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TEST BENCH SAV-1 FOR AUTOMATED MANAGEMENT OF THE AUTOMOTIVE GASOLINE FUEL INJECTORS

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Abstract: *The modern automotives are subject of more stringent requirements corresponding to power, torque, fuel economy and ecology legislations. The main factor in this area is the automotive engine fuel system, which is controlled by the electronic control unit (ECU). The electronic control of the Spark Ignition Engines (SI engines), as well as the Direct Ignition Engines (DI engines) is based on the certain sensors signals, program maps and management algorithms. The final result in this electronic control is the management of the fuel injectors. The management of the fuel injectors consists in the start of injection, injection duration, number of injection events, injection advance, injection pressure etc. The learning of these devices and their management is the ground for achievement of quality results in the education of the automotive engineers, as well as for obtaining of scientific researching for developments and innovations. The students researching interest is exciting and supporting by open platforms and free conception for their expression and implementations. Significant meaning in this concept has the real, live and practical performance with the help of testing equipment and test-benches. This paper renders the possibilities of the test bench SAV-1 for automated management of the automotive gasoline fuel injectors with support of controller Matrix MIAC MI0245 and Flowcode 7 software.*

INTRODUCTION

The research equipments and test benches and the corresponding researching and practices are the base for increasing the student's qualification and attracting the attention to these specialties, which involve them [1].

The modern automotive engineers and constructors must know the process work of the automotive sensors and actuators [2], must be able to render of ideas for their structure and managing programs as well as to use the appropriate software to generate such programs according the level of their specialization [3].

These prerequisites are used as foundation for the building of the test bench for automated management of the automotive gasoline fuel injectors SAV-1. At same time the test-bench managing program is generated by the Flowcode 7 software [4], which performs the real work mode of the fuel injectors in the modern automobiles.

CONSTRUCTION

The building of the test bench SAV-1 consists of two stages.

The first stage consists in the selection of real elements for construction of the test bench. It may be described in the following sequence:

- ♦Selection of the gasoline fuel injectors;
- ♦Selection of the fuel accumulator (rail);
- ♦Selection of the fuel pump, fuel filter, fuel lines and fuel tank;
- ♦Selection of control devices;
- ♦Selection of metering gauges.

As a result of the first stage implementation is selected the layout of test bench SAV-1 for automated management of the automotive gasoline fuel injectors, which is represented on the fig.1.

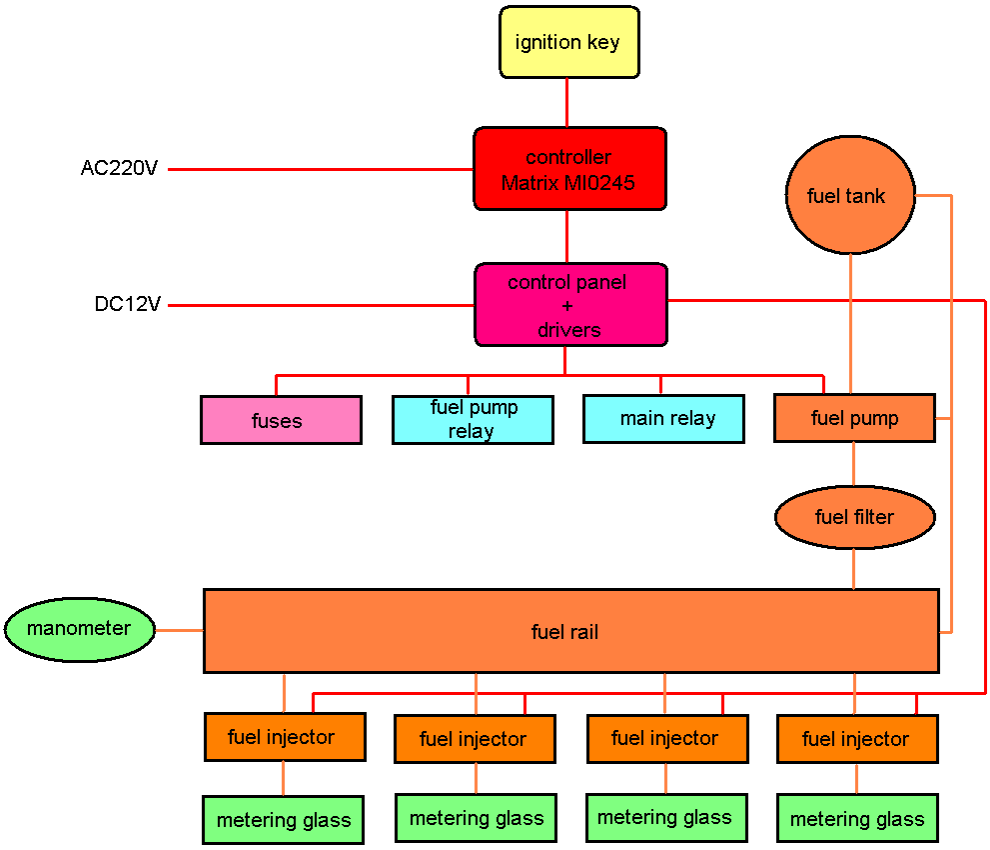

Figure 1. Layout of the test bench SAV-1 for automated management of the automotive gasoline fuel injectors

The test bench components are real automotive elements and additional components, which are involved in the corresponding layout.

The test bench control devices are:

1) Controller MI0245 [5];
2) Control panel with drivers;
3) Ignition key.

With the controller MI0245 and corresponding Flowcode 7 software is performed the program generation, program compile and record in the controller memory and program implementation with aim to managing the test bench injectors work mode.

The necessity of the control panel rises because of the electric connections concerns. The power transistors (drivers) are used to direct operating of fuel injectors and by this way the

controller drivers are relieved. The control panel is designed with the special collaboration of the Olimex Ltd - Plovdiv [6]. The ignition key implements the work of the test bench as well as at the real automobile.

As the metering gauges is selected a manometer for measuring the fuel rail pressure with range 0…6 bar and metering glasses with volume 100 ml, 1ml/division accuracy class B for the measuring of the injected fuel quantity by each injector. The data obtained by these gauges is to be used to analyze the system and injectors state.

The second stage of constructing is connected with placing the selected components and their connecting, fixing and supporting. For this aim is worked metal plate and bar for fixing the test bench components.

The common view of the constructed test bench SAV-1 is represented on the fig.2.

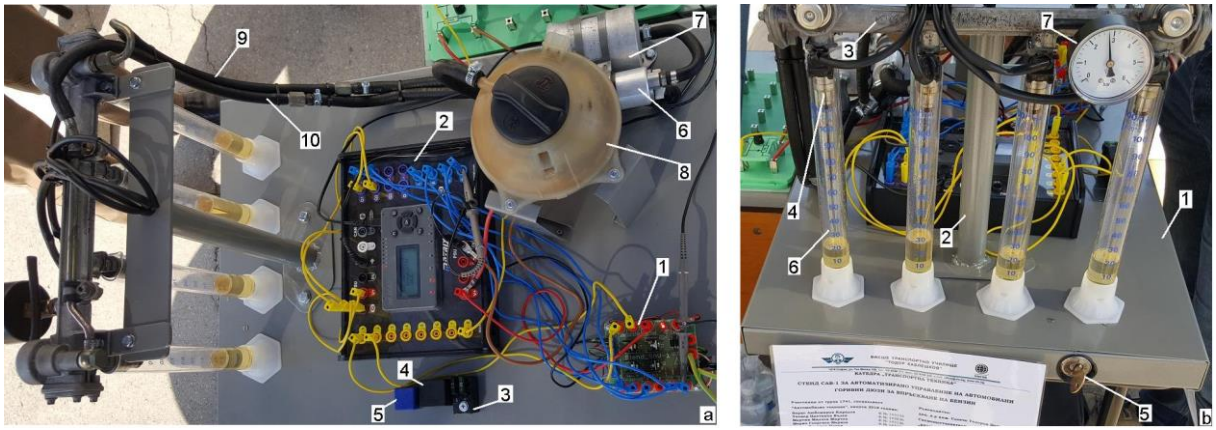

Figure 2. Common view of the test bench SAV-1 for automated management of the automotive gasoline fuel injectors:
a) 1-control panel; 2-controller MI0245; 3-fuses; 4-fuel pump relay; 5-main relay; 6-fuel pump; 7-fuel filter; 8-fuel tank; 9-pump line; 10-return line
b) 1-base plate; 2-fuel rail bar; 3-fuel rail; 4-fuel injector; 5-ignition key; 6-metering glass; 7-manometer

MANAGEMENT

The designing of the program for management of the test bench SAV-1 consists of four stages.

First stage of analyze consists of selection of certain process to be managed. By default it is the automotive ICE start, operation and stop processes. As object of management is selected the automotive fuel injection system of 4-cylinder gasoline ICE. During the system analyze are specified the sensors to be connected and components to be managed, as well as the links between them, which is part of test bench SAV-1:

1) Sensors – ignition key and potentiometer emulating the accelerator pedal;
2) Actuators – main relay (activating the injectors), fuel pump relay, fuel pump, fuel injectors;
3) Electronic Control Unit (ECU) – controller MI0245 and test bench control panel;
4) Work sequence – switching ON, start, idle, acceleration, switching OFF;
5) Switching conditions – switching ON the pump at the ignition key position ON, activating the injectors at the ignition key position START, switching OFF the test bench at the ignition key position OFF;
6) Time of injection, injection duration and injection sequence – according to the managing program, which can be designed and modified depending on work mode or designer interest;
7) Operation duration – according on the ignition key position, as well it is ensured switch OFF mode of the fuel pump and of the injectors;
8) Restricted work modes – at the ignition key position OFF;

9) Permissible work modes – at the ignition key position ON.

The second stage (stage of design) consists in generating of the managing program, which is connected with determining of the work modes macros, components parameters and functions and work state variables.

Work modes macros are:

1) Main macros (main program);
2) ON macros;
3) START macros;
4) IDLE macros;
5) ACCELERATION macros.

The structure of some typical macros is shown on the fig.3 and fig.4

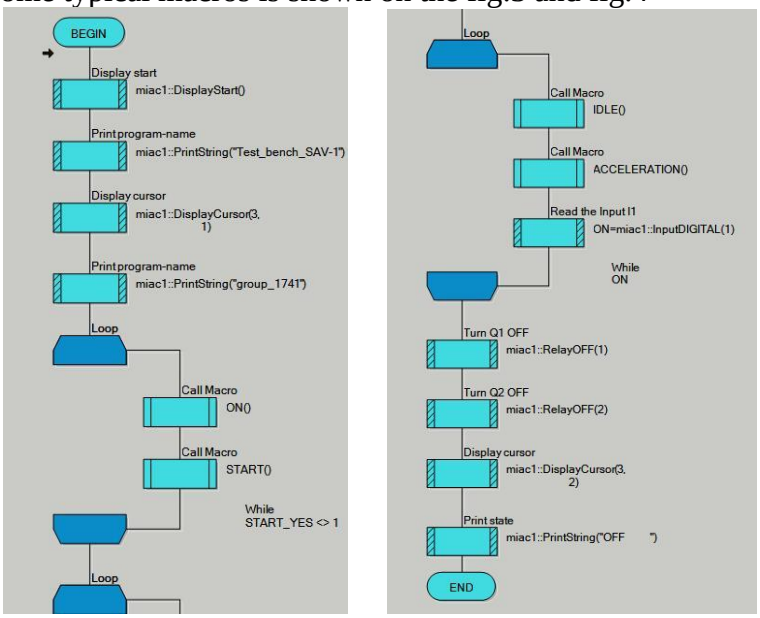

Figure 3. Main macros structure

The ON macros is realized by the turning the ignition key in position ON. Thus to the controller MI0245 input I1 is transmitted control signal, which permitting the activation of the fuel pump relay and the main relay, therefore the pump starts to operate and increasing the rail fuel pressure, and fuel injectors are in stand-by mode to be operated by the controller. This performs the real automotive ignition ON process, and can be pre-designed and modified.

When the ignition key is turned in position START, to the controller input I2 is transmitted control signal, which permit realization of the START macros. The macros is set up for managing of injectors with maximum fuel quantity, i.e. the injection duration is selected to be 50 ms, which performs approximately the engine start process. This loop is repeated 1 time, after that the START_YES=1 variable is generated, which is a condition for the IDLE macros implementation. This simulates the engine start.

The idle mode of the engine is performed by the IDLE macros. At this macros, the injection duration is decreasing 10 times in comparison with START macros. Meanwhile there is ensured possibility for switching OFF the fuel pump and the injectors by the pushing programmed buttons of the controller MI0245. This macros is repeated in constant loop till the transition to ACCELERATION macros or OFF state.

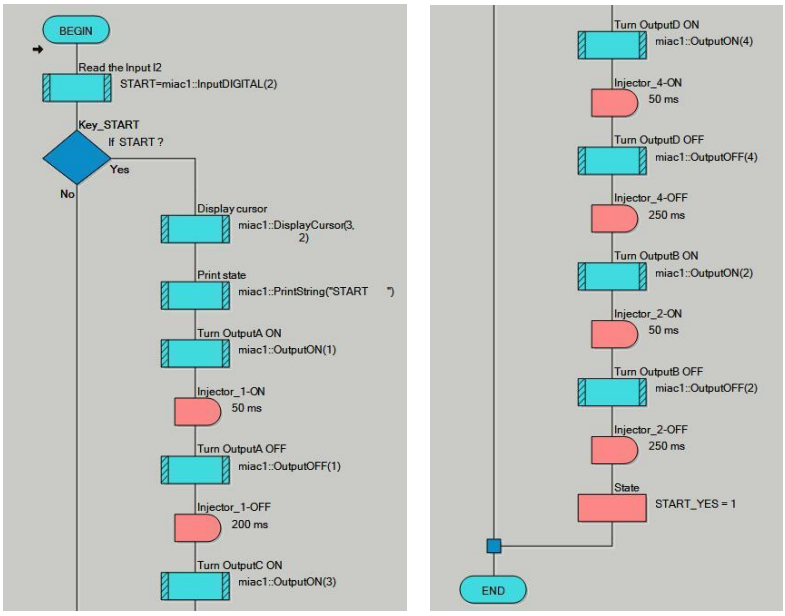

Figure 4. START macros structure

By the turning of the potentiometer, which is connected to the input I8 (or someone else in depending of the program) there is permission to ACCELERATION macros implementation. During this macro the injection duration becomes variable, which depends on the potentiometer voltage, transformed in the decimal number in the controller memory. This simulates the engine acceleration and deceleration.

After the design process the program chart compiles to the hex-file.

The third stage of performance consists of transferring the program as hex-fail and its implementation by the controller MI0245 and the control panel drivers.

The fourth stage of development continues with corrections input, parameters changes, implementations repeating and results analyzing.

CONCLUSION

It is constructed a test bench SAV-1 for automated management of the automotive gasoline fuel injectors, which has perspectives in students education and automotive processes researching.

It is designed and generated a managing program for initial management of test bench SAV-1, which can be use as successful foundation for the rendering the researchers skills and interests.

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СТЕНД CAB-1 ЗА АВТОМАТИЗИРАНО УПРАВЛЕНИЕ НА АВТОМОБИЛНИ ГОРИВНИ ДЮЗИ ЗА ВПРЪСКВАНЕ НА БЕНЗИН

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Ключови думи: *автомобили, горивни дюзи, стенд, управление*

Резюме: *Към съвременните автомобили продължават да се поставят нови и повишени изисквания за мощност и въртящ момент, горивна икономичност и екологична съвместимост. Определящ фактор в това направление е автомобилната горивна уредба, която се управлява от електронен блок за управление (ЕБУ). Електронното управление на ДВГ с принудително възпламеняване на горивната смес, както и на ДВГ със самовъзпламеняване се базира на сигналите от отделните сензори, програмираните данни и управляващите алгоритми. Крайният резултат от това електронно управление се свежда до управление на горивните дюзи. Управлението на горивните дюзи се състои в определянето на началото на впръскване, продължителността на впръскване, брой на впръскванията, ъгъл на изпреварване на впръскването и др. Изучаването на тези устройства и тяхното управление е основа за постигането на качествени резултати в обучението на специалистите по автомобилна техника, както и за получаването на научноизследователски резултати с оглед на тяхното развитие и усъвършенстване. Изследователският интерес на студентите се поражда и поддържа чрез отворени платформи и свободни възможности за израз и изпълнение. Голямо значение в тази постановка има реалното, живо и практично възпроизвеждане на процесите с помощта на стендове и съоръжения. Статията разглежда възможностите на стенд CAB-1 за автоматизирано управление на автомобилни горивни дюзи за впръскване на бензин с помощта на контролен модул Matrix MIAC MI0245 и програмен продукт Flowcode 7.*