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 <u>practical example of how to find these tables in</u> <u>WinOLS software.</u>

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.

A TE BE 44 4 B > >> J Project fold Mandesare Man age notes from	Selection	427	Macattan	953	Autorities	P. 2133	-1036	3413	47 : 	\$120		6027		-
Comment in Huges (2)-1-0- Comment in Huges (2)-1-0- Comment in Huges (2)-1-0- Comment in Huges (2)-0-0- Comment in Huges (2)-0-0-0- Comment in Huges (2)-0-0-0- Comment in Huges (2)-0-0-0-0- Comment in Huges (2)-0-0-0-0-0-0-0-0-0-0-0-0- Comment in Huges (2)-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0	24899 8000 6320 8000 12000 12000 12000 12000 22000 224000 2000 24000 24000 24000 24000 24000 24000 24000 2000 2000 2000 24000 2000 24000 20000 20000 2000000	2377 2414 25676 3676 3676 3676 3676 3706 3706 3706 3	3412 3484 4945 4945 4976 5025 4954 8175 5101 5128 4015 5128 4016 5128 4016 5128 4016 5128	\$010 8120 8520 4676 4676 4676 4676 4676 7075 7075 7075 7075 7075 7075 7075 7	34000 10194 205000 11037 116370 116570 116570 116570 116570 116570 116570 116570 116570 116570 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700 1159700000000000000000000000000000000000	13298 14207 18445 18747 18446 28593 28593 28593 28593 28593 28593 28593 27227 17257 17577 17577 17577 17577 17577 17577 17577 175777 175777 175777 17577777 17577777777	279934 19276 29290 21949 21949 21946 219749 22934 22934 22934 22934 22934 22934 22934 22934 22934 22934 22934 22934 22934 22934 23934 23934 23934	211.85 243.27 243.27 243.27 240.23 24	23640 239863 316147 31617 233420 233420 24344 34510 34513 34613 346016 34705 3	323540 (44733) 341260 331260 331260 331648 402770 40448 407764 415470 415480 415357 415448 415480 41555 41555 41555	31649 42013 42470 44475 4425 46259 46259 47594 4106 41930 41930 41956 47696 47696 47696 47696 47696 47680 47585	457588 477857 477857 8510578 512629 512659 512655555555555555555555555555555555555	Produce Map "Statistics 15"	-11
	Test III 1	61.HC	1+											

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.

	19 18 E	4 🕐 🏦 🕨 i Miccharmat	Properties of, Map 31, Auto 4	An Orenet hit	61
Way watches Way Way Way Image: Lange Way Image: Lange Sale Addr. Ray Addr. Ray	- 411 1400 - 1 1400 - 1 1710 - 1		Nami kalam (Ale Data) Tata) Manta Nami a Nami a	e a la l	Process (Mag. Statistical and
			factor office Collectored Presiden	(23) - fam - 5 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	

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

A TER 44 4 II > >>	1 20 12	The sta	e di F	Mindow	Properties of	Ann Command Balls	6	* (*)
Nan akainen Die General Contract Progent Neurone & Maps (12) - 4 - 4 - 4 - 7 (12) - 6 Model Neurone & Maps (12) - 4 - 4 - 7 (12) - 6 Model Neurone & Maps (12) - 4 Model Neurone (12) - 4 Model Neu	100 3080 3480 7570 7570 3066 4000 5000 8000 8000 8000 8000 8000 8000	10 4 4 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5	11		Description Class Tanle Million Class Research Represented Processes Foresame	In the International States		Parker May Statistical IP

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.



e table numbers is specified in the n from the left to the right side. This you see this area that is high load an increased torque because m



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 <u>spark</u> 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".

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 <u>WinOLS software</u>.

Before the advent of "<u>Electronic Throttle Control</u>", "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.

e to increased accuracy in engine addition of modern equipment such ectric throttle to control the amoun

tric throttle also eliminated some par control system. One of the most imp ng the engine and automatic transm but if we want to mention it brief ed by the driver and the amount of the ideal throttle position with the overter mode of the gearbox, to com

on the driver

The coordination between ECU and \underline{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 <u>dyno</u> 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 <u>MAF sensors</u> 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".

-	600		1480		1840		3000		4500		5500		
10		1000	1000 1720			2000	3500			5000		6000	
0	0	0	0	0	0	0	0	0	0	0	0	0	
7	35	19	7	2	2	1	1	1	0	0	0	0	
10	49	27	11	4	4	3	2	2	1	1	1	0	
16	65	38	20	11	.9	2	7	6	3	3	2	1	-
21	72	46	22	17	14	13	10	9	8	7	6	5	
26	82	56	.36	27	23	23	20	17	14	14	11	13	1 mar
30	93	71	49	38	32	31	31	26	20	20	17	17	In.
35	97	82	60	49	43	44	40	36	31	29	27	26	Stanson,
39	96	90	68	61	53	53	50	47	42	4.0	35	35	I Sugara
4.4	97	98	79	71	62	61	57	55	52	50	45	45	Susana
54	96	96	-91	82	72	72	70	69	65	63	58	60	
63	9.8	97	97	92	82	83	81	80	76	75	72	70	I I I Revez
72	100	100	100	100	91	92	91	92	88	88	86	83	SECTOR:
81	100	100	100	100	97	98	97	. 98	96	9.6	95	93	CORTORS I
88	100	100	100	100	100	100	99	100	100	100	100	100	
001	100	100	100	100	100	100	100	100	100	100	100	100	

able, you can see that the vertical axial, and the horizontal axis is the engorque requests based on the ver request or driver wish map. Note that it is the engine rpm, a different among the imple, when the driver presses the atomic of the tot

IP means how much torque we ask belerator pedal. If you change this tab n. In some cars with motorized elect ise and you can improve it by n This means that the higher the mu er, this

requested by

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.

7 Project Kall Handware Vers ag anderters 📴	Selection	19333	2050	2000	écco	5000	4-	-¥- 1000	6002	9000	10000	16000	24000	1	
Seeway Dahad Yejeth, Wrates & Hack (D1-5- '''', A T (R) (R) (R) (R) '''', A T (R) (R) (R) '''', A T (R) (R) ''''', A T (R) (R) '''''', A T (R) ''''''''''''''''''''''''''''''''	0 1633 4653 8153 19745 11745 16024 22938 229054 47271 35054 41187 47271 35056 41187 47271 85706 85535	0 13314 23672 24740 21304 318026 318020 32594 32594 325768 32768 32768 32768 32768 32768 32768	0 12120 15482 23056 23050 23050 32054 32352 32760 32760 32760 32760	0 9558 11040 11548 14523 20510 34574 29510 34574 125768 32748 32748 32748 32748	0 5578 6968 9445 12614 17640 21207 23744 21207 23744 31206 31206 31206 31208 31208 31208 31208	0 3109 4013 4036 6626 6549 12314 16739 211694 29710 31494 32760 32760	0 11688 3300 4423 12049 12049 12049 12049 12049 28253 30719 31104 32746 32746	0 15455 13961 13961 13590 16414 13590 16414 13590 16414 13590 27077 32768 32768	0 1244 1668 3169 9322 12225 12225 12225 12225 12225 12225 12225 12225 12225 12225 12225 12225 12255 1429 12256 1429 12565 1429 12565 1244 1456 1456 1456 1456 1456 1456 1456 14	0 992 1454 1648 1648 1742 17281 17281 17281 17281 17281 28595 28529 28529 28529 28529 28529 28529 28529 28529 28529 28529	0 754 1057 2207 2207 20049 20049 2493 2493 2493 24978	0 594 836 1598 1598 1598 6556 6556 6556 6556 6557 12148 24017 24017 24017 24017 24017 24017 24017 24017 24017 24017 25064 25066 2506	0 360 1176 1776 1776 2631 6621 8621 8474 11755 27949 27949 27949 27949 27949 27949		
	Tel 141	10.00	12											and the second se	

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

A TO A A A A A A A A A A A A A A A A A A	RE III 4	P = >		Properties of , Map (8-Aux - 11-Au	n Conversed Rom	6	
North second s	- 13333 0 0 0 126 43 137 44 138 44 139 44 139 44 139 44 139 44 139 44 139 44 139 44 130 100 132 100 132 100 135 100 135 100 100	2300 31 50 50 50 50 50 50 50 50 50 50	000 4000 0 134 25 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 26 40 34 40 40 40 40 40 40 40 40 40 4	Name Derectpass Line Derectpass Line Skathadhase Type Datashase Da	Image: Second	2008 0 1 2 3 4 4 4 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	Protect / Mee





pushes the accelerate pedal relatives is requested by the driver. For example, lal by 30% and the engine revolution

ie is requ

at the 2D view. If we want to mak as are in a row. And their particular view. (And also the 3D view



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.

> box is more than twenty percent. It whicle shakes severely when s ECUs we have more than one table have different driving condition

uest ta

n the driver is driving the car in state table to control the engine. But in ca ECU uses the torque request table d s, we must first identify the approprialain in next part (5), and then inconceased values in this table are too state intervention, poor drivability, can be different for various cars depoer, you have to apply the right amount and the drive

tura

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