

# MSA-11



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## **Introduction:**

The MSA-11 ECU is used in older cars like a BMW e36 325TDS which also will be the example. It has two 27C256 EPROM's inside (UV-erasable). The EPROM's are mounted in sockets, so no soldering is needed. On the EPROM with the lowest software number are the limitation maps, drivers wish and the quantity adjuster map. The EPROM with the higher software number contains the Beginning of injection maps (3 the same maps in this case). Sometimes other EPROM's are used like the 87C257 (UV-erasable). The MSA-11 is used in the following cars:

ALFA 155 2.5 TD  
ALFA 164 2.5 TD  
BMW 318 TDS  
BMW 325 TDS  
BMW 525 TDS  
BMW 725 TDS  
FIAT MAREA 2.4 TD  
LANCIA KAPPA 2.4 TD  
FREELANDER 2.0 D  
OPEL TD's  
RANGE ROVER II 2.5 DTI  
ROVER 825 2.5 TD

There may be more cars using MSA-11 which are not in the list.

**Map explanations:**

The MSA-11 ECU has no boost control, only fuel-management. The boost is regulated mechanically.

Fuel related maps:

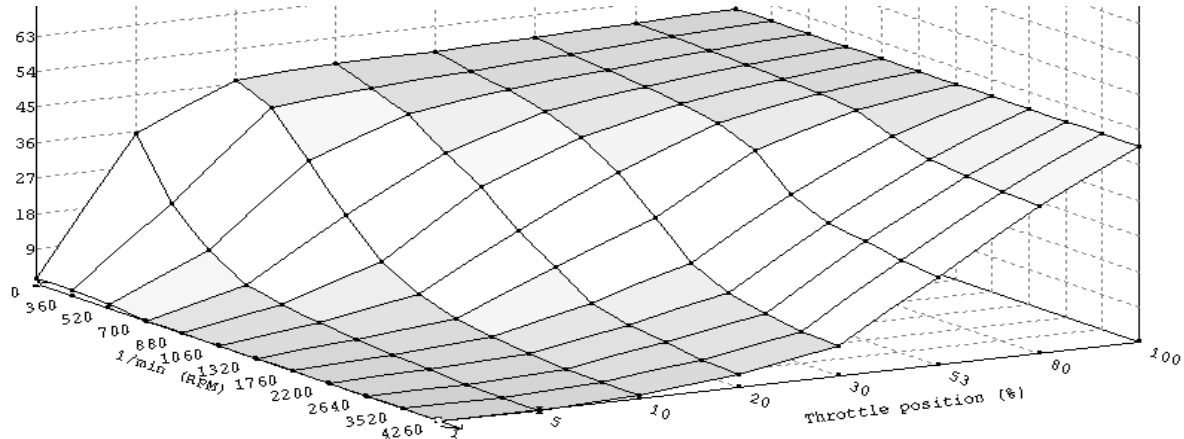
- Drivers Wish
- Torque limiter
- Smoke limiter
- Quantity adjuster

## Fuel related maps

### 1. Drivers wish Map:

#### General:

This map shows the required injected quantity diesel into the engine depending on the RPM and the Throttle position. The output of this map is injected quantity (IQ) in mg diesel/stroke.



Picture 1.1: 3D view of the drivers wish map.

#### Factors & offsets:

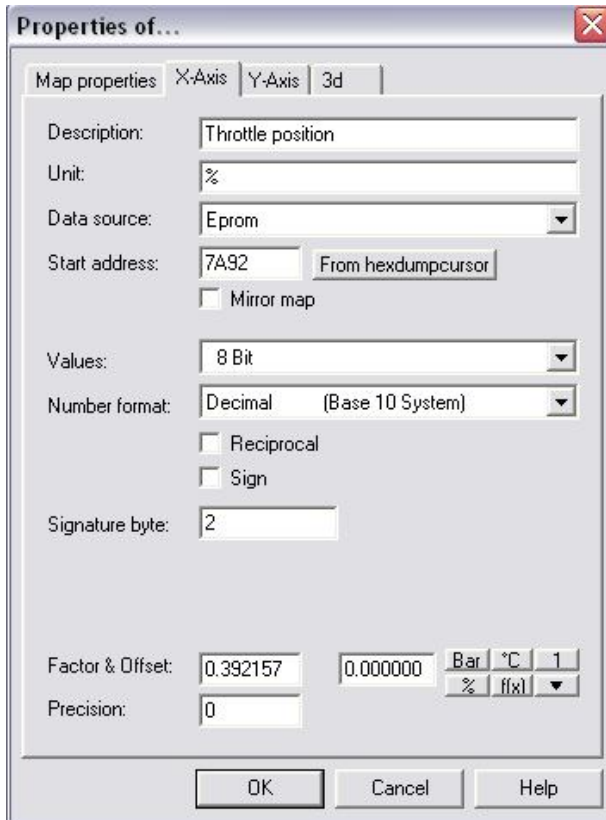
All factors, offsets, axis descriptors and names are given by the pictures below.

The screenshot shows the 'Properties of...' dialog box for the 'Drivers wish' map. The 'Map properties' tab is selected. The fields are as follows:

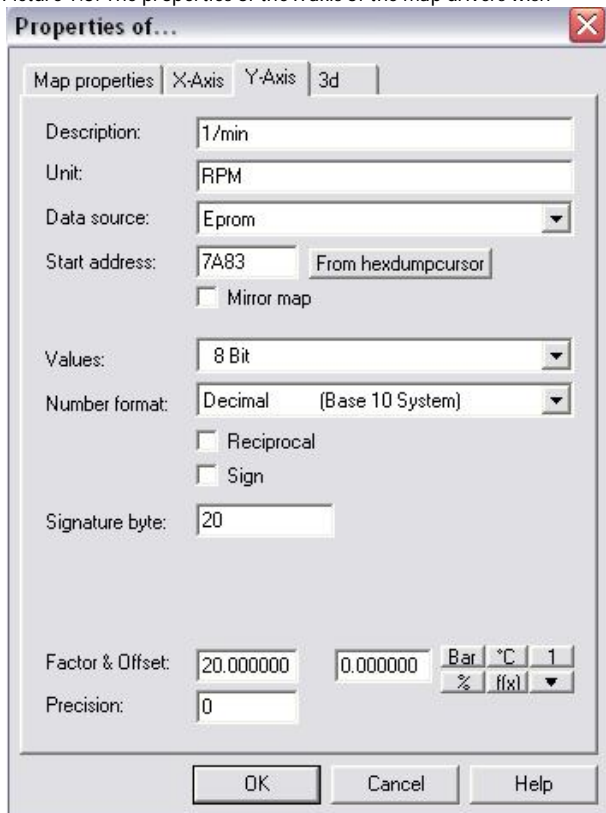
- Description: IQ
- Unit: mg / stroke
- Name: Drivers wish
- Start address: 7A9A
- Column x rows: 8 x 12
- Values: 8 Bit
- Number format: Decimal (Base 10 System)
- Organization: Twodimensional
- Factor & Offset: 0.200000 (Factor), 0.000000 (Offset)
- Precision: 0.000000

Buttons: OK, Cancel, Help

Picture 1.2: The factor and offset from the map drivers wish



Picture 1.3: The properties of the X axis of the map drivers wish

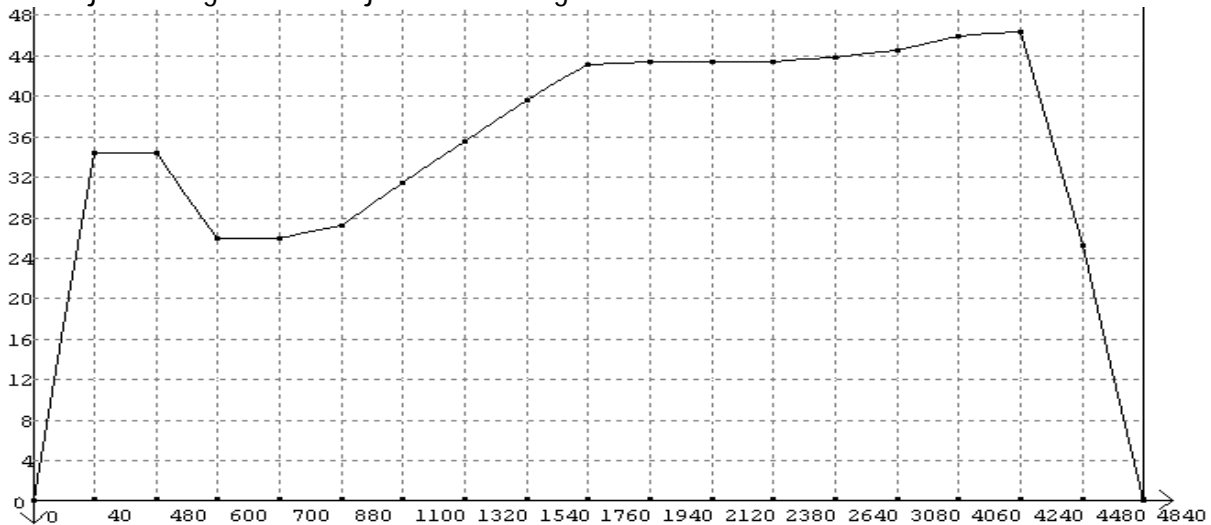


Picture 1.4: The properties of the Y axis of the map drivers wish

## 2. Torque limiter:

### General:

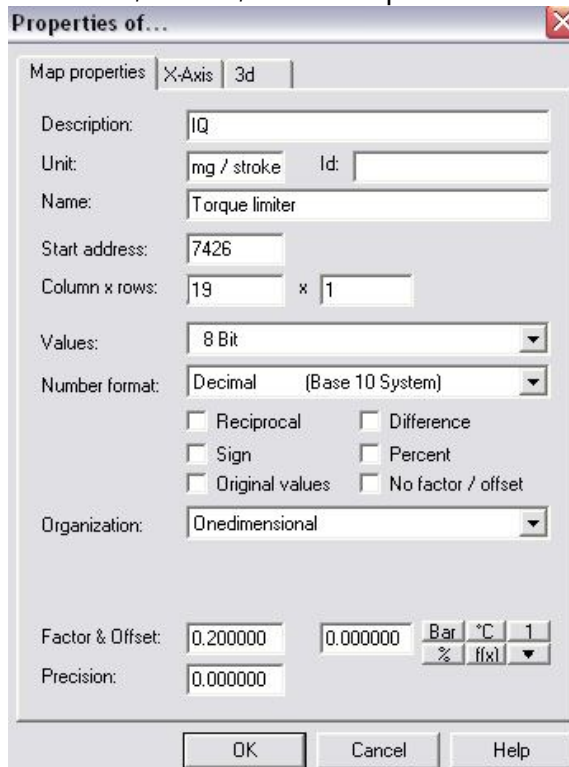
This map limits the injected quantity of diesel based on RPM. The output of this map is also mg diesel / stroke. So if the drivers wish is 50mg, and the torque limiter is 45 at that location, it won't inject 50mg but limit injection at 45mg/stroke.



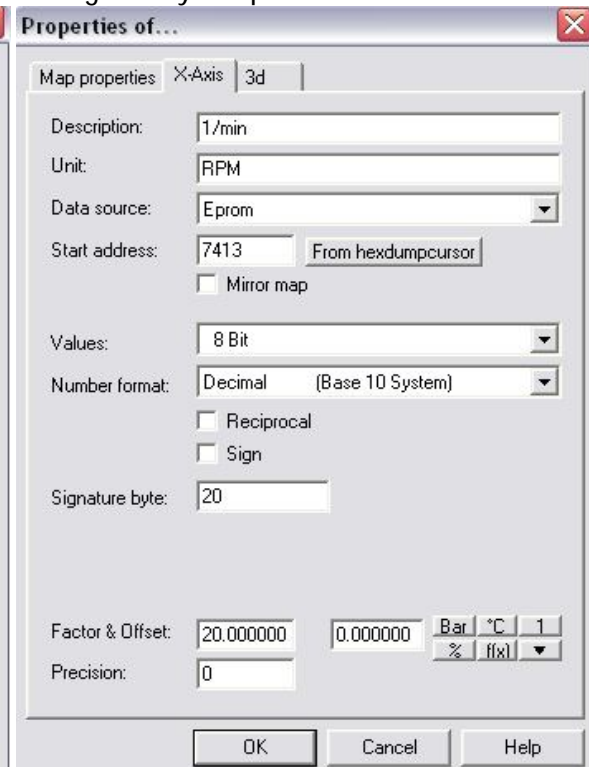
Picture 2.1: 2D view of the Torque limiter

### Factors & offsets:

All factors, offsets, axis descriptors and names are given by the pictures below.



Picture 2.2: The factor and offset from the Torque limiter

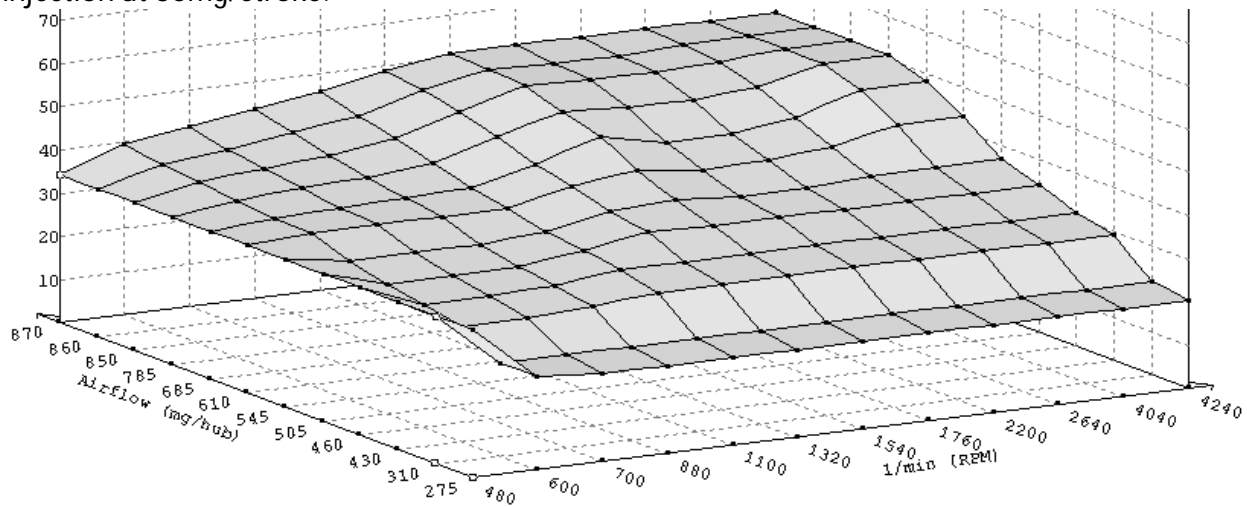


Picture 2.3: The properties of the X axis of the Torque limiter

### 3. Smoke limiter:

#### General:

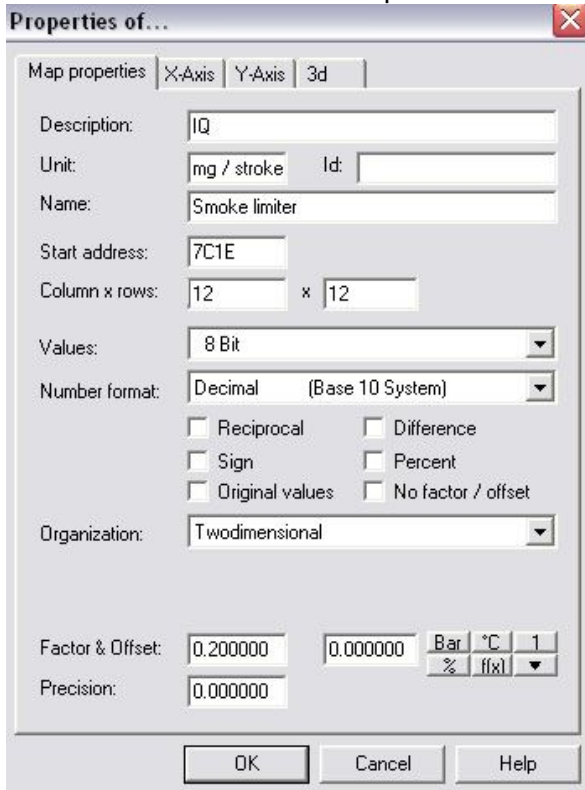
This map limits the injected quantity of diesel based on RPM and inlet air. So if the drivers wish is 40mg, and there is only enough air to burn 35mg diesel, it won't inject 40mg but limit injection at 35mg/stroke.



Picture 3.1: 3D view of the Smoke limiter

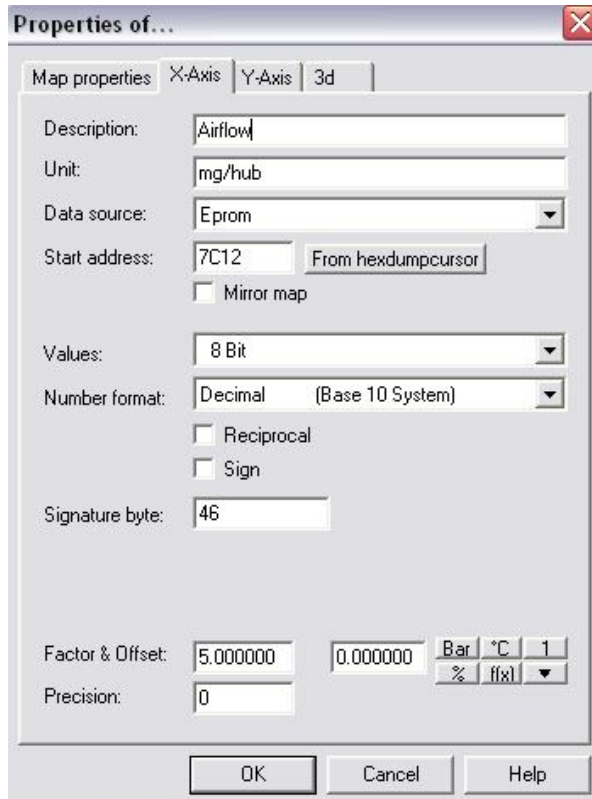
#### Factors & offsets:

All factors, offsets, axis descriptors and names are given by the pictures below.

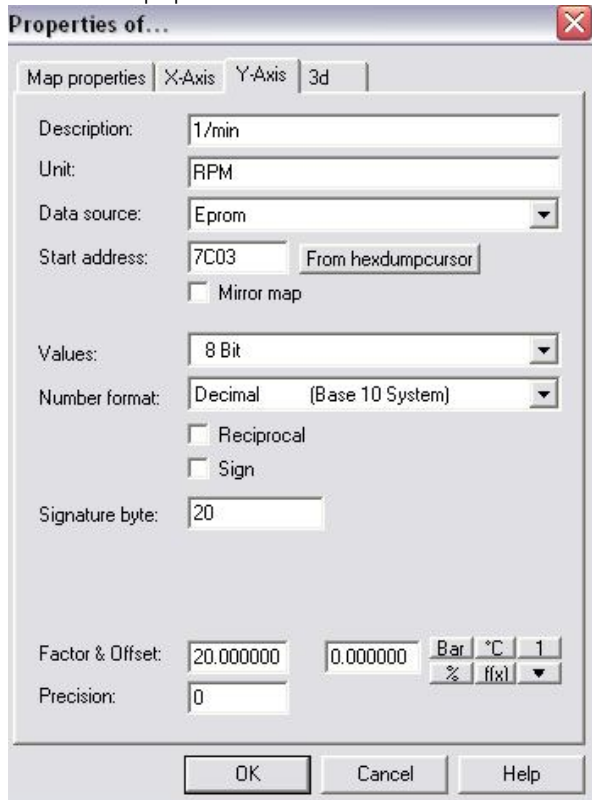


Picture 3.2: The factor and offset from the Smoke limiter





Picture 3.3: The properties of the X axis of the Smoke limiter

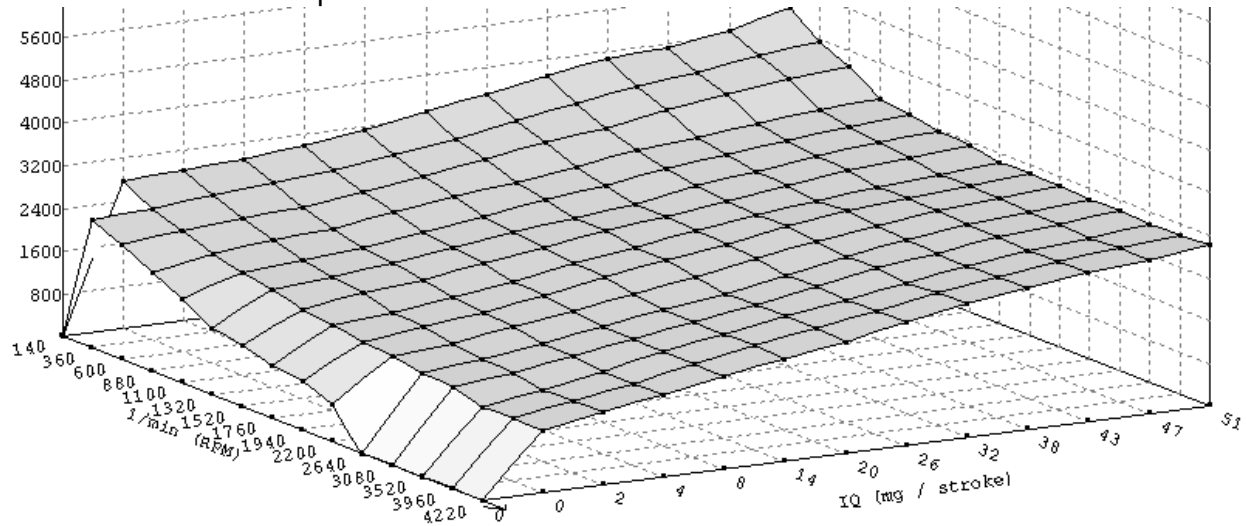


Picture 3.4: The properties of the Y axis of the Smoke limiter

## 4. Quantity adjuster:

### General:

This map shows how much volt the diesel pump need to inject a certain amount of diesel. So this is a "calibration" map.



Picture 4.1: 3D view of the Quantity adjuster map

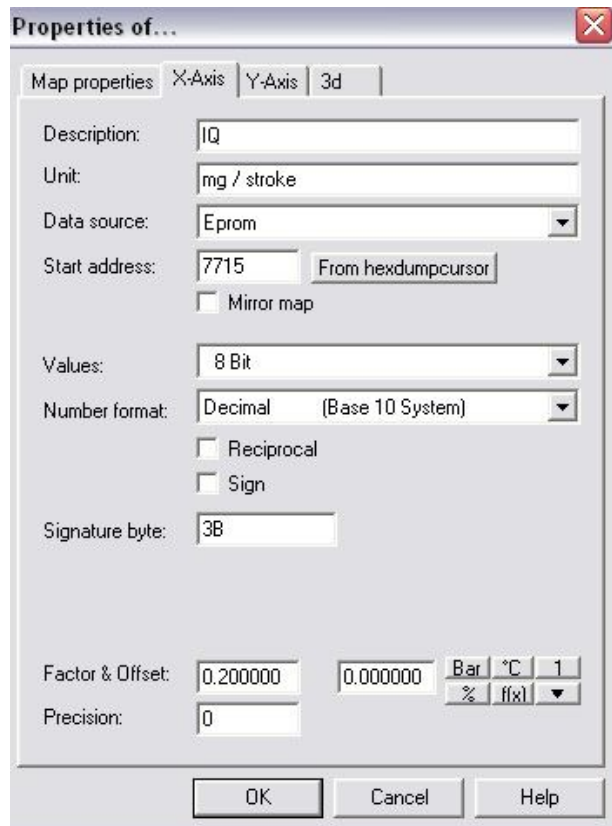
### Factors & offsets:

All factors, offsets, axis descriptors and names are given by the pictures below.

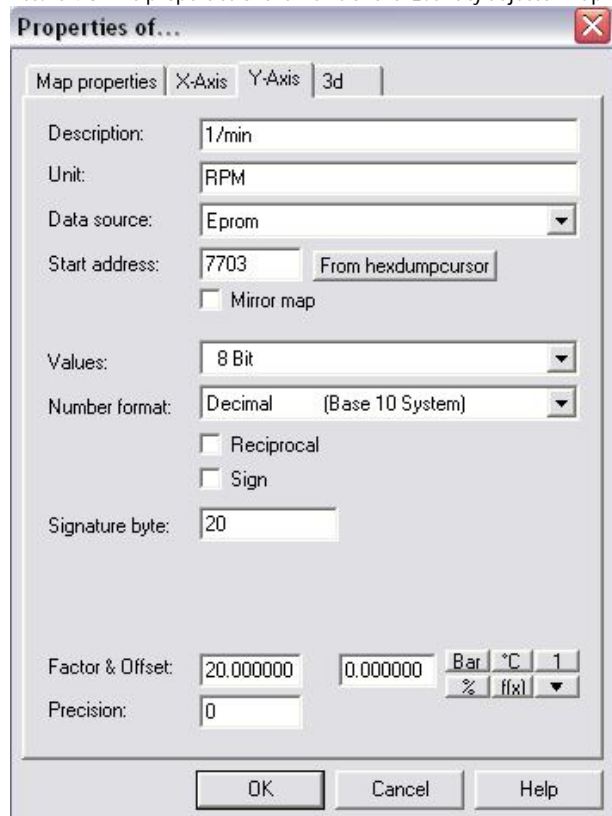
The screenshot shows a dialog box titled "Properties of..." with a close button (X) in the top right corner. The dialog is divided into several sections:

- Map properties:** Includes tabs for "X-Axis", "Y-Axis", and "3d".
- Description:** "Voltage / requested IQ"
- Unit:** "milliVolt" and "Id:" (empty)
- Name:** "Quantity adjuster map"
- Start address:** "7722"
- Column x rows:** "13" x "15"
- Values:** "16 Bit (HiLo)" (dropdown)
- Number format:** "Decimal (Base 10 System)" (dropdown)
- Options:** Reciprocal, Difference, Sign, Percent, Original values, No factor / offset (all unchecked)
- Organization:** "Twodimensional" (dropdown)
- Factor & Offset:** "0.076295" and "0.000000" (input fields), with units "Bar", "°C", "1" and a dropdown for "%", "f(x)", "1".
- Precision:** "0.000000" (input field)
- Buttons:** "OK", "Cancel", "Help"

Picture 4.2: The factor and offset from the Quantity adjuster map



Picture 4.3: The properties of the X axis of the Quantity adjuster map



Picture 4.4: The properties of the Y axis of the Quantity adjuster map

## 5. Tuning the fuel maps:

If we want to tune a stock engine we need to change the drivers wish, torque limiter, smoke limiter and in this case (BMW 325tds) also the quantity adjuster.

### Drivers wish:

The drivers wish is not very high in the original so it needs to be set higher. At full throttle it may be set 25% higher as original. Also at high revs from 50-100% throttle it may be a bit higher.

To give an example, look at the picture below. It is an original text view of the torque limiter.

RPM	IQ(Throttle position,l/min)/mg / stroke							
	1	5	10	20	30	53	80	100
0	2	36	46	47	48	48	49	50
360	2	21	42	44	45	47	49	50
520	1	12	32	41	44	47	48	50
700	0	7	21	34	42	45	48	50
880	0	5	13	29	38	44	48	50
1060	0	3	8	21	33	43	47	50
1320	0	3	5	15	25	39	46	50
1760	0	2	3	9	16	31	42	50
2200	0	1	2	6	12	27	40	50
2640	0	1	2	5	10	25	39	50
3520	0	0	1	4	8	23	38	50
4260	0	0	1	4	8	23	38	50

Picture 5.1: The original Drivers wish

The modified torque limiter can look something like the picture below.

RPM	IQ(Throttle position,l/min)/mg / stroke							
	1	5	10	20	30	53	80	100
0	2	36	46	47	48	48	49	51
360	2	21	42	44	45	47	49	51
520	1	12	32	41	44	47	48	51
700	0	7	21	34	42	45	48	51
880	0	5	13	29	38	44	48	51
1060	0	3	8	21	33	43	47	51
1320	0	3	7	16	27	40	47	51
1760	0	2	5	11	22	33	45	51
2200	0	1	4	9	18	29	44	51
2640	0	1	4	8	16	28	43	51
3520	0	0	3	6	14	26	42	51
4260	0	0	3	6	14	25	41	51

Picture 5.2: The modified Drivers wish

If we look at this you can see that we have a problem. The requested injected quantity at full throttle should be  $50\text{mg} \times 1,25\% = 63\text{ mg/stroke}$ . We can only add this value up to 51 because that is the upper limit of the map ( $255 \times 0.2 = 51$ ). This problem also occurs by the torque limiter and by the smoke limiter. Of course there is a solution: changing the quantity adjuster map. This will be discussed later.

Torque limiter:

The torque limiter can be increased from 1250rpm to 4800rpm by  $\pm 25\%$ . The highest value should be around 4000rpm, due to the big turbo mounted on this car.

To give an example, look at the picture below. It is an original text view of the torque limiter.

RPM	IQ(l/min)/mg / stroke																		
	0	480	700	1100	1540	1940	2380	3080	4240	4840	40	600	880	1320	1760	2120	2640	4060	4480
	0	34	34	26	26	27	31	36	40	43	43	43	43	44	45	46	46	25	0

Picture 5.3: The original torque limiter

The modified torque limiter can look something like the picture below.

RPM	IQ (l/min)/mg / stroke																			
	0	480	700	1100	1540	1940	2380	3080	4240	4840	40	600	880	1320	1760	2120	2640	4060	4480	
	0	34	34	26	26	27	35	42	48	51	51	51	51	51	51	51	51	51	48	0

Picture 5.4: The modified torque limiter

We also see that the same problem occurs as the one with the drivers wish. it cannot be set higher as 51mg/stroke.

Smoke limiter:

As you can see the values (mg/stroke) are increased. At this point the smoke limiter will still limit the IQ. So we need to change the smoke limiter as well. We only want to change the smoke limiter at high IQ's. Original the text view of the smoke map looked like the picture 5.5.

g/hub RPM	IQ(Airflow, l/min)/mg / stroke											
	275	430	505	610	785	860	310	460	545	685	850	870
480	34	34	34	34	34	34	34	34	34	34	34	34
600	22	22	27	28	30	32	35	36	36	37	38	40
700	20	22	27	28	30	32	35	36	37	38	40	42
880	20	22	28	29	30	32	35	37	38	40	42	44
1100	20	22	29	31	32	33	35	37	39	42	44	46
1320	20	22	29	31	35	36	39	41	44	46	48	49
1540	20	22	29	31	34	37	40	45	47	50	51	51
1760	20	22	29	31	34	36	38	42	46	49	50	51
2200	20	22	29	31	34	36	39	42	46	49	50	51
2640	20	22	29	31	34	37	40	44	47	50	51	51
4040	20	22	29	31	34	37	43	49	51	51	51	51
4240	20	22	29	31	34	37	43	49	51	51	51	51

Picture 5.5: The original smoke limiter

At full throttle only the higher airflow parts will be used.

To change the smoke limiter not too much (we don't want to smoke a lot). The air fuel ratio at which not too much smoke appears is 1:17. So if we pick the value 870 (highest value on smoke map scale) and divide that by 17 we get:  $870/17 = 51\text{mg}$ . So the max value in the most right column may be 51 mg/stroke.

Then the smoke limiter looks like the picture below.

rflow RPM	IQ(mg/hub,l/min)/mg / stroke											
	55	86	101	122	157	172						
	62	92	109	137	170	174						
480	34	34	34	34	34	34	34	34	34	34	34	34
600	22	22	27	28	30	32	35	36	36	37	38	40
700	20	22	27	28	30	32	35	36	37	38	40	42
880	20	22	28	29	30	32	35	37	38	40	44	46
1100	20	22	29	31	32	33	35	37	39	42	45	47
1320	20	22	29	31	35	36	39	41	44	46	49	51
1540	20	22	29	31	34	37	40	45	47	50	51	51
1760	20	22	29	31	34	36	38	42	46	50	51	51
2200	20	22	29	31	34	36	39	42	47	51	51	51
2640	20	22	29	31	34	37	40	44	48	51	51	51
4040	20	22	29	31	34	37	43	49	51	51	51	51
4240	20	22	29	31	34	37	43	51	51	51	51	51

Picture 5.6: The modified smoke limiter

And, again, we run into the limits of the map(51mg/stroke).

Quantity adjuster map:

The problem is that the system will max allow 51mg/stroke to inject. To solve this problem we let the ECU believe that it is injecting 51mg/stroke, but actually is injecting more. How do we do that? By changing the quantity adjuster map.

stroke RPM	Voltage / requested IQ(IQ,l/min)/milliVolt												
	0	0	2	4	8	14	20	26	32	38	43	47	51
140	0	2754	2813	2891	2988	3145	3337	3515	3692	3867	3925	4102	4373
360	2383	2440	2560	2660	2749	2879	3028	3227	3377	3536	3676	3825	3945
600	2149	2265	2346	2408	2565	2704	2884	3048	3128	3332	3501	3621	3711
880	1853	2052	2152	2211	2387	2526	2644	2793	2934	3038	3148	3247	3322
1100	1574	1922	2012	2112	2241	2396	2555	2685	2814	2948	3060	3167	3260
1320	1270	1828	1927	2037	2199	2323	2447	2571	2723	2859	2983	3103	3183
1520	1155	1668	1833	1937	2102	2256	2416	2540	2660	2798	2929	3028	3113
1760	996	1594	1703	1838	1987	2196	2341	2490	2612	2739	2841	2948	3033
1940	899	1504	1629	1753	1922	2122	2296	2455	2610	2752	2853	2929	3039
2200	703	1459	1559	1708	1858	2037	2216	2406	2565	2706	2838	2929	3023
2640	0	1390	1494	1649	1808	1977	2139	2326	2510	2689	2808	2903	3006
3080	0	1325	1434	1594	1788	1967	2139	2321	2498	2615	2784	2894	2995
3520	0	1170	1350	1539	1783	1967	2147	2311	2450	2610	2752	2860	2978
3960	0	1170	1350	1529	1758	1957	2131	2310	2480	2615	2769	2871	2973
4220	0	1170	1365	1544	1746	1932	2102	2321	2490	2640	2782	2889	3024

Picture 5.7: The original quantity adjuster map

We demand the ECU to apply more voltage for an amount of injected quantity diesel.

RPM deg/stroke	Voltage / requested IQ(1/min,IQ)/millivolt														
	140	360	600	880	1100	1320	1520	1760	1940	2200	2640	3080	3520	3960	4220
0	0	2383	2149	1853	1574	1270	1155	996	899	703	0	0	0	0	0
0	2754	2440	2265	2052	1922	1828	1668	1594	1504	1459	1390	1325	1170	1170	1170
2	2813	2560	2346	2152	2012	1927	1833	1703	1629	1559	1494	1434	1350	1350	1365
4	2891	2660	2408	2211	2112	2037	1937	1838	1753	1708	1649	1594	1539	1529	1544
8	2988	2749	2565	2387	2241	2199	2102	1987	1922	1858	1808	1788	1783	1758	1746
14	3145	2879	2704	2526	2396	2323	2256	2196	2122	2037	1977	1967	1967	1957	1932
20	3337	3028	2884	2644	2555	2447	2416	2341	2296	2216	2139	2139	2147	2131	2102
26	3515	3227	3048	2793	2685	2571	2616	2567	2532	2482	2402	2397	2387	2386	2397
32	3692	3377	3128	2934	2814	2723	2737	2856	2854	2809	2754	2742	2695	2724	2734
38	3867	3536	3332	3038	2948	2859	2874	2983	2996	2951	2933	2859	2854	2859	2884
43	3925	3676	3501	3148	3060	2983	3005	3085	3097	3082	3053	3028	2996	3013	3026
47	4102	3825	3621	3247	3167	3103	3104	3193	3173	3173	3147	3138	3104	3115	3133
51	4373	3945	3711	3322	3260	3183	3189	3277	3283	3267	3250	3239	3222	3218	3268

Picture 5.8: The modified quantity adjuster map

Don't "over tune" this map. Adding 10% at higher IQ's above 1500 rpm can be a guideline.

**Conclusion:**

All information and values given in this document may be used at own risk. I do not stand in for any problems or blown turbo's. My special thanks go out to Matt and Tomek who helped me with all this information and tuning advice. I hope you enjoy the information.