POSSIBILITIES OF CHANGES OF PARAMETERS OF THE DRIVER TOENGINE FIAT 1.3 JTD PERFORMANCES

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Abstract

The aim is t\ present possible ways of interference in the factory engine control program and the impact of what you want changes made changes on engine performance. This objective has been completed on the basis of the programme steering engine Fiat 1.3 MultiJet engine compartment is fitted on the chassis in the Faculty at Motor Vehicles Exploitation. Methods of reading logic. The activity and the construction of an electronic control circuit. Discusses the operation and construction of an electronic control. Shows the selected map control for driver, sample modifications and their impact on power, torque and the composition of the gases.

The main assumption during modification of the factory driver software controlling Fiat 1.3 JTD engine was to increase torque within the low range of rotational speeds. The range of modifications had the task of evaluating the software methodology, changes in driver parameters and they effect on engine performance only. The obtained results are evidence of the correctness of modifications carried out within injection dose and supercharging pressure. Hexadecimal notation values and decimal notation values corresponding to them, modified bitmap for pilot injection dose, original bitmap values for pilot injection dose time, modified bitmap values for injection dose time, modified bitmap for main injection dose, original bitmap for supercharging pressure, original bitmap for supercharging pressure delimiter, comparison of external characteristic curve are presented in the paper.

Keywords: *combustion engines, impact on power, torque, composition of the gases, chiptuning*

1. Introduction

A possibility has appeared together with the emergence of vehicles equipped with injection systems with electronic control system EDC (Electronic Diesel Control) to introduce modifications in the factory driver software controlling engine operation. This enables precise and diverse formation of combustion. Apart from controlling the injection dose (being dependent, among others, on engine load and temperature), EDC exchanges information with other electronic systems in a vehicle, mainly with gearbox and vehicle trajectory stabilisation (ESP) systems as well as ASR system.

In the systems controlling engine operation ECU (Engine Control Unit), EEPROM and FLASH memories are being used to store the programme. This is undoubtedly an advantage due to their reliability and, in case of FLASH memory, a possibility to store the programme many times. This is convenient both for manufacturer and user. Manufacturer has possibility to make corrections in the programme through the data being received from service stations. This is induced by stricter and stricter exhaust gas toxicity standards, improvement of engine efficiency and reduction of fuel consumption as well as constantly growing requirements imposed on modern combustion engines. On the other hand, user has a chance to increase the performance of his / her vehicle with no need to replace expensive mechanical parts. Greater dynamics of a vehicle increases safety during passing and abrupt manoeuvres.

It is necessary to note, however, that modifications in the programme should not be made without using an appropriate procedure. Before starting bitmap reading, it is necessary to carry out vehicle and engine diagnostics to make sure that engine and power units (coupling, gearbox and drive shaft) are in working order and can stand higher power and load.

Different methods of interference in the driver software controlling engine operation have appeared together with gradual development of ECU to mention, among others, programme replacement in EEPROM memory, connection of external modules (so called Boxes) and programming through EOBD (European On Board Diagnosis) diagnostic connector being most popular at present.

2. Test bed

Research centres perform specific examinations in a special laboratory on a test bed which is called engine test bed to determine actual engine parameters, such as power, fuel consumption, etc., being termed engine operational parameters.

Depending on the needs, the scope of these examinations can vary greatly – from simple measurements of power and fuel consumption to complex scientific tests which depend on the engine test bed equipment.

At the Department of Automotive Vehicles Operation of the Western Pomeranian University of Technology in Szczecin, examinations were carried out on a test bed presented in Fig. 1.

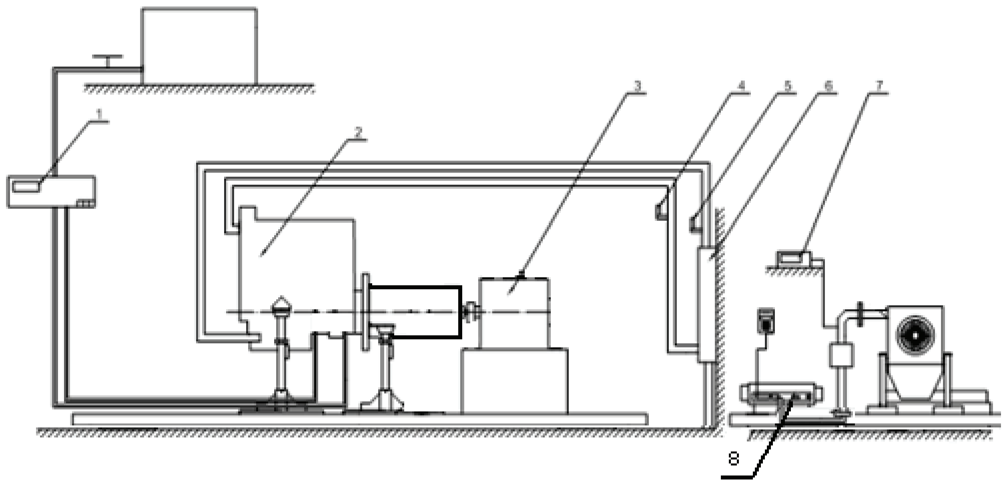

Fig. 1. Schematic diagram of a test bed with FIAT 1.3JTD MultiJet engine 1 – AMX212F gauge, 2 – 1.3JTD engine, 3 – AMX 100 brake, 4 – coolant thermometer, 5 – coolant thermometer, 6 – coolant tank, 7 – exhaust gas temperature meter, 8 –MDO 2 smoke meter with consol

One of more important elements on the test bed is a brake loading FIAT 1.3JTD MultiJet combustion engine with a smooth control of set load value. During examinations, AUTOMEX AMX 100 eddy current brake was used together with AUTOMEX AMX 212F fuel mass gauge.

3. Programming through OBD-II diagnostic connector

The method of driver programming being most popular at present is to use EOBD diagnostic connector. Its popularity is affected by many factors. In the first place, this is high availability of cars with a diagnostic connector, possibility to use drivers in all their types (EDC16, EDC15 and older drivers but also EDC17, mostly in most recent systems), low cost of programming itself and ease of data readout.

It is enough to connect a programmer (Fig. 2) with a diagnostic connector and a computer and it is possible to start very quickly to read out the programme from ECU. An important advantage of this method is the fact that such interference is almost undetectable by service station. This enables introduction any modifications in the programme without changes in other settings (immobiliser, VIN number) [9, 10].

Fig. 2. Galletto 1260 programmer

In the example under discussion, the programme readout was made by means of Galletto 1260 programmer through a diagnostic connector. The software used for this purpose was a programme attached to this programmer. The values of FLSH and EEPROM memories were read out (Fig. 3).

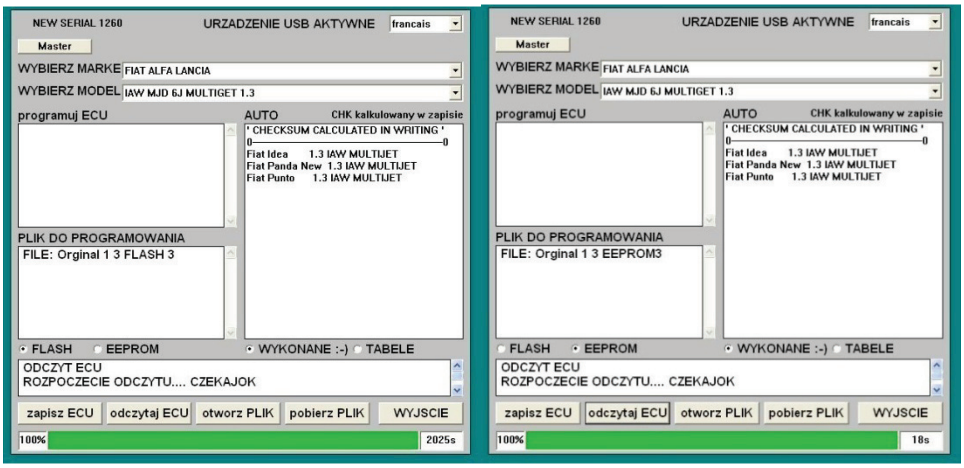

Fig. 3. FLASH and EEPROM memory contents readout using Galletto 1260 programmer

The procedure of data readout itself was carried out easily and correctly. This can be stated by comparing the driver version on its cover with the readout of stored programme through FiatECUScan (Fig. 4).

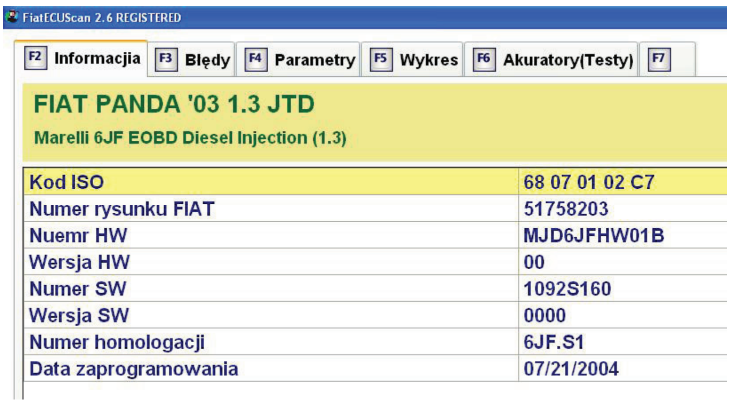

Fig. 4. Data readout for Fiat ECUScan driver

4. Comparison of bitmaps

Bitmaps are a graphical method to present the course of dependencies between three parameters on x, y and z axes. However, the programme recording itself is not stored in this form. The basic object code is recorded by hexadecimal notation method (hex). This recording is composed of 5 signs presented in Tab. 1.

Tab.1. Hexadecimal notation values and decimal notation values corresponding to them

Hexadecimal notation	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal notation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

There are special programmes for reading out and making modifications to read out the contents of driver software. One of them is WinOLS on the basis of which the bitmaps of selected engine parameters were made.

4.1. Pilot injection dose

Modifications within pilot injection were induced by changes in main injection dose. The range of changes includes the whole range of rotational speed and throttle valve opened over 40%.

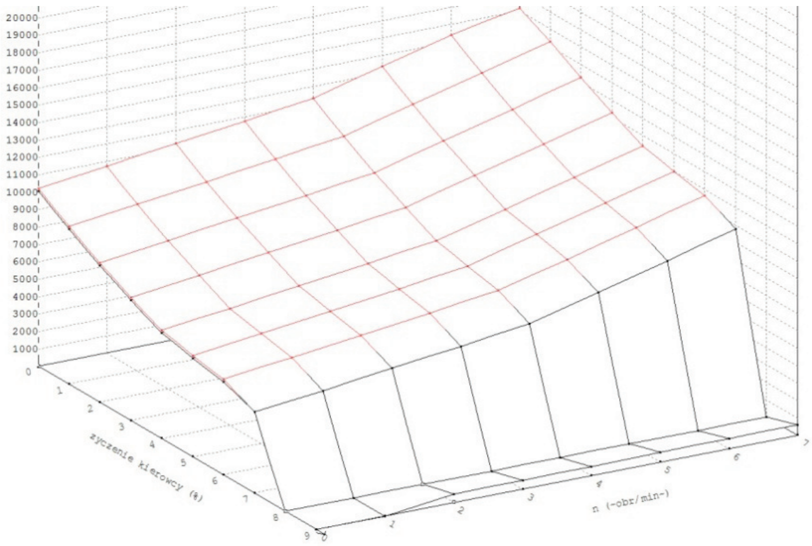

Fig. 5. Modified bitmap for pilot injection dose

Tab. 2. Original bitmap values for pilot injection dose time

/min- %	n, Driver's request 0	1	2	3	4	5	6	7
0	10055	10585	11110	11640	12165	13210	14240	15000
1	8905	9430	9905	10485	11010	12060	13100	14120
2	7865	8385	8905	9435	9960	11010	12055	13085
3	6925	7440	7955	8480	9000	10050	11100	12135
4	6080	6585	7100	7615	8135	9180	10230	11270
5	5695	6195	6700	7215	7730	8775	9820	10865
6	5325	5820	6325	6830	7345	8335	9435	10480
7	4650	5130	5625	6125	6635	7665	8705	9755
8	0	3	5	8	10	13	16	19
9	22	26	512	538	555	583	601	625

Tab. 3. Modified bitmap values for injection dose time

/min- %	n, Driver's request 0	1	2	3	4	5	6	7
0	10205	10735	11260	11790	12315	13360	14390	15150
1	9055	9580	10055	10635	11160	12210	13250	14270
2	8015	8535	9055	9585	10110	11160	12205	13235
3	7075	7590	8105	8630	9150	10200	11250	12285
4	6230	6735	7250	7765	8285	9330	10380	11420
5	5845	6345	6850	7365	7880	8925	9970	11015
6	5475	5970	6475	6980	7495	8485	9585	10630
7	4650	5130	5625	6125	6635	7665	8705	9755
8	0	3	5	8	10	13	16	19
9	22	26	512	538	555	583	601	625

4.2. Main injection dose

Since the injection dose has a substantial importance for engine performance, modifications in the bitmap controlling main injection dose are ones of the key modifications for increasing power and torque. The presented modification (Fig. 6) anticipates increase in injection dose by 10-14%, i.e. 4-4.5 mg within the range of 1200-3400 rpm with wide open throttle valve. The expected result is power and torque increase, in particular at low rotational speeds.

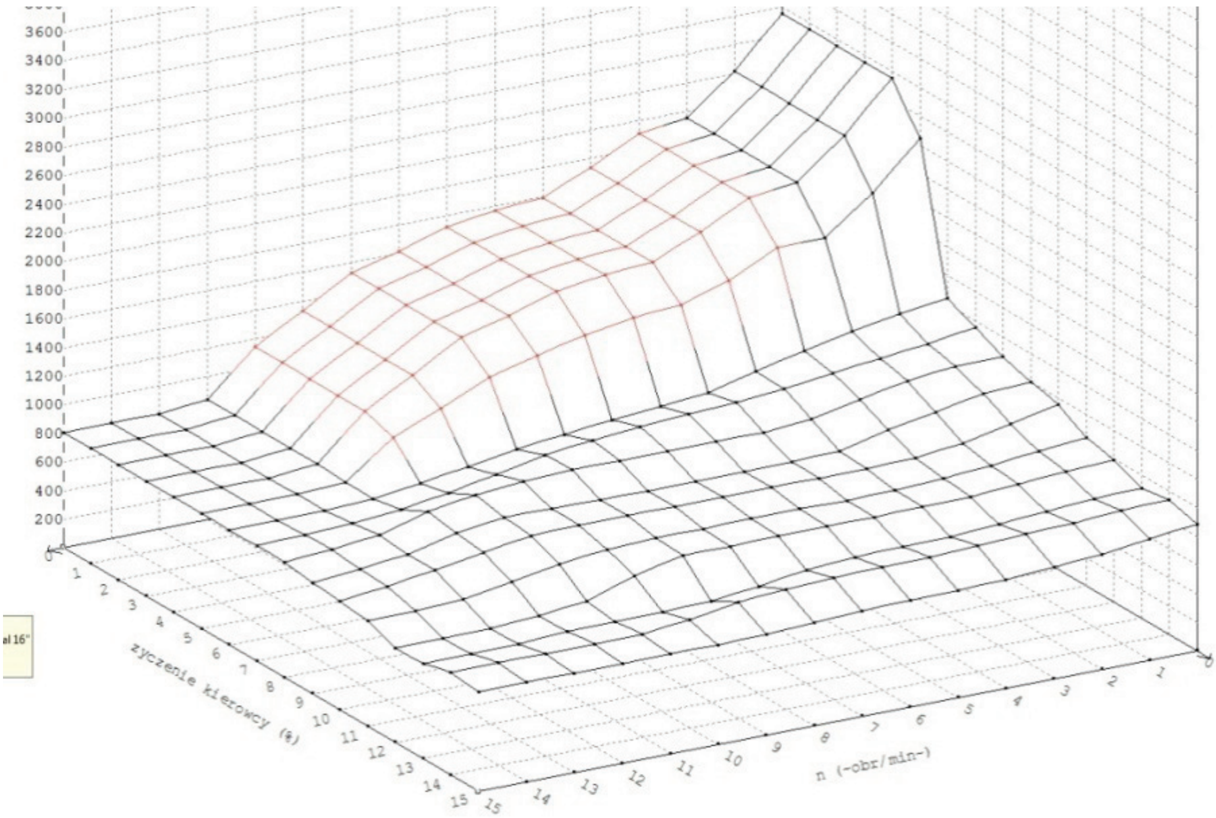

Fig. 6. Modified bitmap for main injection dose

4.3. Supercharging pressure of turbosupercharger

The bitmap controlling supercharging pressure was also covered by modification together with the increase of injection dose. This modification (Fig. 7) included changes in supercharging pressure by approximately 5-8% (4-10 kPa) within a wide range of rotational speed of 1200-4600 rpm.

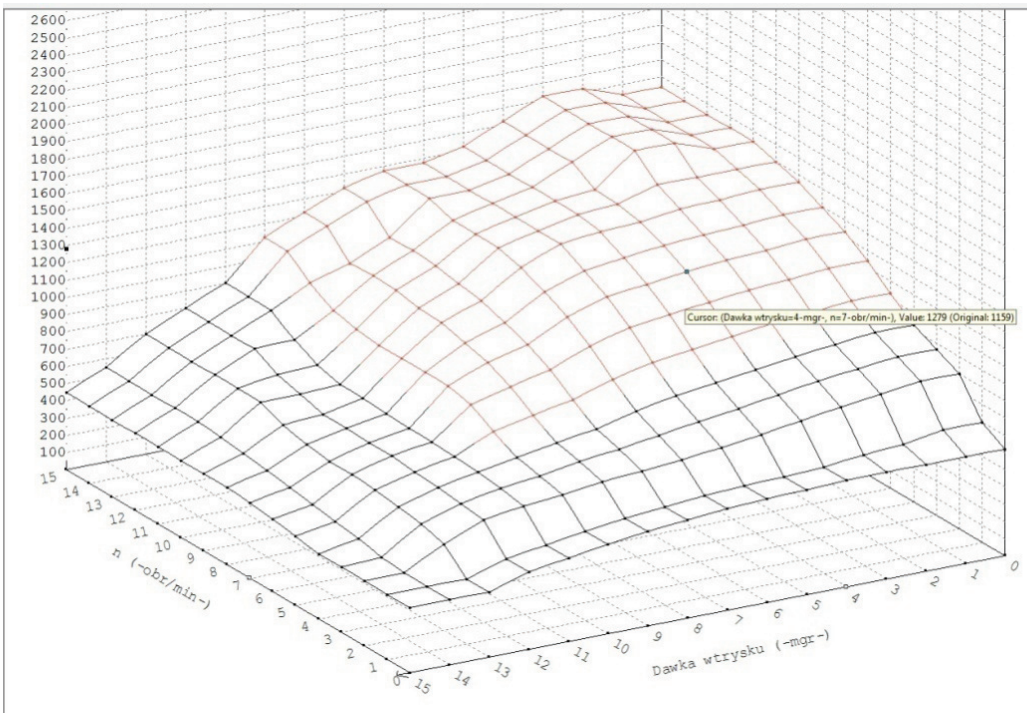

Fig. 7. Original bitmap for supercharging pressure

4.4. Supercharging pressure delimiter

Supercharging pressure delimiter has the task of limiting supercharging pressure in case specific values of supercharging are exceeded depending on rotational speed. It is one of many safeguards against undesirable interference protecting turbosupercharger from exceeding the maximum amount of rotations by turbine.

In the example below, no modifications were made. The reason for that was a small change in supercharging pressure which was within the safety limits and there was no need to modify the delimiter.

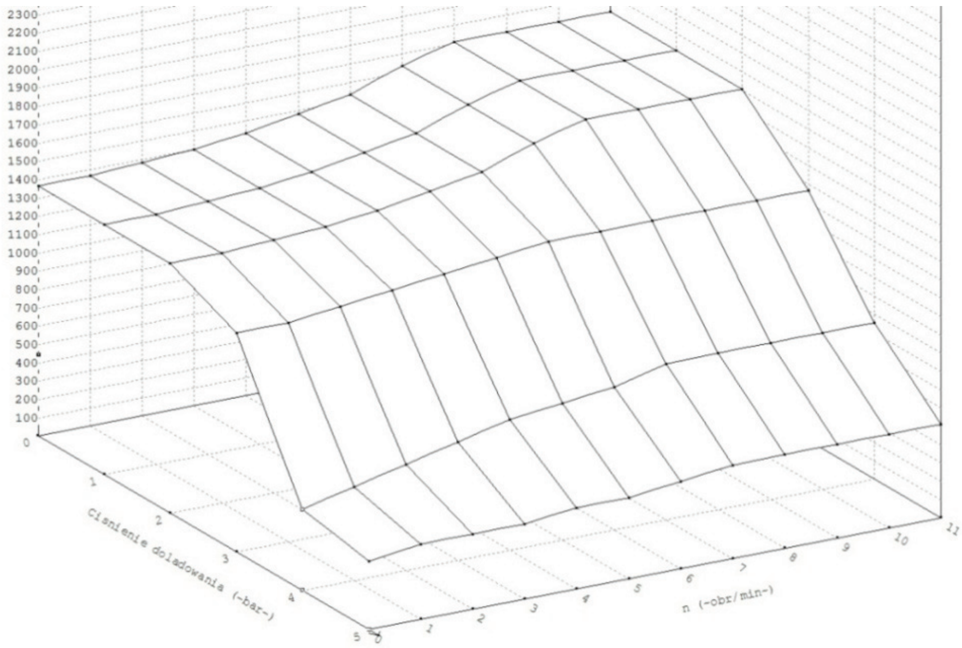

Fig. 8. Original bitmap for supercharging pressure delimiter

5. Analysis of findings

The objective of carried out modifications in Magneti Marelli 6.JF.S1 1.3 JTD driver programme was to increase torque within the range of low rotational speeds through increasing injection dose and supercharging pressure.

Based on the measurements obtained on engine test bed, the results of measurements were compared (Tab. 4) and a diagram comparing external characteristics was made (Fig. 9).

It can be seen from the obtained data that the assumed modification objectives brought a desired effect in the form of moving maximum torque into a lower range of rotational speeds, small increase of engine power and reduction of hourly fuel consumption. When considering also slightly lower temperature of exhaust gases, it is possible to state that engine operating on modified programme will not exceed thermal and mechanical limits of strength anticipated by manufacturer.

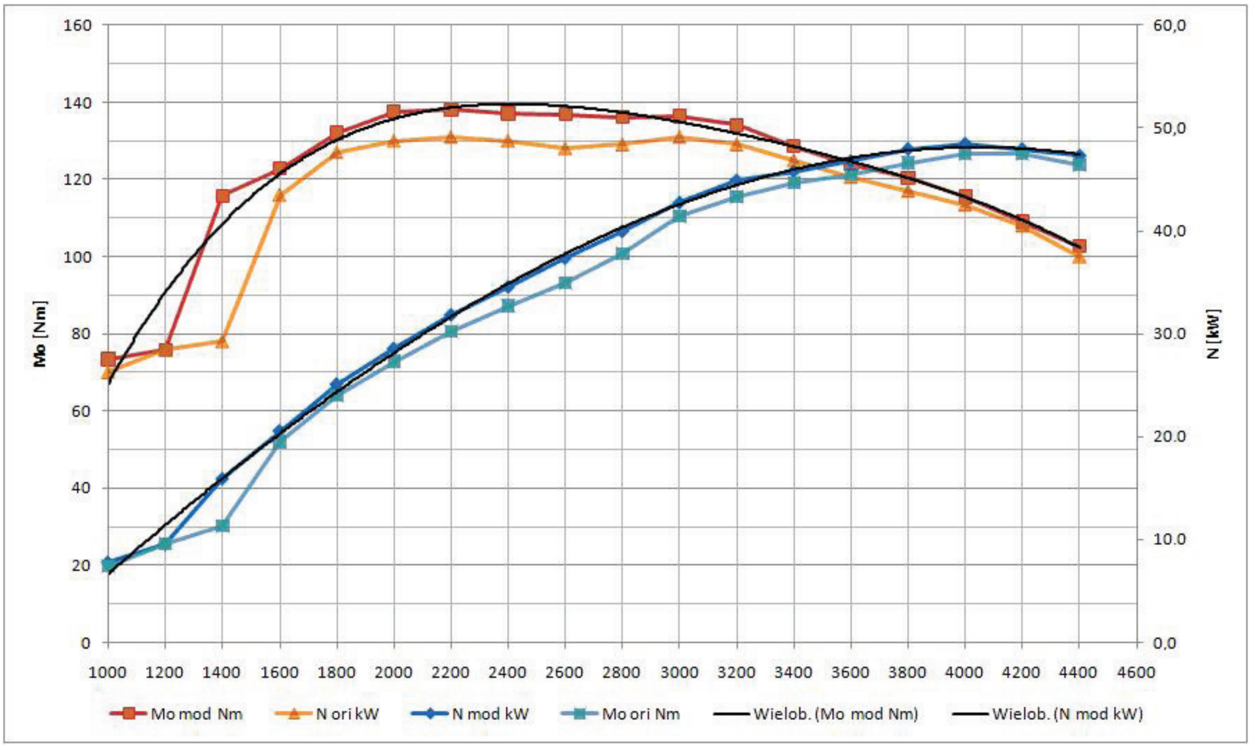

Fig. 9. Comparison of external characteristic curves

6. Conclusions

In modern engines, each element of the operation of modern engine is strictly controlled by a specific driver software which is a result of dependency of several parameters. This is induced by greater and greater requirements imposed on combustion engines both in respect of performance and exhaust gas cleanness. Therefore, every modification should be adapted to specific needs or tasks. Furthermore, it is necessary to keep with the limitations resulting from technical parameters of actuators. When making modifications, it is necessary to pay particular attention to dependencies between different controlling bitmaps, e.g. for injection dose, supercharging pressure and exhaust gas smokiness. Omission of indispensable corrections may result in the damage of many engine elements, e.g. piston head burn-up, destruction of supercharger turbine, or destruction of flywheel.

The main assumption during modification of the factory driver software controlling Fiat 1.3 JTD engine was to increase torque within the low range of rotational speeds. The range of modifications had the task of evaluating the software methodology, changes in driver parameters

Tab. 4. Results of measurements

n [rpm]	N [kW]		M_o [Nm]		G_e [g/s]		G_e [kg/h]		g_e [g/kWh]	
	Original	Modification	Orig.	Mod.	Orig.	Mod.	Orig.	Mod.	Orig.	Mod.
1000	7.4	7.8	70	73	0.65	0.60	2.34	2.16	303.70	271.20
1200	9.6	9.5	76	76	0.81	0.78	2.92	2.81	290.30	285.40
1400	11.3	15.9	78	116	1.05	0.97	3.78	3.49	320.50	299.80
1600	19.5	20.6	116	123	1.56	1.23	5.62	4.43	275.60	208.90
1800	24.0	25.1	127	132	1.76	1.46	5.34	5.26	252.00	205.60
2000	**27.3**	**28.6**	**130**	**138**	**1.95**	**1.77**	**7.02**	**6.37**	**245.50**	**214.50**
2200	30.2	31.8	131	138	2.05	1.96	7.38	7.06	232.50	214.43
2400	32.7	34.6	130	137	2.23	2.18	8.03	7.85	234.70	218.38
2600	34.9	37.3	128	137	2.52	2.34	9.07	8.42	248.60	218.08
2800	37.8	40.0	129	136	2.58	2.47	9.29	8.89	233.70	213.45
3000	41.4	42.7	131	136	2.86	2.78	10.30	10.01	234.40	223.98
3200	43.3	44.9	129	134	2.98	2.95	10.73	10.62	236.60	226.25
3400	44.7	45.8	125	129	3.11	3.07	11.20	11.05	239.20	231.40
3600	45.5	46.8	121	124	3.17	3.15	11.41	11.34	239.40	232.35
3800	46.6	48.0	117	120	3.29	3.37	11.84	12.13	242.50	243.00
4000	**47.5**	**48.5**	**113**	**116**	**3.31**	**3.40**	**11.92**	**12.24**	**239.50**	**242.53**
4200	47.5	47.9	108	109	3.36	3.42	12.10	12.31	243.00	247.00
4400	46.4	47.3	100	103	3.37	3.44	12.13	12.38	250.03	251.45

and they effect on engine performance only. The obtained results are evidence of the correctness of modifications carried out within injection dose and supercharging pressure. Although the increase of performance is small and amounts to approximately 6% for torque and 2% for power, the hourly fuel consumption decreased by 4-10% at 1000-2800 rpm. Due to better cylinder filling with air-fuel mixture, a slightly better combustion was obtained which was directly reflected in fuel consumption. It is a good indication for engine susceptibility to further increase of its performance without a risk of increasing the costs of its operation or a risk of reaching too high temperatures by engine.

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