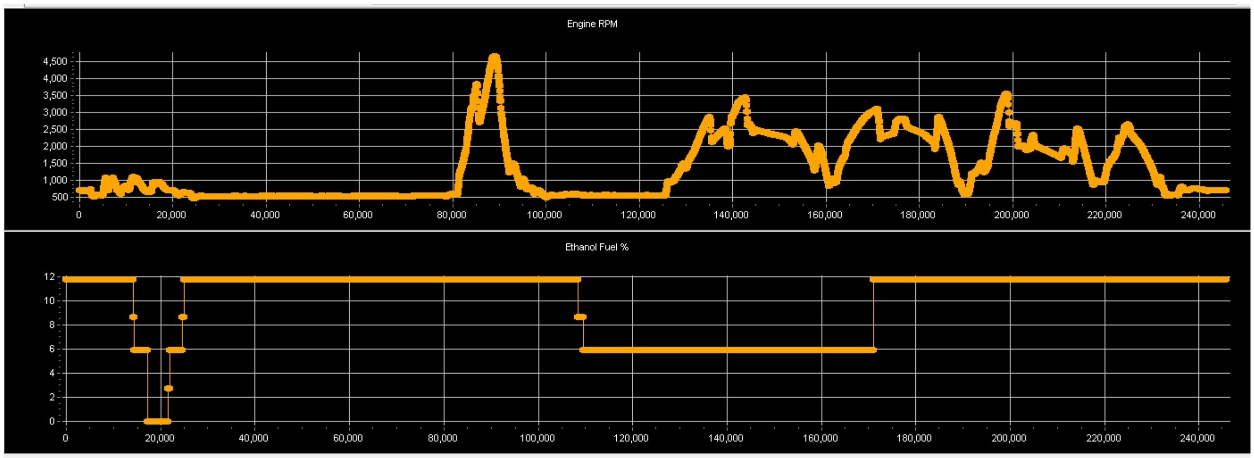


Fig 3.3 showing Learned content, immediately after fill up (between 0 and max allowed 12%)

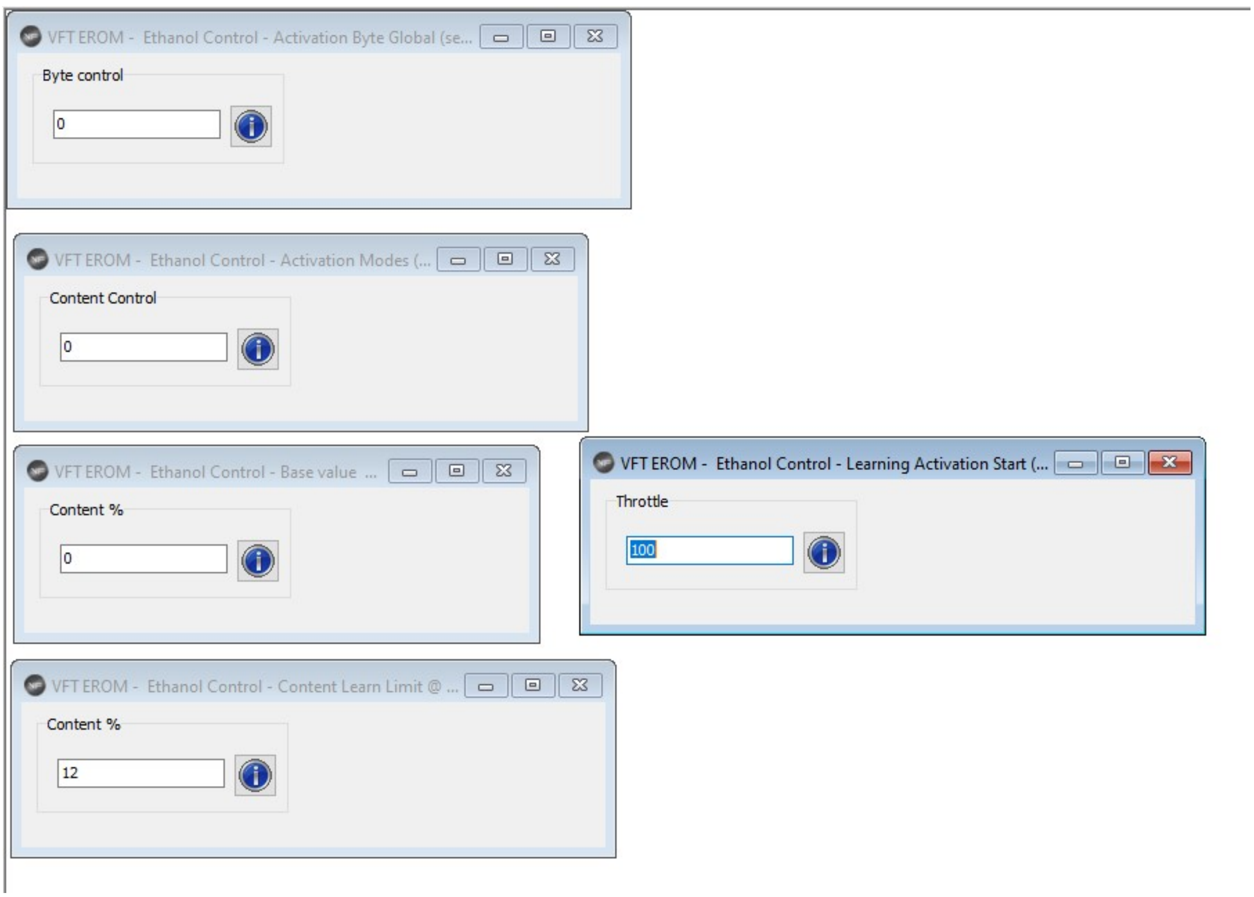


Fig 3.4 showing Example values provided by VF Tuner:

Note:

- Byte control table (1, set 0) disables certain tables from **SWITCHING** through the Ethanol content axis, even if content is not disabled

4. Tuning - Ignition Timing

The ignition timing strategy is as follows (simplified)

- Lowest Ignition table value + compensations + current knock retard + Knock Retard learn value.

There are multiple components to the ignition control system and each one needs to be observed. When tuning for a supercharger on the 3UR-xxx engine (5.7), you should be observant of total ignition timing. Ignition timing limit (***the amount you can tune for***) is a factor of octane and knock retard. In this example, we will provide a basic overview of the ignition control scheme and values that you can use to get started.

NOTE:

- Proper tuning of the ignition timing requires a dyno.

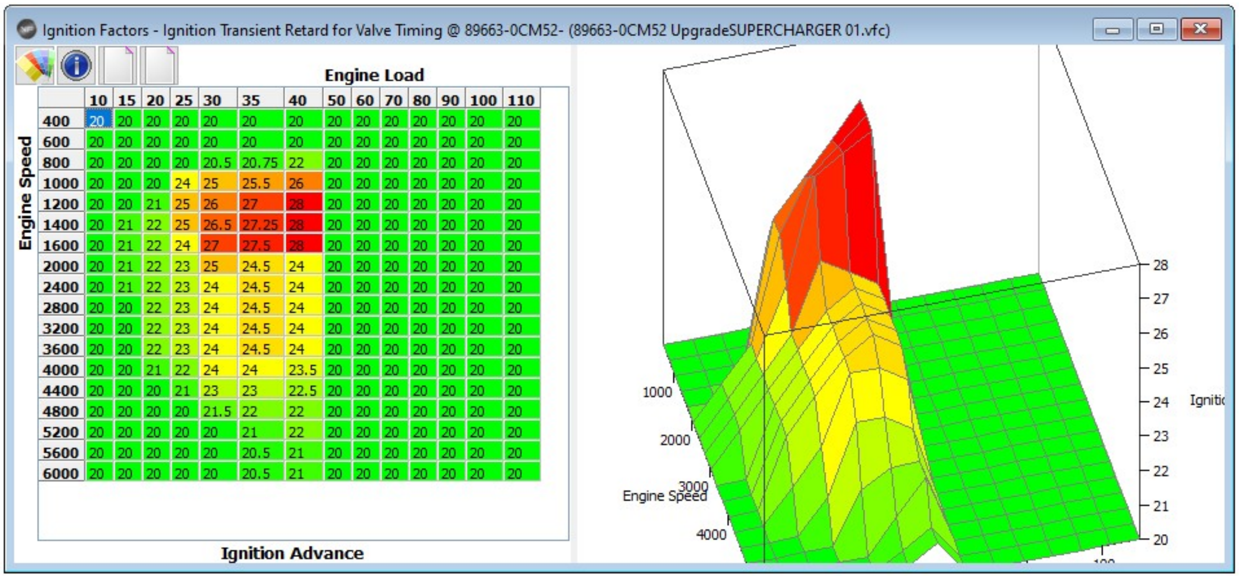
4.1. Ignition Timing Compensations

When tuning, it is important to understand that there are compensations (tables that add, subtract, or multiply). Some of these compensations are found under the

IGNITION FACTORS tab→Ignition Factors→Ignition Transient Retard for Valve Timing
These tables can retard (subtract) or increase timing.

NOTE:

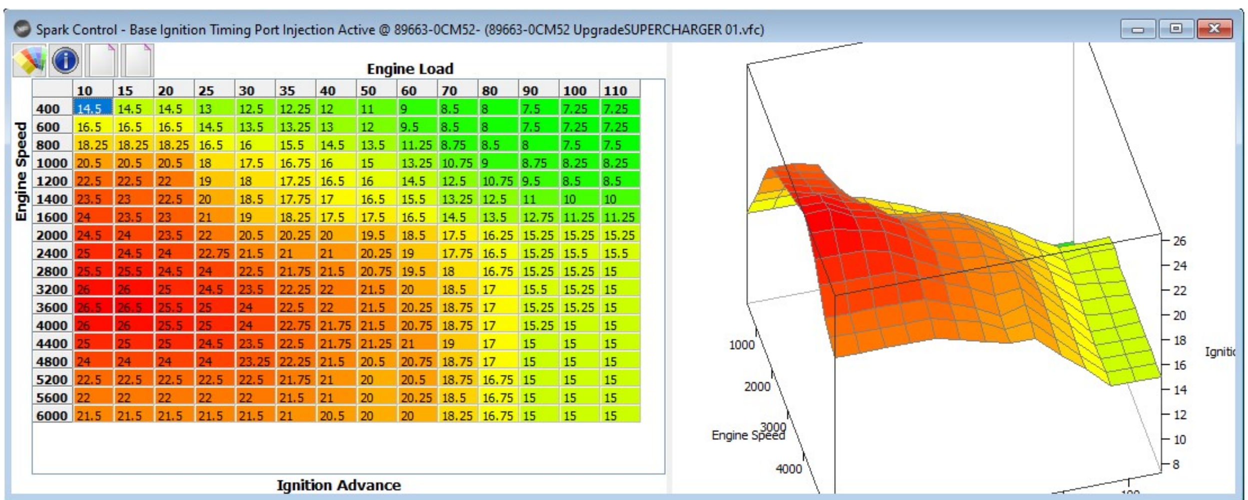
- The **BASE VALUE** which means 0* Added is 20, for these tables. That means values
  UNDER 20 = LESS TIMING
  Values ABOVE 20 = MORE TIMING
  VALUES THAT ARE 20 = NO TIMING is compensated



Engine Speed	10	15	20	25	30	35	40	50	60	70	80	90	100	110
400	20	20	20	20	20	20	20	20	20	20	20	20	20	20
600	20	20	20	20	20	20	20	20	20	20	20	20	20	20
800	20	20	20	20	20.5	20.75	22	20	20	20	20	20	20	20
1000	20	20	20	24	25	25.5	26	20	20	20	20	20	20	20
1200	20	20	21	25	26	27	28	20	20	20	20	20	20	20
1400	20	21	22	25	26.5	27.25	28	20	20	20	20	20	20	20
1600	20	21	22	24	27	27.5	28	20	20	20	20	20	20	20
2000	20	21	22	23	25	24.5	24	20	20	20	20	20	20	20
2400	20	21	22	23	24	24.5	24	20	20	20	20	20	20	20
2800	20	20	22	23	24	24.5	24	20	20	20	20	20	20	20
3200	20	20	22	23	24	24.5	24	20	20	20	20	20	20	20
3600	20	20	22	23	24	24.5	24	20	20	20	20	20	20	20
4000	20	20	21	22	24	24	23.5	20	20	20	20	20	20	20
4400	20	20	20	21	23	23	22.5	20	20	20	20	20	20	20
4800	20	20	20	20	21.5	22	22	20	20	20	20	20	20	20
5200	20	20	20	20	20	21	22	20	20	20	20	20	20	20
5600	20	20	20	20	20	20.5	21	20	20	20	20	20	20	20
6000	20	20	20	20	20	20.5	21	20	20	20	20	20	20	20

Fig 4.1 Showing Ignition factors for Ignition Transient retard for valve timing

Base ignition timing –port injection active is the primary (base) ignition timing table that the ECU will use to start from. This table is only ignored if there are other tables with a lower ignition value (cold start ignition)



Engine Speed	10	15	20	25	30	35	40	50	60	70	80	90	100	110
400	14.5	14.5	14.5	13	12.5	12.25	12	11	9	8.5	8	7.5	7.25	7.25
600	16.5	16.5	16.5	14.5	13.5	13.25	13	12	9.5	8.5	8	7.5	7.25	7.25
800	18.25	18.25	18.25	16.5	16	15.5	14.5	13.5	11.25	8.75	8.5	8	7.5	7.5
1000	20.5	20.5	20.5	18	17.5	16.75	16	15	13.25	10.75	9	8.75	8.25	8.25
1200	22.5	22.5	22	19	18	17.25	16.5	16	14.5	12.5	10.75	9.5	8.5	8.5
1400	23.5	23	22.5	20	18.5	17.75	17	16.5	15.5	13.25	12.5	11	10	10
1600	24	23.5	23	21	19	18.25	17.5	17.5	16.5	14.5	13.5	12.75	11.25	11.25
2000	24.5	24	23.5	22	20.5	20.25	20	19.5	18.5	17.5	16.25	15.25	15.25	15.25
2400	25	24.5	24	22.75	21.5	21	21	20.25	19	17.75	16.5	15.25	15.5	15.5
2800	25.5	25.5	24.5	24	22.5	21.75	21.5	20.75	19.5	18	16.75	15.25	15.25	15
3200	26	26	25	24.5	23.5	22.25	22	21.5	20	18.5	17	15.5	15.25	15
3600	26.5	26.5	25.5	25	24	22.5	22	21.5	20.25	18.75	17	15.25	15.25	15
4000	26	26	25.5	25	24	22.75	21.75	21.5	20.75	18.75	17	15.25	15	15
4400	25	25	25	24.5	23.5	22.5	21.75	21.25	21	19	17	15	15	15
4800	24	24	24	24	23.25	22.25	21.5	20.5	20.75	18.75	17	15	15	15
5200	22.5	22.5	22.5	22.5	22.5	21.75	21	20	20.5	18.75	16.75	15	15	15
5600	22	22	22	22	22	21.5	21	20	20.25	18.5	16.75	15	15	15
6000	21.5	21.5	21.5	21.5	21.5	21	20.5	20	20	18.25	16.75	15	15	15

Fig 4.2 showing Base ignition timing port injection active table

NOTE:

- An important distinction between LOW and HIGH knock ignition tables is that:- Low knock tables are referenced when the KNOCK correction learn value is **LOW**. When the value is low, that means that the ECU is correcting for multiple logged knock events. When the value is **HIGH**, the ECU is not logging on knock events and is effectively increasing timing

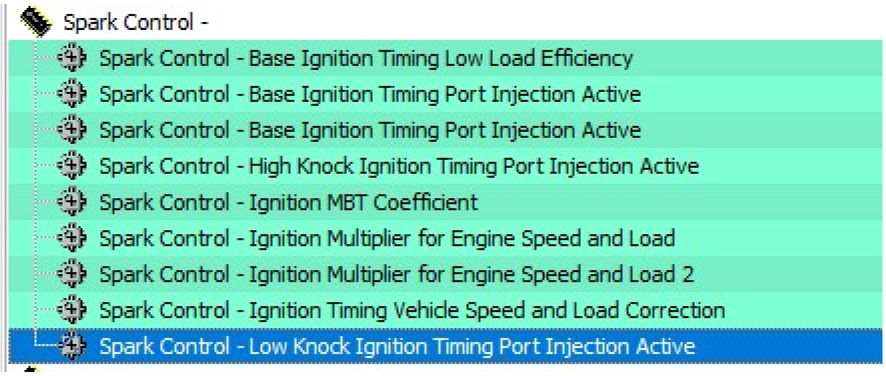


Fig 4.3 showing Spark control PID showing low knock ignition timing port injection active

Proper ignition timing requires a dyno to safely calibrate. In our tests we found that the 3UR Engine can safely handle around 15-16* ignition peak at high load with an off the shelf TVS2650 Supercharger on 7psi

5. Tuning - Camshafts and VVT

Calibrating the Camshafts for boost or a supercharger is CRITICAL to safe engine operation. Failure to calibrate the camshafts can cause:-

- low load stumbling (exhaust cam)
- Low load surging (intake cam)
- Detonation
- loss of power and torque

Toyota, through their TRD Toyota Racing Development Program has taken extensive time to calibrate the Valve system for use with the TRD TVS1900 Supercharger. These camshaft tables are great bases for starting with and are recommended to work from. The stock valve system has over-lap that will need to be mitigated for proper forced induction tuning.

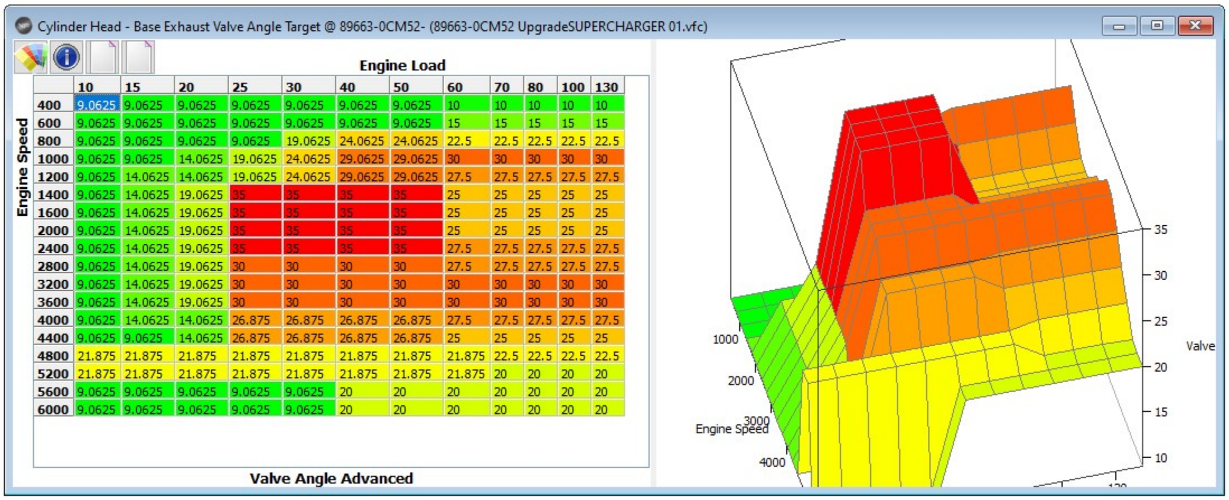
5.1. Exhaust Camshaft

NOTE:

- The exhaust camshaft will not function past the lock point (no advance or retard) when the vehicle is not moving
- Vehicle movement (speed past 5KPH) is required for the exhaust cams VVT to function Exhaust Valve retard (higher numbers)

A general, well known tuning method for camshafts are:-

- More Advance > LOW RPM Torque increased
- More Retard > HIGH RPM torque increased
- More Overlap - Energy wasted (when forced induction is present)
- Less overlap - More torque potential / less energy wasted

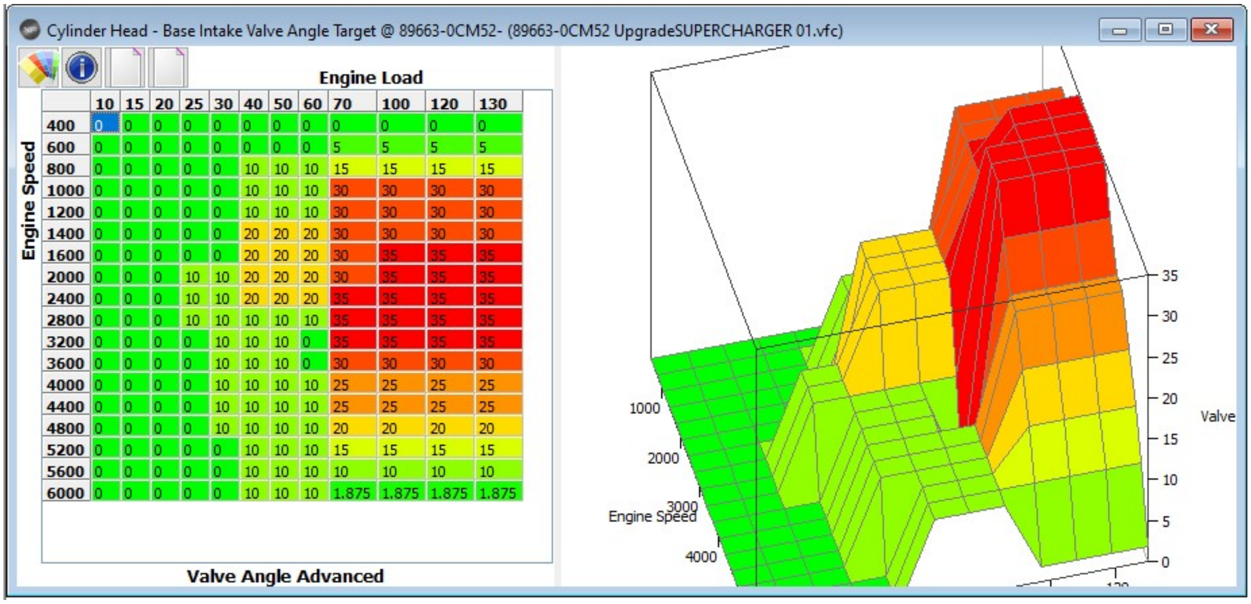


Engine Speed \ Engine Load	10	15	20	25	30	40	50	60	70	80	100	130
400	9.0625	9.0625	9.0625	9.0625	9.0625	9.0625	9.0625	10	10	10	10	10
600	9.0625	9.0625	9.0625	9.0625	9.0625	9.0625	9.0625	15	15	15	15	15
800	9.0625	9.0625	9.0625	9.0625	19.0625	24.0625	24.0625	22.5	22.5	22.5	22.5	22.5
1000	9.0625	9.0625	14.0625	19.0625	24.0625	29.0625	29.0625	30	30	30	30	30
1200	9.0625	14.0625	14.0625	19.0625	24.0625	29.0625	29.0625	27.5	27.5	27.5	27.5	27.5
1400	9.0625	14.0625	19.0625	35	35	35	35	25	25	25	25	25
1600	9.0625	14.0625	19.0625	35	35	35	35	25	25	25	25	25
2000	9.0625	14.0625	19.0625	35	35	35	35	25	25	25	25	25
2400	9.0625	14.0625	19.0625	35	35	35	35	27.5	27.5	27.5	27.5	27.5
2800	9.0625	14.0625	19.0625	30	30	30	30	27.5	27.5	27.5	27.5	27.5
3200	9.0625	14.0625	19.0625	30	30	30	30	30	30	30	30	30
3600	9.0625	14.0625	19.0625	30	30	30	30	30	30	30	30	30
4000	9.0625	14.0625	14.0625	26.875	26.875	26.875	26.875	27.5	27.5	27.5	27.5	27.5
4400	9.0625	9.0625	14.0625	26.875	26.875	26.875	26.875	25	25	25	25	25
4800	21.875	21.875	21.875	21.875	21.875	21.875	21.875	21.875	22.5	22.5	22.5	22.5
5200	21.875	21.875	21.875	21.875	21.875	21.875	21.875	21.875	20	20	20	20
5600	9.0625	9.0625	9.0625	9.0625	9.0625	20	20	20	20	20	20	20
6000	9.0625	9.0625	9.0625	9.0625	9.0625	20	20	20	20	20	20	20

Fig 5.1.1 showing an example Exhaust cam Base table setup for a TVS2650 Supercharger

5.2. Intake Camshaft

The intake camshaft has a range that can advance from 0 only (0 = most retarded intake cam value).



Engine Speed	10	15	20	25	30	40	50	60	70	100	120	130
400	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	5	5	5	5
800	0	0	0	0	0	10	10	10	15	15	15	15
1000	0	0	0	0	0	10	10	10	30	30	30	30
1200	0	0	0	0	0	10	10	10	30	30	30	30
1400	0	0	0	0	0	20	20	20	30	30	30	30
1600	0	0	0	0	0	20	20	20	30	35	35	35
2000	0	0	0	10	10	20	20	20	30	35	35	35
2400	0	0	0	10	10	20	20	20	35	35	35	35
2800	0	0	0	10	10	10	10	10	35	35	35	35
3200	0	0	0	0	10	10	10	0	35	35	35	35
3600	0	0	0	0	10	10	10	0	30	30	30	30
4000	0	0	0	0	10	10	10	10	25	25	25	25
4400	0	0	0	0	10	10	10	10	25	25	25	25
4800	0	0	0	0	10	10	10	10	20	20	20	20
5200	0	0	0	0	0	10	10	10	15	15	15	15
5600	0	0	0	0	0	10	10	10	10	10	10	10
6000	0	0	0	0	0	10	10	10	1.875	1.875	1.875	1.875

Fig 5.2.1 showing an example Intake Cam Base Table setup for a TVS650 Supercharger

6. Tuning - Airflow controls

Airflow control tables are a series of table used to control throttle, calculate engine load, and calculate engine torque. These tables affect almost every other part of the calibration. A common symptom of failure to modify these tables is throttle limitations under boost or accelerator at 100%, severely retarded ignition timing, and more. With proper tuning of these tables you should be able to achieve full throttle (80%) through the entire RPM range

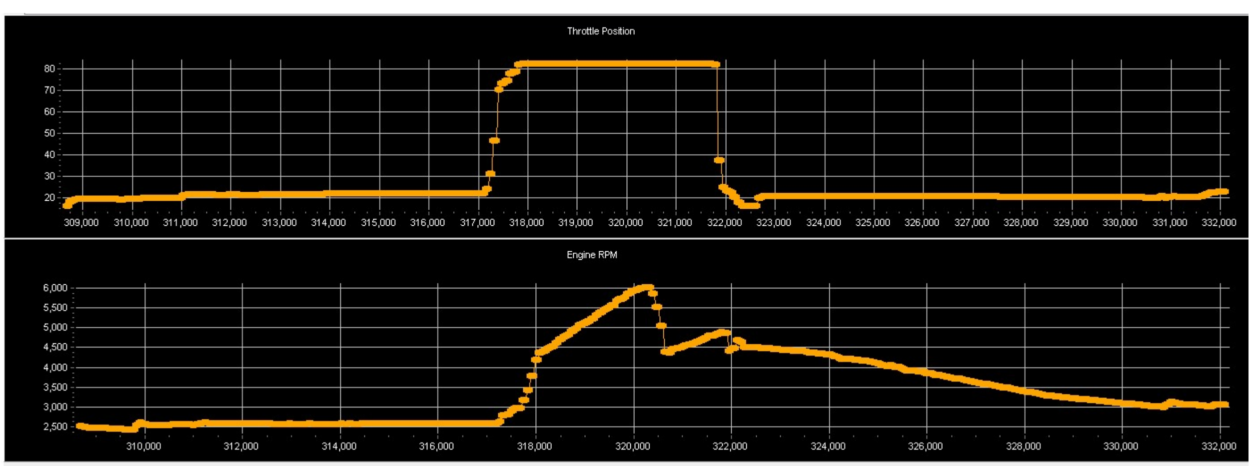


Fig 6.1 showing a proper tuned airflow table

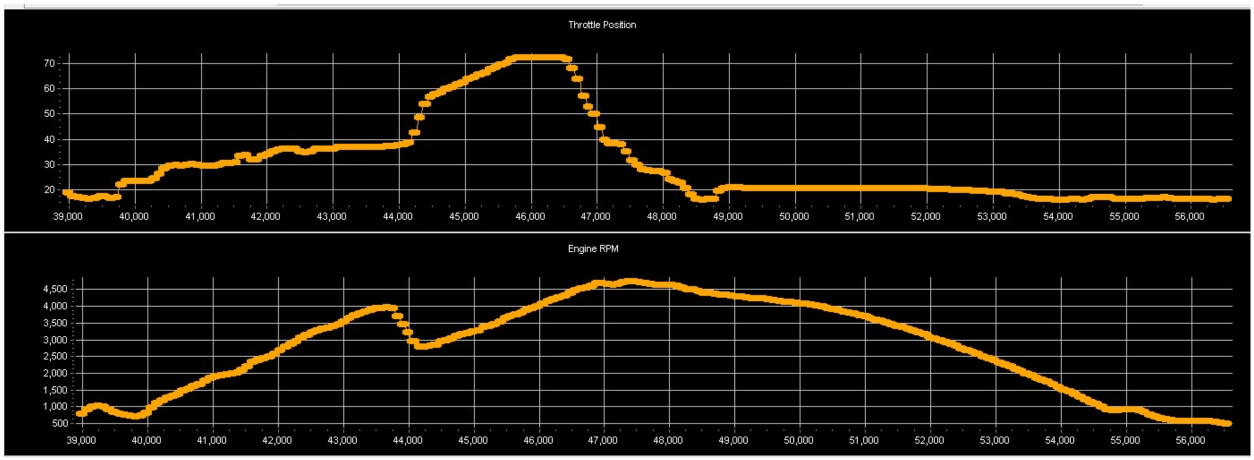
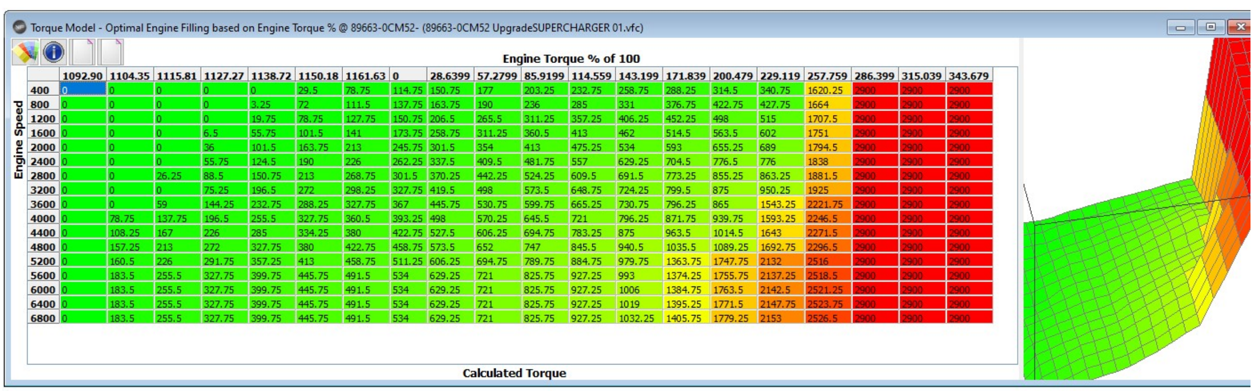


Fig 6.2 showing an example of throttle limitations on a TVS2650 Supercharged Tundra when airflow tables are not calibrated:

6.1. Optimal Engine Filling

This table represents raw values that correspond to filling (volumetric). A supercharger can cause excess filling calculations. As a result this table and others need to be modified. Increasing the values increase the amount of filling calculated (and allowed) so that full throttle can be achieved.



Torque Model - Optimal Engine Filling based on Engine Torque % @ 89663-0CM52- (89663-0CM52 UpgradeSUPERCHARGER 01.vfc)

Engine Torque % of 100

Engine Speed	1092.90	1104.35	1115.81	1127.27	1138.72	1150.18	1161.63	0	28.6399	57.2799	85.9199	114.559	143.199	171.839	200.479	229.119	257.759	286.399	315.039	343.679
400	0	0	0	0	0	29.5	78.75	114.75	150.75	177	203.25	232.75	258.75	288.25	314.5	340.75	1620.25	2900	2900	2900
800	0	0	0	0	3.25	72	111.5	137.75	163.75	190	236	285	331	376.75	422.75	427.75	1664	2900	2900	2900
1200	0	0	0	0	19.75	78.75	127.75	150.75	206.5	265.5	311.25	357.25	406.25	452.25	498	515	1707.5	2900	2900	2900
1600	0	0	0	6.5	55.75	101.5	141	173.75	258.75	311.25	360.5	413	462	514.5	563.5	602	1751	2900	2900	2900
2000	0	0	0	36	101.5	163.75	213	245.75	301.5	354	413	475.25	534	593	655.25	689	1794.5	2900	2900	2900
2400	0	0	0	55.75	124.5	190	226	262.25	337.5	409.5	481.75	557	629.25	704.5	776.5	776	1838	2900	2900	2900
2800	0	0	26.25	88.5	150.75	213	268.75	301.5	370.25	442.25	524.25	609.5	691.5	773.25	855.25	863.25	1881.5	2900	2900	2900
3200	0	0	0	75.25	196.5	272	298.25	327.75	419.5	498	573.5	648.75	724.25	799.5	875	950.25	1925	2900	2900	2900
3600	0	0	59	144.25	232.75	288.25	327.75	367	445.75	530.75	599.75	665.25	730.75	796.25	865	1543.25	2221.75	2900	2900	2900
4000	0	78.75	137.75	196.5	255.5	327.75	360.5	393.25	498	570.25	645.5	721	796.25	871.75	939.75	1593.25	2246.5	2900	2900	2900
4400	0	108.25	167	226	285	334.25	380	422.75	527.5	606.25	694.75	783.25	875	963.5	1014.5	1643	2271.5	2900	2900	2900
4800	0	157.25	213	272	327.75	380	422.75	458.75	573.5	652	747	845.5	940.5	1035.5	1089.25	1692.75	2296.5	2900	2900	2900
5200	0	160.5	226	291.75	357.25	413	458.75	511.25	606.25	694.75	789.75	884.75	979.75	1363.75	1747.75	2132	2516	2900	2900	2900
5600	0	183.5	255.5	327.75	399.75	445.75	491.5	534	629.25	721	825.75	927.25	993	1374.25	1755.75	2137.25	2518.5	2900	2900	2900
6000	0	183.5	255.5	327.75	399.75	445.75	491.5	534	629.25	721	825.75	927.25	1006	1384.75	1763.5	2142.5	2521.25	2900	2900	2900
6400	0	183.5	255.5	327.75	399.75	445.75	491.5	534	629.25	721	825.75	927.25	1019	1395.25	1771.5	2147.75	2523.75	2900	2900	2900
6800	0	183.5	255.5	327.75	399.75	445.75	491.5	534	629.25	721	825.75	927.25	1032.25	1405.75	1779.25	2153	2526.5	2900	2900	2900

Calculated Torque

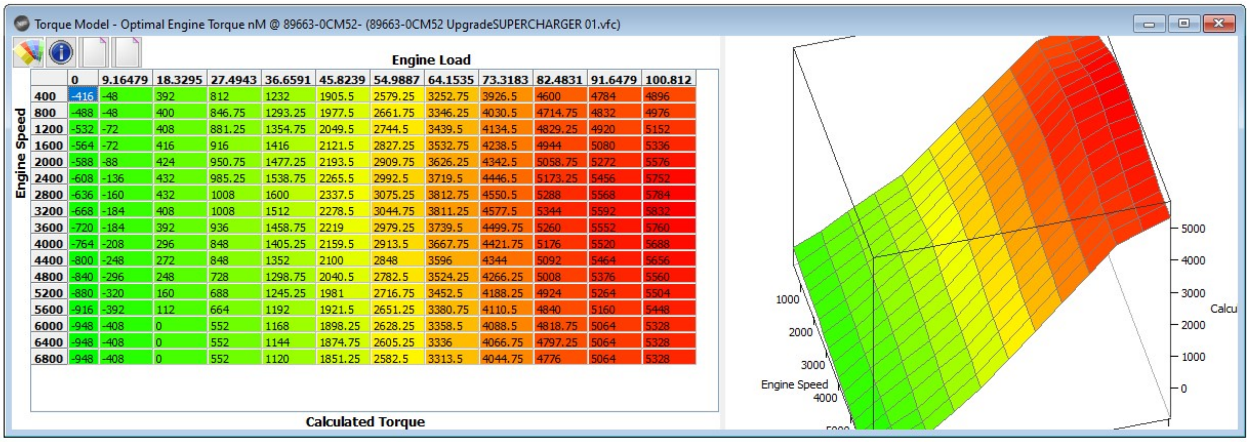
Fig 6.1.1 showing an example table provided below is based off of the Toyota Racing Development TVS1900 3UR Calibration

6.2. Optimal Engine Torque

The Optimal Engine Torque is a table the ECU or Logic References as a target to achieve as the Optimal value the engine should produce. Torque is calculated through a complex series of:-

- Airflow + Throttle Position + ignition Timing + Fuel AFR

If this table is not increased, you may see ignition retard or throttle limitations.



Torque Model - Optimal Engine Torque nM @ 89663-0CM52- (89663-0CM52 UpgradeSUPERCHARGER 01.vfc)

Engine Load

Engine Speed	0	9.16479	18.3295	27.4943	36.6591	45.8239	54.9887	64.1535	73.3183	82.4831	91.6479	100.812
400	-416	-48	392	812	1232	1905.5	2579.25	3252.75	3926.5	4600	4784	4896
800	-488	-48	400	846.75	1293.25	1977.5	2661.75	3346.25	4030.5	4714.75	4832	4976
1200	-532	-72	408	881.25	1354.75	2049.5	2744.5	3439.5	4134.5	4829.25	4920	5152
1600	-564	-72	416	916	1416	2121.5	2827.25	3532.75	4238.5	4944	5080	5336
2000	-588	-88	424	950.75	1477.25	2193.5	2909.75	3626.25	4342.5	5058.75	5272	5576
2400	-608	-136	432	985.25	1538.75	2265.5	2992.5	3719.5	4446.5	5173.25	5456	5752
2800	-636	-160	432	1008	1600	2337.5	3075.25	3812.75	4550.5	5288	5568	5784
3200	-668	-184	408	1008	1512	2278.5	3044.75	3811.25	4577.5	5344	5592	5832
3600	-720	-184	392	936	1458.75	2219	2979.25	3739.5	4499.75	5260	5552	5760
4000	-764	-208	296	848	1405.25	2159.5	2913.5	3667.75	4421.75	5176	5520	5688
4400	-800	-248	272	848	1352	2100	2848	3596	4344	5092	5464	5656
4800	-840	-296	248	728	1298.75	2040.5	2782.5	3524.25	4266.25	5008	5376	5560
5200	-880	-320	160	688	1245.25	1981	2716.75	3452.5	4188.25	4924	5264	5504
5600	-916	-392	112	664	1192	1921.5	2651.25	3380.75	4110.5	4840	5160	5448
6000	-948	-408	0	552	1168	1898.25	2628.25	3358.5	4088.5	4818.75	5064	5328
6400	-948	-408	0	552	1144	1874.75	2605.25	3336	4066.75	4797.25	5064	5328
6800	-948	-408	0	552	1120	1851.25	2582.5	3313.5	4044.75	4776	5064	5328

Calculated Torque

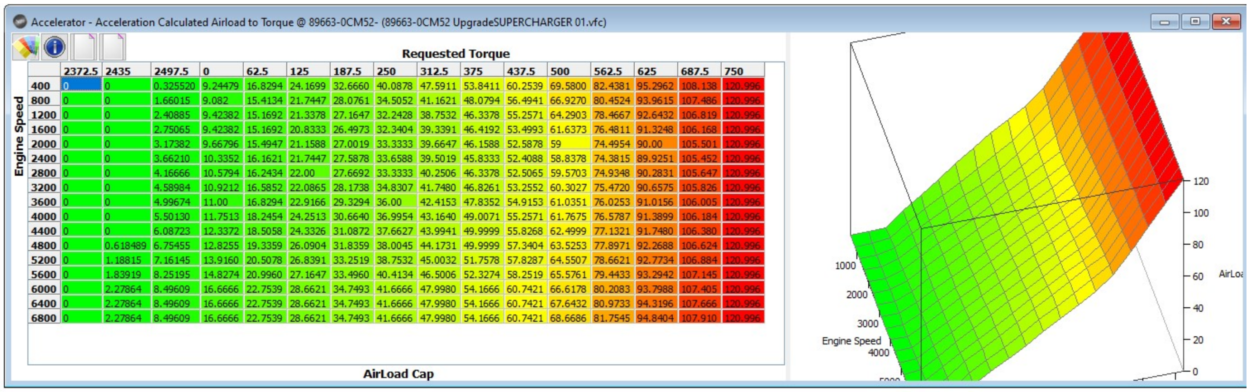
Fig 6.1.2 showing an example provided from an extrapolated Toyota Racing Development Calibration

6.3. Acceleration Calculated Airload to Torque

Acceleration Calculated Airload to torque gives the ECU a direct Air reference value (volumetric) that it can use based on calculation of torque and engine speed. This table is used logically as a limit of airflow in relation to torque. The higher the values are in this table, the more airflow the ECU will expect for a given torque vs RPM.

NOTE:

- Increasing these values too far can cause various issues including
  - Cold start throttle limits
  - Cold start limp mode
  - Throttle limitations
  - Throttle over-run and loss of throttle
- Be cautious when making any change to throttle and Airload controls



Engine Speed	2372.5	2435	2497.5	0	62.5	125	187.5	250	312.5	375	437.5	500	562.5	625	687.5	750
400	0	0	0.325520	9.24479	16.8294	24.1699	32.6660	40.0878	47.5911	53.8411	60.2539	69.5800	82.4381	95.2962	108.138	120.996
800	0	0	1.66015	9.082	15.4134	21.7447	28.0761	34.5052	41.1621	48.0794	56.4941	66.9270	80.4524	93.9615	107.486	120.996
1200	0	0	2.40885	9.42382	15.1692	21.3378	27.1647	32.2428	38.7532	46.3378	55.2571	64.2903	78.4667	92.6432	106.819	120.996
1600	0	0	2.75065	9.42382	15.1692	20.8333	26.4973	32.3404	39.3391	46.4192	53.4993	61.6373	76.4811	91.3248	106.168	120.996
2000	0	0	3.17382	9.66796	15.4947	21.1588	27.0019	33.3333	39.6647	46.1588	52.5878	59	74.4954	90.00	105.501	120.996
2400	0	0	3.66210	10.3352	16.1621	21.7447	27.5878	33.6588	39.5019	45.8333	52.4088	58.8378	74.3815	89.9251	105.452	120.996
2800	0	0	4.16666	10.5794	16.2434	22.00	27.6692	33.3333	40.2506	46.3378	52.5065	59.5703	74.9348	90.2831	105.647	120.996
3200	0	0	4.58984	10.9212	16.5852	22.0865	28.1738	34.8307	41.7480	46.8261	53.2552	60.3027	75.4720	90.6575	105.826	120.996
3600	0	0	4.99674	11.00	16.8294	22.9166	29.3294	36.00	42.4153	47.8352	54.9153	61.0351	76.0253	91.0156	106.005	120.996
4000	0	0	5.50130	11.7513	18.2454	24.2513	30.6640	36.9954	43.1640	49.0071	55.2571	61.7675	76.5787	91.3899	106.184	120.996
4400	0	0	6.08723	12.3372	18.5058	24.3326	31.0872	37.6627	43.9941	49.9999	55.8268	62.4999	77.1321	91.7480	106.380	120.996
4800	0	0.618489	6.75455	12.8255	19.3359	26.0904	31.8359	38.0045	44.1731	49.9999	57.3404	63.5253	77.8971	92.2688	106.624	120.996
5200	0	1.18815	7.16145	13.9160	20.5078	26.8391	33.2519	38.7532	45.0032	51.7578	57.8287	64.5507	78.6621	92.7734	106.884	120.996
5600	0	1.83919	8.25195	14.8274	20.9960	27.1647	33.4960	40.4134	46.5006	52.3274	58.2519	65.5761	79.4433	93.2942	107.145	120.996
6000	0	2.27864	8.49609	16.6666	22.7539	28.6621	34.7493	41.6666	47.9980	54.1666	60.7421	66.6178	80.2083	93.7988	107.405	120.996
6400	0	2.27864	8.49609	16.6666	22.7539	28.6621	34.7493	41.6666	47.9980	54.1666	60.7421	67.6432	80.9733	94.3196	107.666	120.996
6800	0	2.27864	8.49609	16.6666	22.7539	28.6621	34.7493	41.6666	47.9980	54.1666	60.7421	68.6686	81.7545	94.8404	107.910	120.996

Fig 6.3.1 showing Acceleration Calculated Airload to Torque

7. Tuning - Transmission Torque and Engine Torque

7.1. Wide Open Fuel Tuning

The TVS1900 and TS2650 Supercharger are capable of producing positive manifold pressure in excess of 5psi as early as half throttle on the 3UR-F (B) E engine. Knowing this, the Wide Open Fuel Target **OFF** and **ON** Thresholds should be modified so that at higher throttle blade opening angles in the ECU will enrich fueling. The stock calibration does not introduce additional fuel until the throttle has reached 70+%. This can be dangerous on a supercharged truck as the engine will already be receiving full boost pressure before that time and the ECU will be trying to maintain stoic 14.6. Modifying the tables (*as per example insight*) to a lower throttle threshold will ensure that additional fuel is supplemented when positive manifold pressure is introduced.

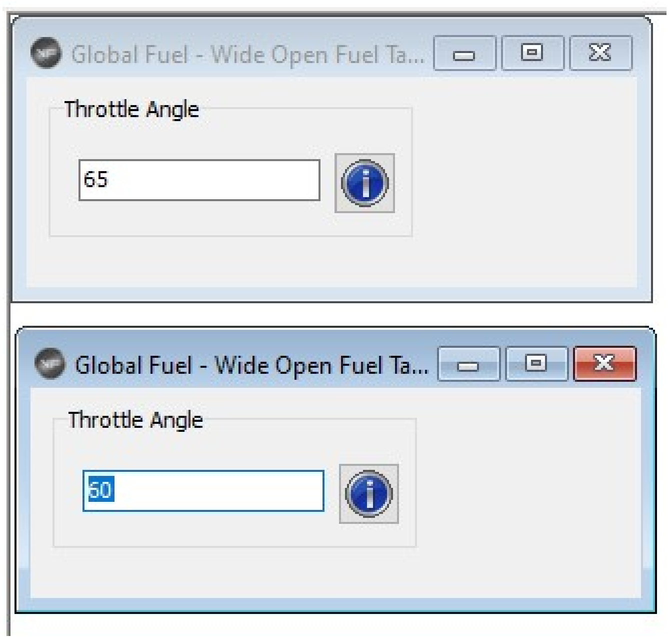


Fig 7.1.1 showing wide open fuel value modification table

7.2. Wide Open Fuel Target

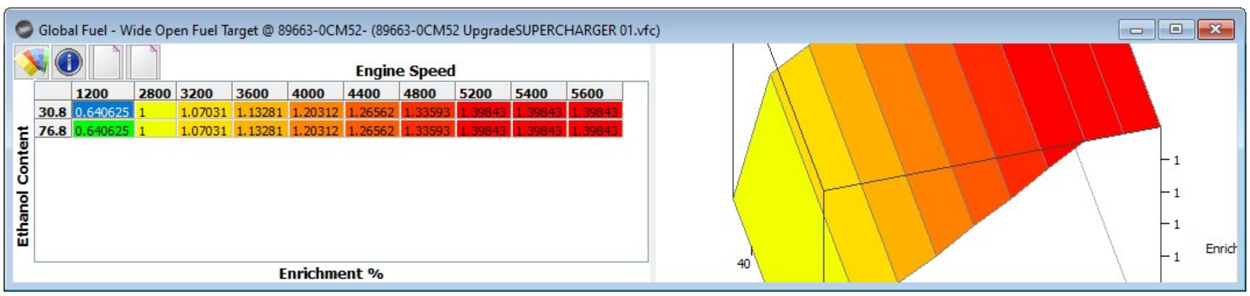
Once the throttle threshold is met for enrichment, the ECU will disregard the 14.6 stoic target value and enter an open-loop fueling method. This method consists of

- All fuel constants (injector, injection multiplier,
- Wide Open Fuel Target,
- Catalyst temperature enrichment) and others

Ensuring that accurate enrichment is provided with a supercharger is required.

NOTE:

- The stock calibration **DOES NOT PROVIDE ENOUGH FUEL!** We have tested and periodically see AFR as lean as 15+ under full boost.
- The Wide Open Fuel Target Table is NOT A lambda or AFR target table. This table is a constant value used to calculate additional fuel.
- The stock O2 sensor cannot read past 11.8 AFR and **should NOT** be used as a sole reference to the fuel ratio you are tuning at
- Be mindful of the catalyst protection table which provides additional fuel on top of this table.



	1200	2800	3200	3600	4000	4400	4800	5200	5400	5600
30.8	0.640625	1	1.07031	1.13281	1.20312	1.26562	1.33593	1.39843	1.39843	1.39843
76.8	0.640625	1	1.07031	1.13281	1.20312	1.26562	1.33593	1.39843	1.39843	1.39843

Fig 7.2.1 showing wide open fuel target table

7.3. O2 Sensor feedback

A Wideband Air fuel gauge is REQUIRED to ensure your AFR is accurate!

The sample log below consists of a full throttle run with a TVS2650 Supercharged 3UR-FBE engine. The O2 sensor is reporting Lambda at 0.813 (roughly 11.89 AFR). This is NOT the actual AFR/Lambda. The stock O2 sensors are NOT accurate during heavy enrichment and should not be relied on.

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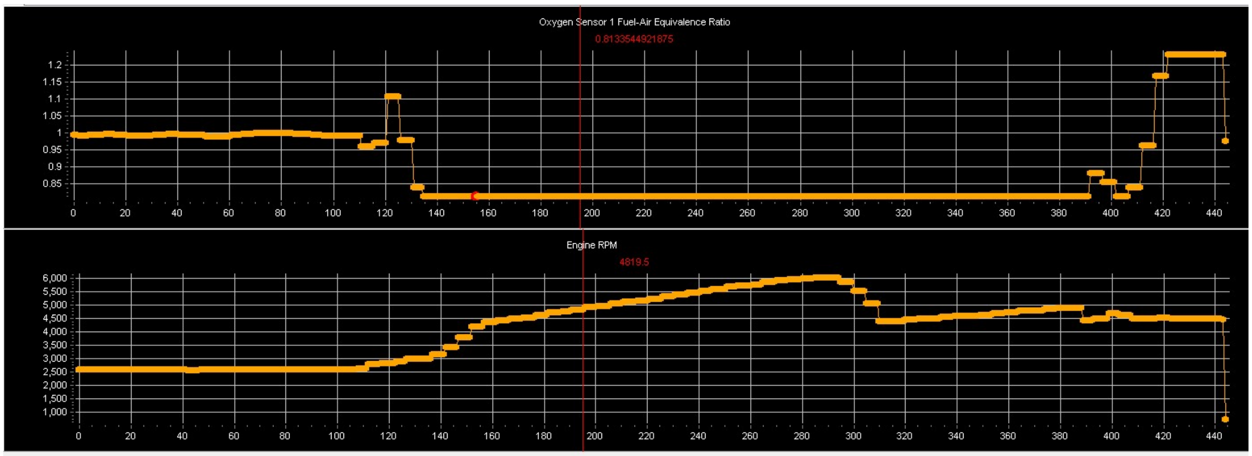


Fig 7.3 showing a sample 02 sensor log feedback

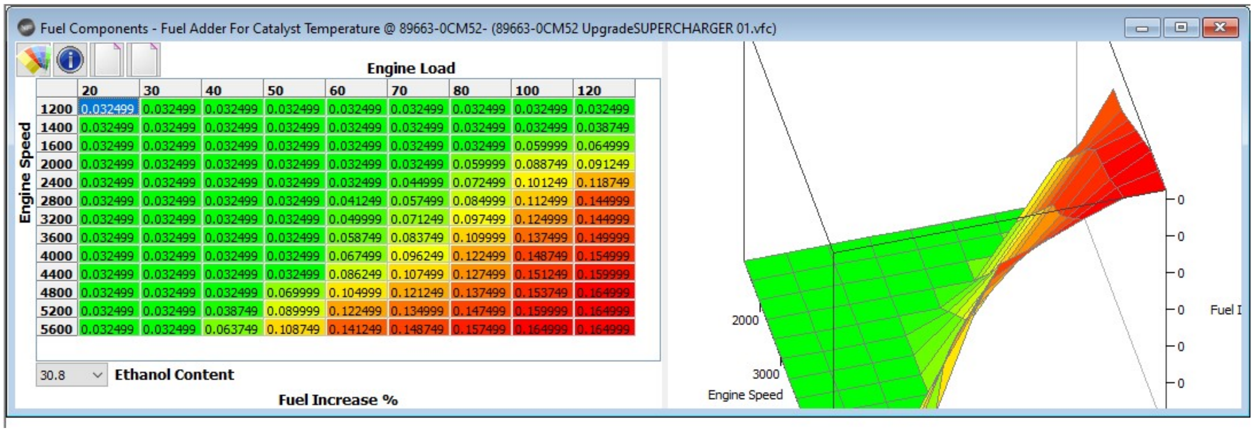
7.4. Catalyst Enrichment tables

The stock ECU provides additional fueling to protect the catalysts from excessive temperatures. This can cause your AFR to dip richer than you expect, and must be properly calibrated. Important information:-

- The catalyst enrichment table is ignored when the engine is cold
- The catalyst enrichment table is ignored when the vehicle is accelerating in 1rst gear.
- The catalyst enrichment table is ignored during stoic 14.6 / closed loop operation.

The exception to this table being ignored is that, the table will be referenced if the vehicle is being accelerated for a set period of time even if the throttle position has not reached the threshold for wide open fuel enrichment.

This can be seeing if you accelerate the vehicle at half throttle for a set period of time. During full throttle or at the point the throttle threshold has been met to activate **Wide Open Fuel Target** tables, the ECU will ADD fueling on top of the calculated fuel based on this 3D Table below.



Fuel Components - Fuel Adder For Catalyst Temperature @ 89663-0CM52- (89663-0CM52 UpgradeSUPERCHARGER 01.vfc)

Engine Load

Engine Speed	20	30	40	50	60	70	80	100	120
1200	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499
1400	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.038749
1600	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.059999	0.064999
2000	0.032499	0.032499	0.032499	0.032499	0.032499	0.032499	0.059999	0.088749	0.091249
2400	0.032499	0.032499	0.032499	0.032499	0.032499	0.044999	0.072499	0.101249	0.118749
2800	0.032499	0.032499	0.032499	0.032499	0.041249	0.057499	0.084999	0.112499	0.144999
3200	0.032499	0.032499	0.032499	0.032499	0.049999	0.071249	0.097499	0.124999	0.144999
3600	0.032499	0.032499	0.032499	0.032499	0.058749	0.083749	0.109999	0.137499	0.149999
4000	0.032499	0.032499	0.032499	0.032499	0.067499	0.096249	0.122499	0.148749	0.154999
4400	0.032499	0.032499	0.032499	0.032499	0.086249	0.107499	0.127499	0.151249	0.159999
4800	0.032499	0.032499	0.032499	0.069999	0.104999	0.121249	0.137499	0.153749	0.164999
5200	0.032499	0.032499	0.038749	0.089999	0.122499	0.134999	0.147499	0.159999	0.164999
5600	0.032499	0.032499	0.063749	0.108749	0.141249	0.148749	0.157499	0.164999	0.164999

30.8 Ethanol Content

Fuel Increase %

Fig 7.4.1 showing Fuel Component –Fuel adder for catalyst Temperature

This table normally does not need modification, however under some circumstances during heavy, extended acceleration the ECU can provide enough fuel through this table to cause your AFR to dip as low as 7s!

8. Tuning - Transmission Shift Points – Optional

Optional information regarding tuning shift points:-

- The stock calibration has upshift and downshift points.

This is a brief overview of how they work and how to modify them.

8.1. Upshift and downshift Tables

The primary upshift tables are controlled by the accelerator position (gas pedal) and a given engine speed. The values in the tables are **LIMITS** for that accelerator angle. This means at 50% accelerator table, for example, the transmission will shift up once you reach the speed in the table –the opposite for downshifting.

Downshifts will occur so long as the speed is below the set value in the table at a given throttle angle.

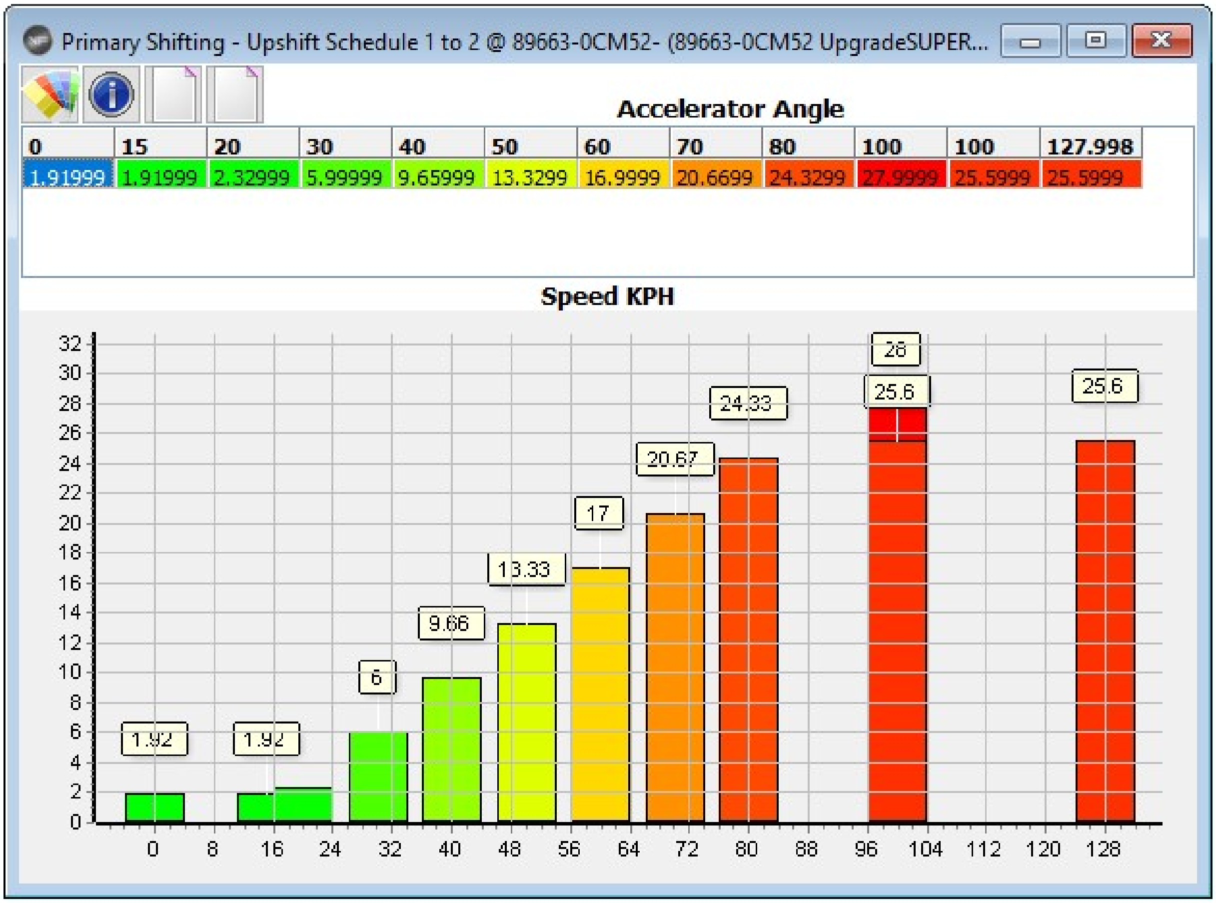


Fig 8.1.1 showing upshift and downshift table

8.2. Optimal Transmission Torque For Shifting

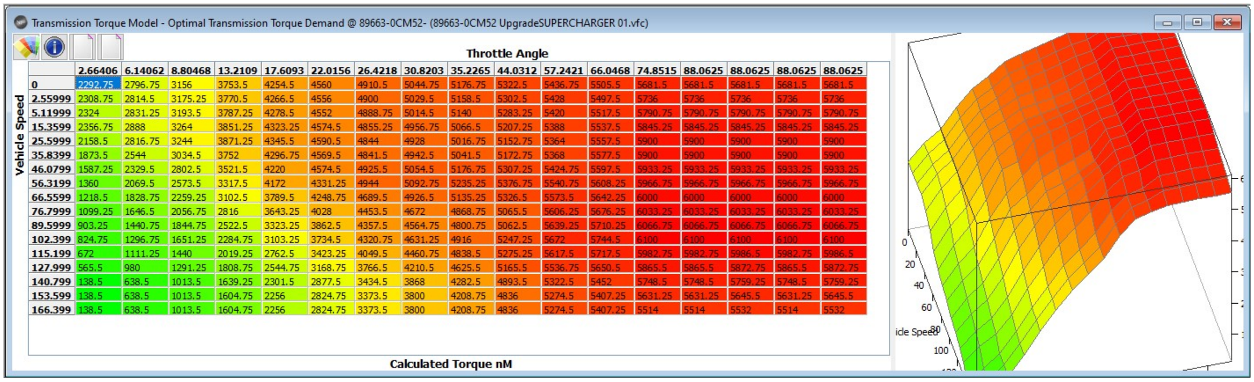
When the Toyota Tundra is supercharged, additional torque is created for the entire driveline. Focusing on improvements to shift timing and shifting, it is necessary to prolong transmission life with supercharged applications.

Increasing the value in this table **increases the optimal torque** value requested for shifting. This can make shifts firmer and faster.
Decreasing this value will **soften the shifts**.

NOTE:

- **Increasing the values too far will create a firm, harsh shift that can damage the transmission.**

- **Decreasing the values too far will cause the transmission to slip during shifting, creating excessive heat and possible transmission damage**.



Vehicle Speed	2.66406	6.14062	8.80468	13.2109	17.6093	22.0156	26.4218	30.8203	35.2265	44.0312	57.2421	66.0468	74.8515	88.0625	88.0625	88.0625	88.0625
0	2292.75	2796.75	3156	3753.5	4254.5	4560	4910.5	5044.75	5176.75	5322.5	5436.75	5505.5	5681.5	5681.5	5681.5	5681.5	5681.5
2.55999	2308.75	2814.5	3175.25	3770.5	4266.5	4556	4900	5029.5	5158.5	5302.5	5428	5497.5	5736	5736	5736	5736	5736
5.11999	2324	2831.25	3193.5	3787.25	4278.5	4552	4888.75	5014.5	5140	5283.25	5420	5517.5	5790.75	5790.75	5790.75	5790.75	5790.75
15.3599	2356.75	2888	3264	3851.25	4323.25	4574.5	4855.25	4956.75	5066.5	5207.25	5388	5537.5	5845.25	5845.25	5845.25	5845.25	5845.25
25.5999	2158.5	2816.75	3244	3871.25	4345.5	4590.5	4844	4928	5016.75	5152.75	5364	5557.5	5900	5900	5900	5900	5900
35.8399	1873.5	2544	3034.5	3752	4296.75	4569.5	4841.5	4942.5	5041.5	5172.75	5368	5577.5	5900	5900	5900	5900	5900
46.0799	1587.25	2329.5	2802.5	3521.5	4220	4574.5	4925.5	5054.5	5176.75	5307.25	5424.75	5597.5	5933.25	5933.25	5933.25	5933.25	5933.25
56.3199	1360	2069.5	2573.5	3317.5	4172	4331.25	4944	5092.75	5235.25	5376.75	5540.75	5608.25	5966.75	5966.75	5966.75	5966.75	5966.75
66.5599	1218.5	1828.75	2259.25	3102.5	3789.5	4248.75	4689.5	4926.5	5135.25	5326.5	5573.5	5642.25	6000	6000	6000	6000	6000
76.7999	1099.25	1646.5	2056.75	2816	3643.25	4028	4453.5	4672	4868.75	5065.5	5606.25	5676.25	6033.25	6033.25	6033.25	6033.25	6033.25
89.5999	903.25	1440.75	1844.75	2522.5	3323.25	3862.5	4357.5	4564.75	4800.75	5062.5	5639.25	5710.25	6066.75	6066.75	6066.75	6066.75	6066.75
102.399	824.75	1296.75	1651.25	2284.75	3103.25	3734.5	4320.75	4631.25	4916	5247.25	5672	5744.5	6100	6100	6100	6100	6100
115.199	672	1111.25	1440	2019.25	2762.5	3423.25	4049.5	4460.75	4838.5	5275.25	5617.5	5717.5	5982.75	5982.75	5986.5	5982.75	5986.5
127.999	565.5	980	1291.25	1808.75	2544.75	3168.75	3766.5	4210.5	4625.5	5165.5	5536.75	5650.5	5865.5	5865.5	5872.75	5865.5	5872.75
140.799	138.5	638.5	1013.5	1639.25	2301.5	2877.5	3434.5	3868	4282.5	4893.5	5322.5	5452	5748.5	5748.5	5759.25	5748.5	5759.25
153.599	138.5	638.5	1013.5	1604.75	2256	2824.75	3373.5	3800	4208.75	4836	5274.5	5407.25	5631.25	5631.25	5645.5	5631.25	5645.5
166.399	138.5	638.5	1013.5	1604.75	2256	2824.75	3373.5	3800	4208.75	4836	5274.5	5407.25	5514	5514	5532	5514	5532

Fig 8.2.1 showing Transmission torque model –Optimal transmission torque demand

9. Setting the Transmission for Dyno Runs / Dyno Mode

In order to accurately tune the vehicle, you need to be able to do full throttle runs from RPM as low as 1500. Normally, this is impossible as the ECU would request a downshift before you can full throttle. A work around to this is simple.

- Given that most Tundras are dynod in 4th gear we will use this gear as an example, but it can be used for any gear.
  - Find the table Primary Shifting - Downshift 3 to 4. (this is the table that controls 4th gear downshifting to 3rd)
  - Set all values on the table (except the value at 0% accelerator) to 0. This will effectively stop the truck from downshifting when you full throttle it in 4th gear at any engine RPM.

NOTE:

- You may also need to do this to downshifting 2nd to 3rd if the vehicle speed is very low in 4th.

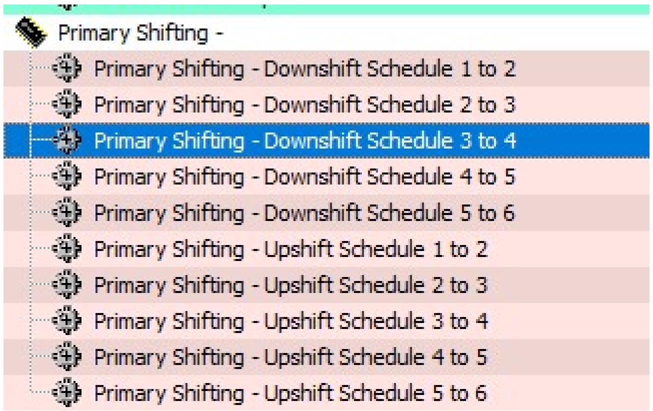


Fig 9.1 showing primary shifting PID tables

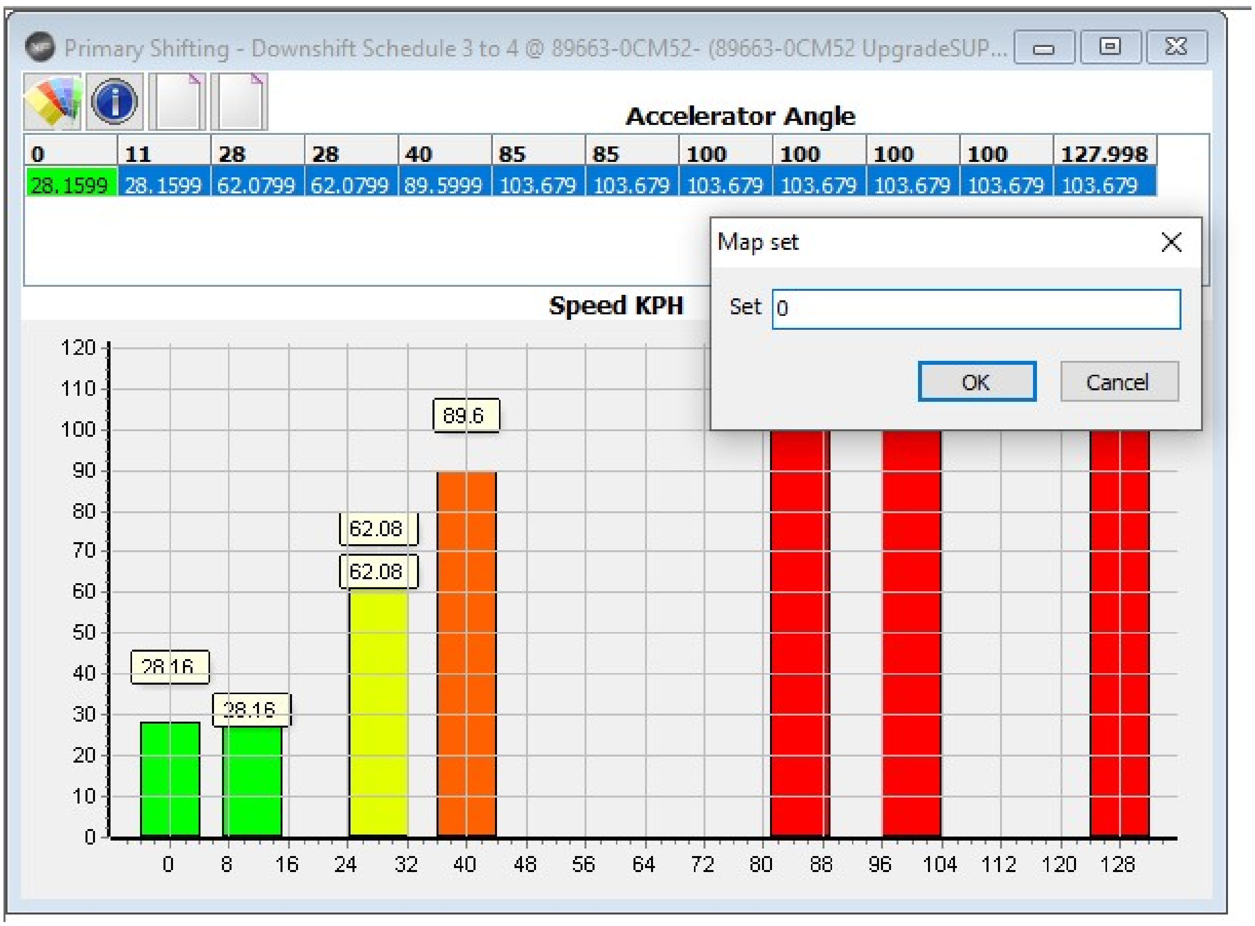


Fig 9.2 showing Primary Shifting –downshift schedule 3 to 4 table on how to set values

RUNNING THE VEHICLE ON THE DYNO

After you have setup dyno mode, be sure to use S MODE 4th gear for dyno runs. This ensures you can still control the shifts up and down.

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