Part 4:

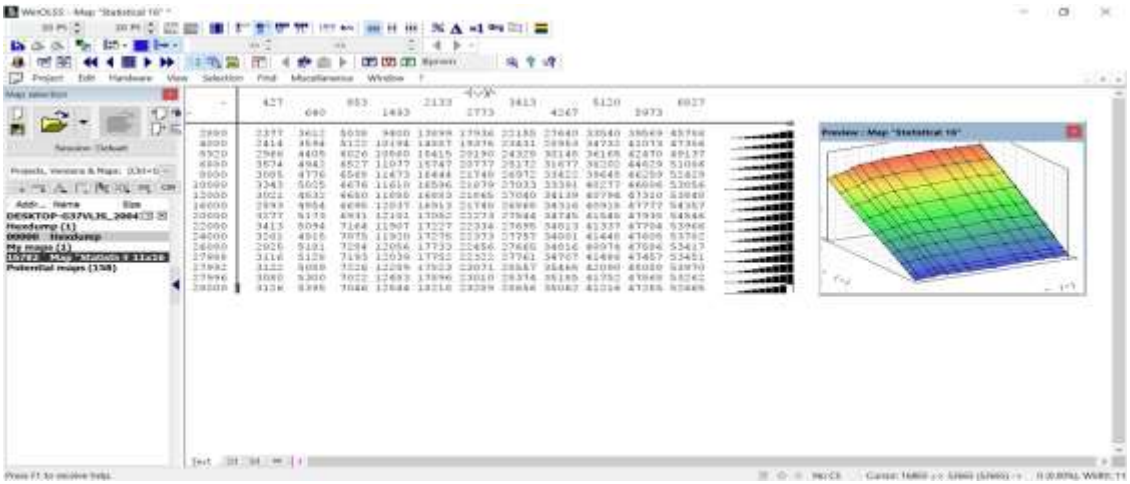
How to find “Optimum Engine Torque” in WinOLS?

First, we show you the tables and its information in WinOLS and then after you learn all of the tables, we do more practical example of how to find these tables in WinOLS software.

Let’s see how optimum engine torque looks like in the WinOLS software.
I already loaded an ECU original file for “Audi TT with Bosch ME7.5” ECU.
I have found this table and selected it, and after that, it is shown on the left side. We are going to describe this table. We are in the “TEXT” view, and I want to talk about it. In WinOLS, tables are shown as a Text, 2D & 3D view that these views help us to find the tables. For instance, the 3D view of this table is mainly in this shape. And also, the 2D view always is like this. This view is handy to find the table.

Now, let’s back to the Text view.

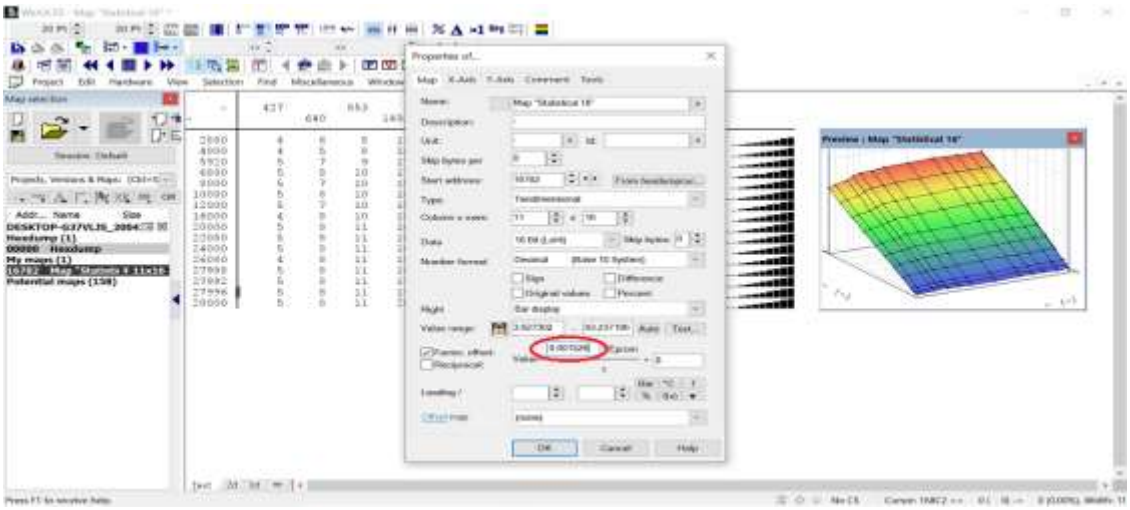
The vertical axis is engine revolution and the horizontal axis is engine load or cylinder air filling, and the numbers inside the table are the percentage of torque based on newton meter.



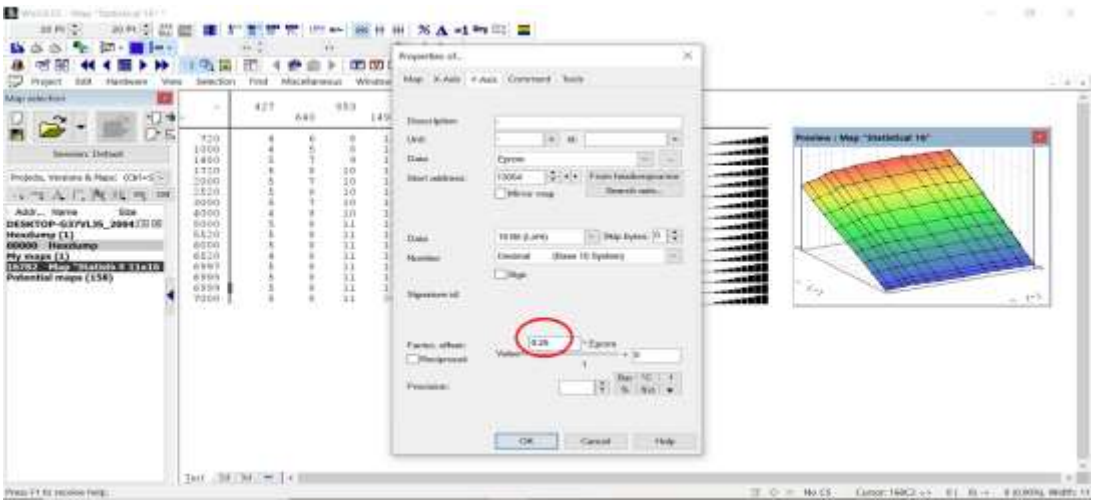
The important point is that in WinOLS, the numbers are always decimal and have no units. Therefore, in order to change this table from the decimal state to real numbers, you should use the “Factor and Offset”.

What is “Factor and Offset”?

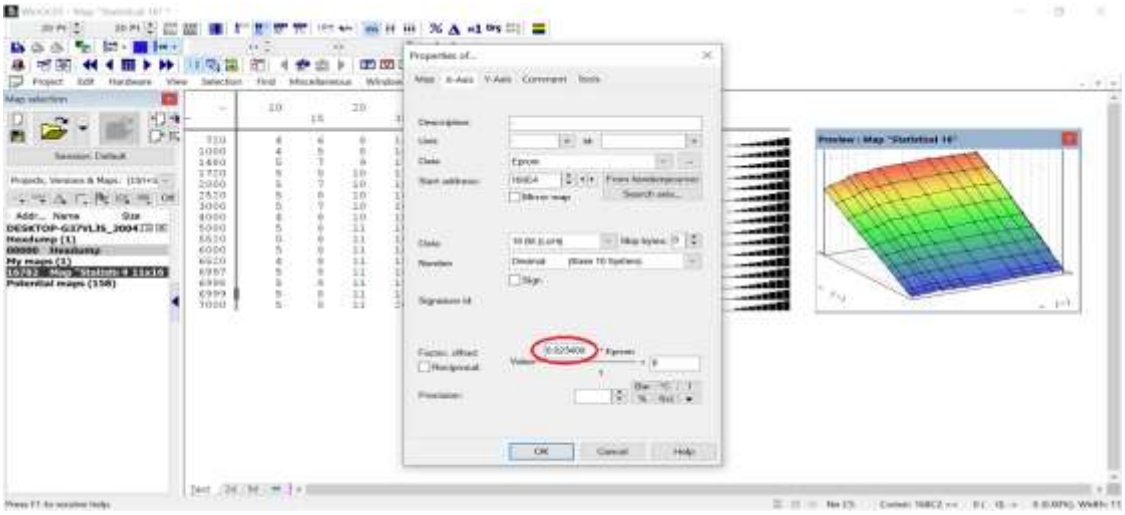
The factor is a term that, if applied to the table, the numbers of the table are multiplied by it. And offset is a term that, if used to the table, the numbers of the table are added or subtracted. For instance, if in this section, we write the number 10, the entire table is multiplied by 10, and if in this section, we report the -1000, the numbers in the table are subtracted by 1000 units. And if in this section we write the +100, the 100 unit is added to a table. Commonly, each ECU manufacturer uses a specific factor and offset for each table.



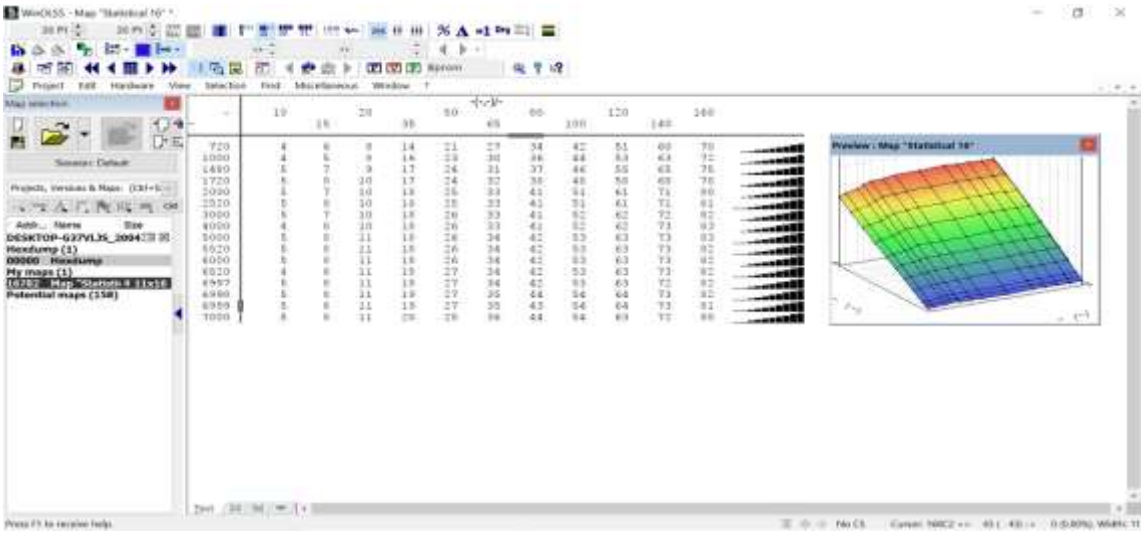
We use the factor of 0.25 for the vertical axis or Y. And the Y-axis is converted to engine revolution.



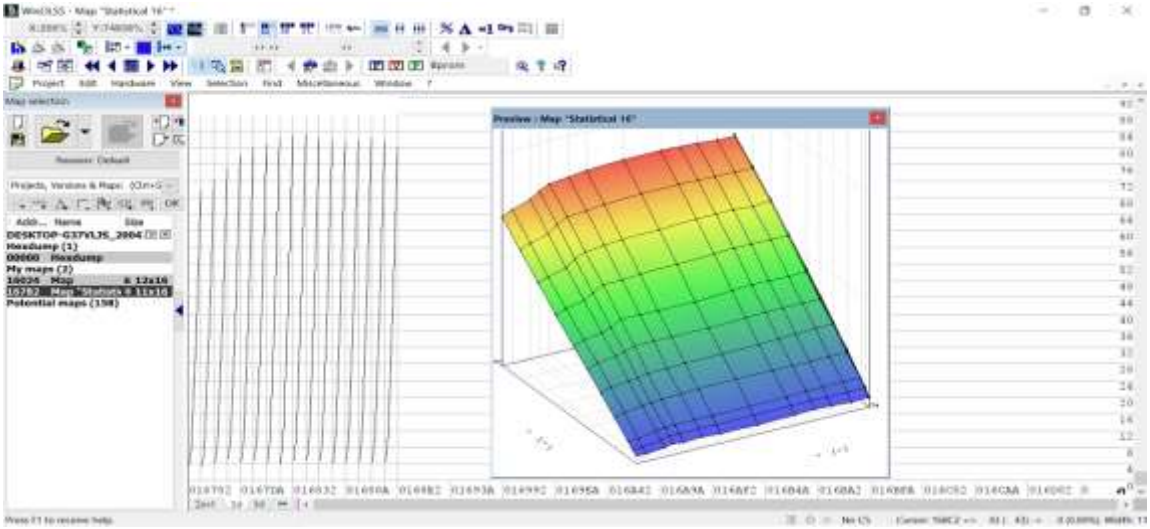
We use the 0.023408 factor for the horizontal axis or X. And the X-axis is converted to cylinder air filling percentage.



As you see, this table is now converted to a table with the actual number. However, we have to say that this offset and factor are for Bosch ECUs and they are different for other ECUs.



The two-dimensional view of this table is as follows:



To remap the ECU file, it is required to change this table because if we don't do this, other changes related to the fuel and spark caused by torque increase are restricted. Naturally, we have to repeat that a ten percent increase of numbers inside this table does not solely increase in the engine performance.

In the section “Modification of Tables” we will show you how to modify this table and in the next, we talk about “Torque Request by driver” or “Torque during takeoff condition”.

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Now, we are going to talk about “Torque Request Table”. To understand this part, you should learn:

1) Why has mechanical throttle body turned to electronic throttle?
2) What is a Torque request table and type of them?
3) The effects of the changes in these tables on the vehicle’s performance.
4) Torque request table in WinOLS software.

Before the advent of “Electronic Throttle Control”, “Mechanical Throttle” was used. The connection between the pedal and the throttle was made via a cable. And when the pedal was pressed, the cable opened the throttle. The amount of air entering the engine was precisely controlled by the driver pressing the accelerator pedal. To do this, a sensor on the throttle valve, called “TPS” or “Throttle Position Sensor” was installed. TPS sent the throttle valve’s openness to the ECU as an input parameter.

The coordination between ECU and TCU in electronic systems with electronic throttle reduces the car's fuel consumption, noise, vibration, and harness.

The use of electric throttle also improves the car's drivability. For example, when we change gears or release the accelerator pedal (manual gearbox vehicles), a sudden

shocks and torque intervention are prevented due to the ECU control over the throttle.

Before we get started, keep in mind that all vehicles with electronic throttle valves have control tables in the ECU called Torque request map or throttle mapping. Of course, we should add that the angle of the throttle and the amount of air entering from the throttle also have control tables that we will deal with in another part.

What is a "Torque Request Map"? And how it works?

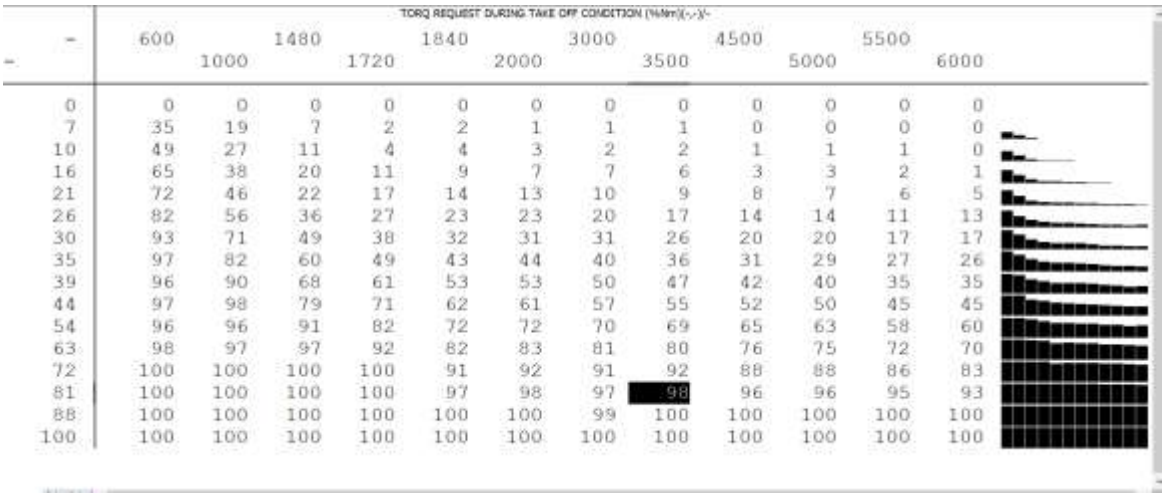
Torque based throttle control is more complex. ECU usually sets the pedal position not as a request for throttle position but as a request for torque. ECU can manage the torque request when the driver presses the pedal. Torque based engine management systems need to have different tables so that ECU can control the engine output torque model in all engine operating conditions. ECU specifies and calculates the torque request by the driver with the position of the accelerator pedal. Torque-based electronic throttle control calibration is the last step in engine calibration. This calibration for the car and engine is done on a load-holding dyno with an "open ECU" by engineers. To obtain the actual values of the throttle angle with the amount of torque requested by the driver in steady state conditions, it balances the amount of engine load relative to engine revolution and the amount of torque close to engine revolution and load.

Once these experiments are completed, the total torque information required is defined as a mathematical model in several tables in ECU. As the operating modes of the engine and driving conditions are different, the torque request from the driver is also variable. Therefore, there are usually several tables for "Torque Requests Tables by Drivers". ECU also compares actual and predicted loads by considering feedback from MAP and MAF sensors to prevent undesirable acceleration or torque intervention. Correct torque request changes have a positive effect on the response of the pedal.

As the torque demand is the only interface between the accelerator pedal position and the engine control strategies, the response of the vehicle corresponding to the pedal position can be easily influenced by changing the deriver wish map.

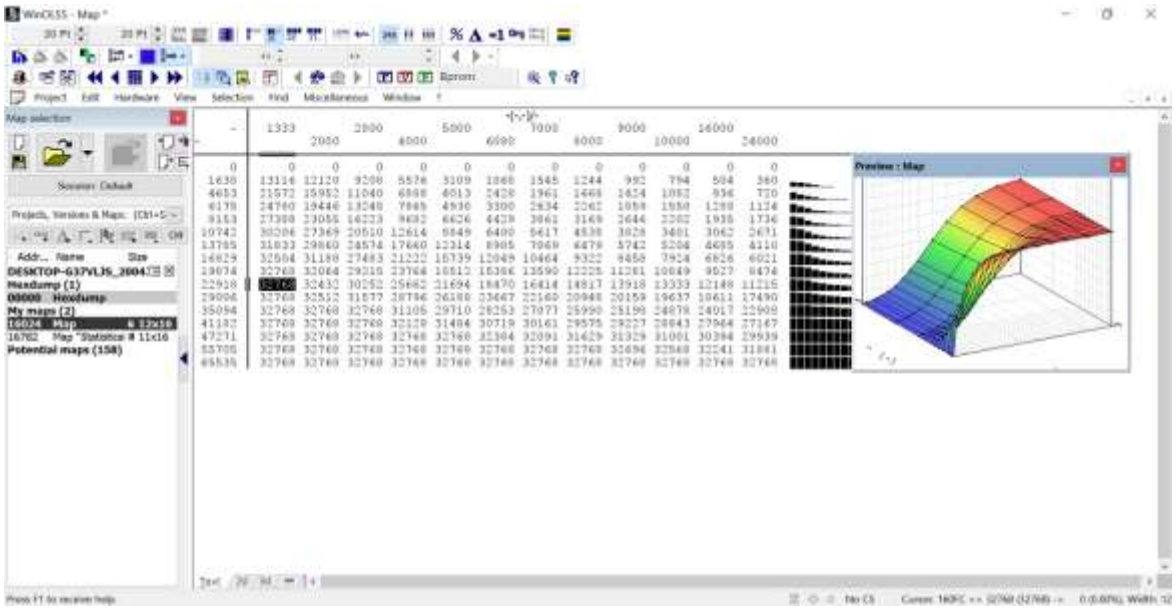
So far, we have become familiar with electronic throttle control and torque request concept, now let's see what the concept of torque request by the driver in ECU is?

This torque request table is also known as a "Driver Wish Map".

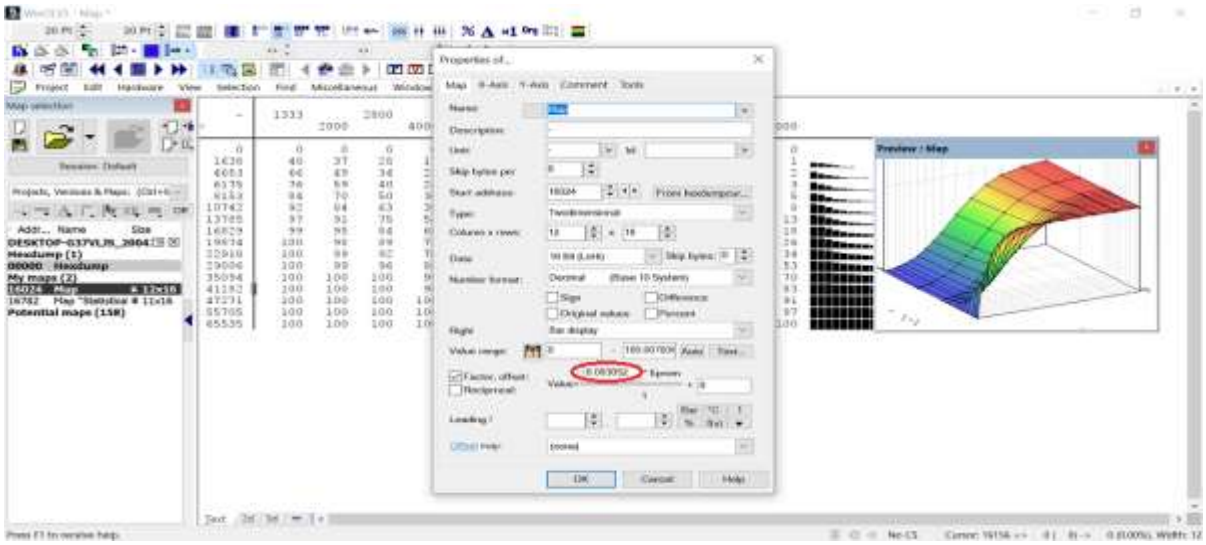


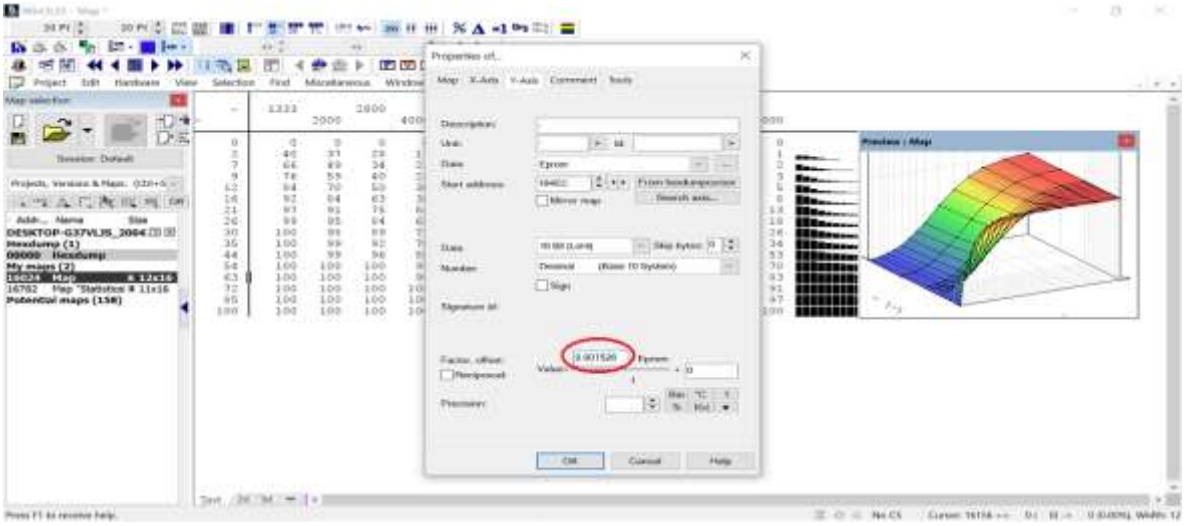
Now you know the torque request by driver, to get acquainted with these tables and give additional explanations directly on the ECU file we use an example of “Audi TT with ME7.5” ECU.

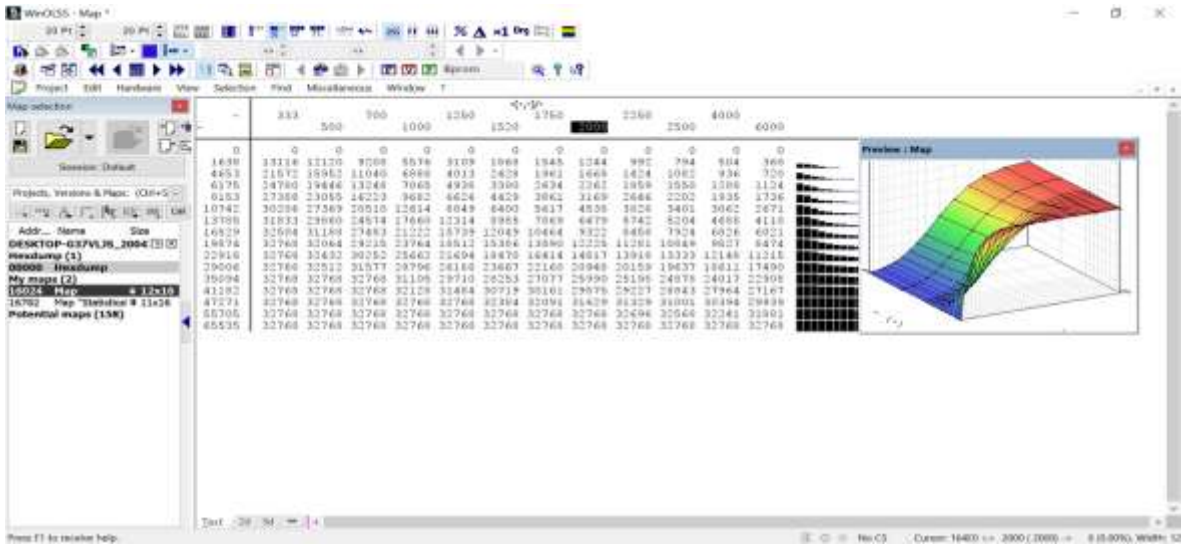
Let’s see how “Torque Request Tables” look like in the WinOLS software. The vertical axis is the percentage of pressing the accelerator pedal and the horizontal axis is the engine revolution. The numbers in the table are torque requests based on the percentage of Newton Meter, which is between 0 and 100 % of Newton Meter.



The factor for Y axis is 0.001526, for X axis is 0.25 and for the table is 0.003052.







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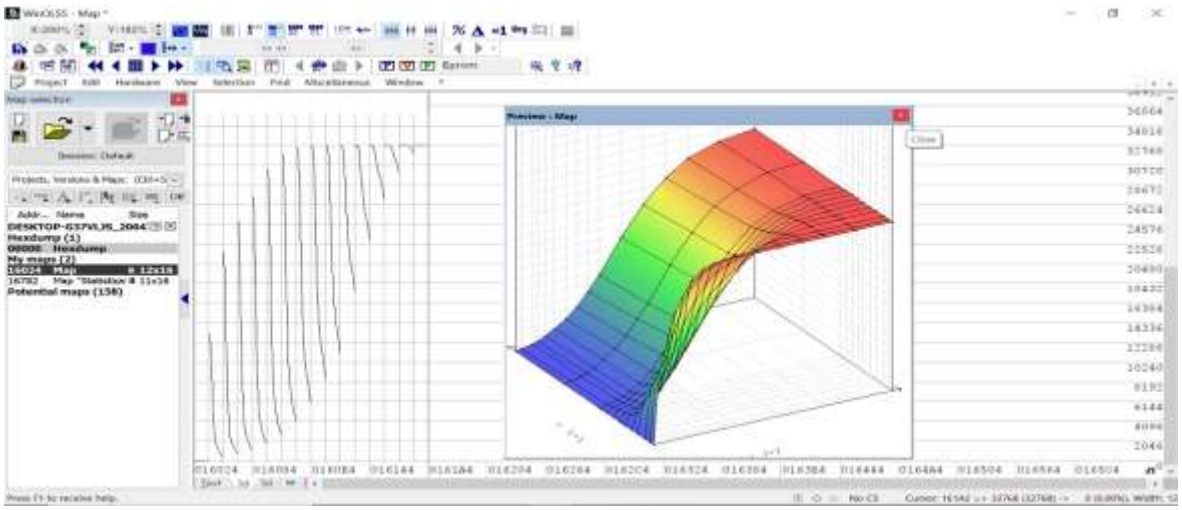

There are 2 torque request tables in this ECU file, and the numbers in these tables are different. First table is torque during take-off condition and the second one is for reverse gear.

Note that changing or increasing the values in this table doesn't affect the maximum engine power and torque. It only effects on torque request and throttle response.

In most cars with electronic throttle there is delay in throttle response, which annoys the driver. If we increase this table to the correct and standard level, that does not cause other problems; It improves the car's initial movement and takeoff. These changes are usually accompanied by an increase of five to twenty percent, which varies depending on the vehicle and the ECU.

Torque Limiters:

When you put your foot to any given pedal position, you are sending an electrical signal to the ECU which in response references a table known as the "Drivers Wish" or "Driver Demand" that simply tells the ECU that you, the driver, are now demanding a certain torque value. That table references RPM Vs Accelerator pedal position and outputs an answer in Newton Meters.

That request from you is then processed by 5 very distinct ECU sub-systems:

1. Checks are made to ensure that this torque request isn't higher than other systems are allowing at that moment.
2. That torque figure is then punched into a very complex and accurate model to determine exactly how much air load is required to create that amount of crankshaft torque.
3. The resulting air load value is then punched into another model to find out how much air mass is required to create that air load.
4. The required air mass result is then punched into another model to determine how much manifold pressure is required to get that much air mass inside the engines cylinders given the current air density.
5. That manifold pressure desired is fired through to the turbocharger model to determine the required turbine speed and waste gate position to create that manifold pressure with the compressor.

Once the answers are all known, the ECU supplies that air load and whatever fuel and spark is required. The whole process is over in microseconds! Now the above is dumbed right down to make it sound simple. Each step of this process is exponentially more complex than we have described, but now we have outlined it and think we can dive in and look at each step in a little more detail.

In engine torque categories there are different types of torque limiter. Engine torque is limited in different condition based on different gears, different vehicle speed, different temperature and etc. ECU limits the torque to have a better control on engine in different working condition.

Summary of part 3 & 4:

1) When we talk about the engine torque, the purpose is the piston's force in the crankshaft's crank resulting from the combustion pressure.
2) In simple terms, the definition of torque is twisting force that speaks to the engine's rotational force and measures how much of that twisting force is available.
3) In torque-based engine management system, the software architecture of the ECU is defined as a mathematical model based on the engine rpm and the amount of intake air to the engine in ECU.
4) Optimal engine torque table is mathematical model of engine torque in various engine revolutions and loads.
5) The vertical axis is engine revolution and the horizontal axis is the cylinder air filling or engine load. The numbers in the table are the optimal engine torque in percentage of the newton meter.
6) The optimum engine torque means the torque that the engine can produce and reach it in the optimal condition.
7) This is one of the main maps for the torque control strategy. It is used in maximum torque efficiency calculation as well. This value works directly with the map, Target Cylinder Filling.
8) ECU usually sets the pedal position not as a request for throttle position but as a request for torque. ECU can manage the torque request when the driver presses the pedal.
9) Modifying this map means how much torque we ask the ECU to deliver when the driver press the accelerator pedal.
10) In some cars with motorized electronic throttle, there is a delay in throttle response and you can improve it by modifying the torque during acceleration table.
11) This means that the higher the numbers in the table, the more torque requested by the driver.

1- Factor for torque request by drivers is 0.003052
2- Factor for pedal position is 0
3- Factor for engine speed
4- Factor for optimal engine torque is
5- Factor for air filling or load is