

ELECTRONIC CONTROL SYSTEMS FOR AUTOMOTIVES AND ELECTRIC VEHICLES

Mirzakarimov Rustambek Xusanboy o'g'li

Assistant at Andijan State Technical Institute

E-mail: rustamkarimov1995095@gmail.com

tel: +99 (894) 389 63 68

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Annotation. An electric vehicle is a type of transport that uses electricity as an energy source and is driven by a traction electric motor.

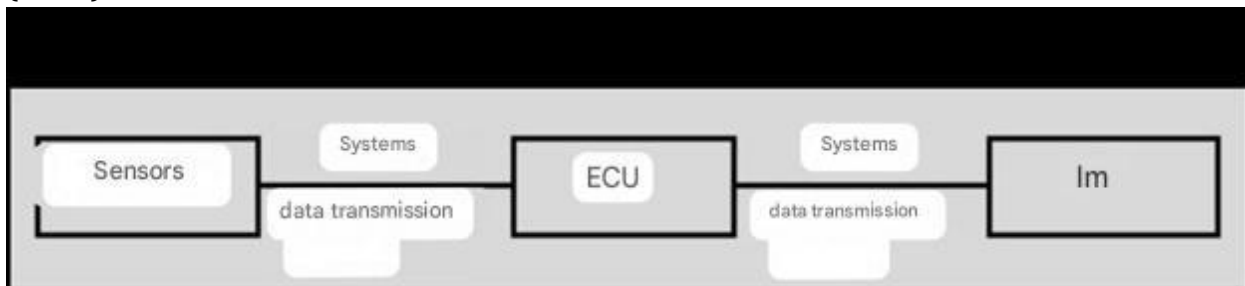
The energy that drives a vehicle can be obtained from several sources, including: from on-board batteries and chemical energy of accumulators (electric vehicles, electric buses, etc.);

An electric vehicle is a vehicle that is driven by one or more electric motors that are not powered by an internal combustion engine, but by an independent source of electrical energy (batteries, fuel cells, capacitors, etc.).

Keywords: electric car, battery, batteries, BYD automobile company, hybrid car.

A modern car and electric vehicle is a vehicle that can automatically adapt to the environment and operating conditions. To do this, electronic control units control the operation of the traction battery, electric motors, steering, braking system, chassis, transmission units, comfort and safety systems.

General scheme of the electronic control system. The basis of the design of a modern car and electric vehicle is the electronic control system. It includes four main units: input signals - sensors (temperature sensor, electric motor shaft speed sensor, etc.), data transmission systems (wires), electronic control units, actuators (AM)) (windshield wiper) (Pic. 1).



Pic. 1. Electronic vehicle control system.

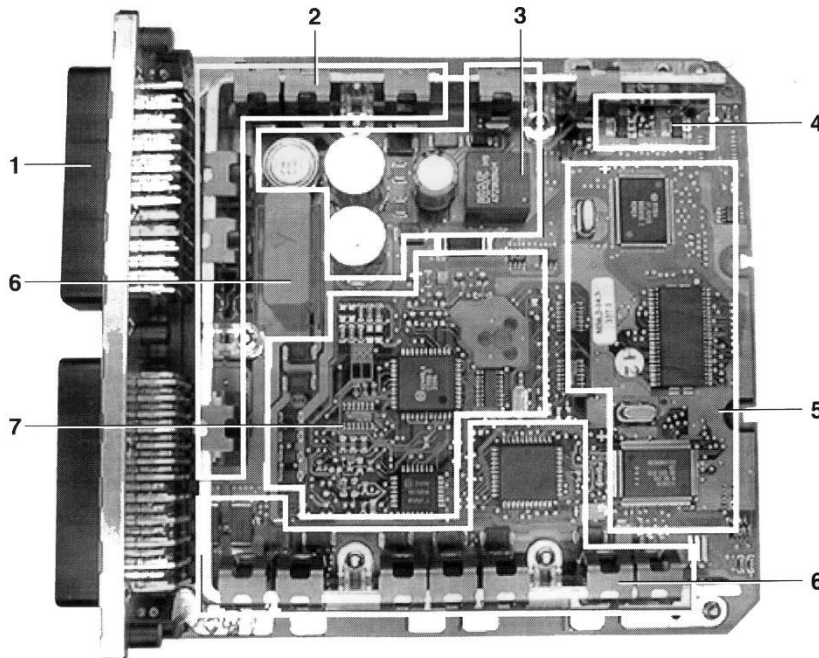
The electronic control unit, also known as the controller, is the most complex device in engine control systems or individual vehicle systems, coordinating their operation. It receives information from many sensors, processes it using special algorithms and, based on the information received, gives commands to the system actuators. The core of the unit is the central processor or microcontroller.

Information exchange is carried out through the control unit (CAN), which unites all electronic and digital systems of a modern car into a single network.

In a simplified form, the operation of the control system can be represented as follows using the example of the operation of the engine control system. Suppose the ambient temperature is low. The temperature sensor sends information about the low temperature to

the information transmission system (ECU-engine control unit). The information is processed in the ECU and sends the necessary command to the injector that injects fuel. In this case, the opening time of the injector needle lasts longer than usual, which leads to an increase in fuel supply. As the engine warms up, the injector opening time decreases, which leads to a decrease in fuel supply.

ECU (2-rasm) metall korpusga joylashtirilgan va ko'p pinli ulagich 1 orqali datchiklar, aktuatorlar va quvvat manbaiga ulangan.



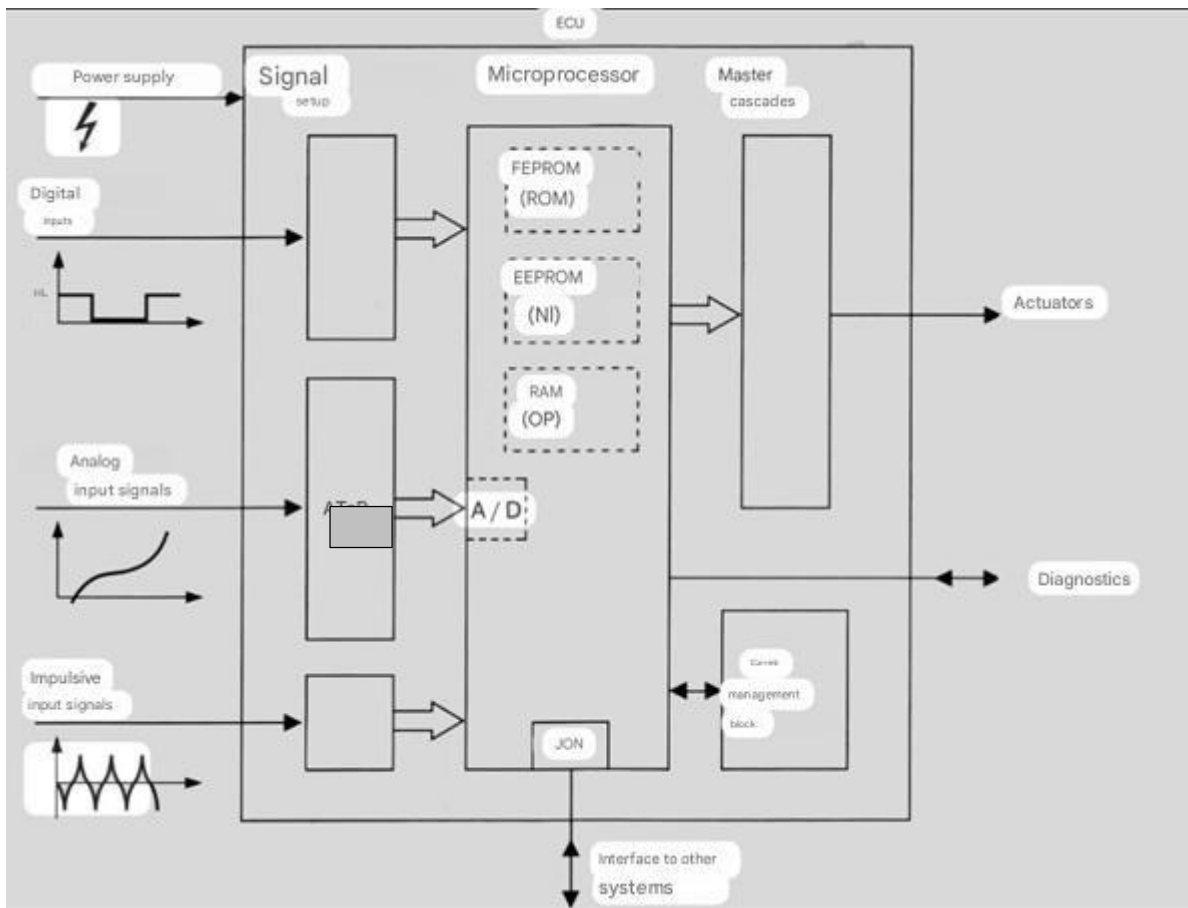
Pic. 2. Electronic control unit

1 - connector; 2 - low-power drive stages 3 - switching power supply (SMPS); 4 - CAN interface (data block interface); 5 - microprocessor memory block; 6 - high-power main cascades; 7 - input and output circuits.

The components of the electronic system for direct control of the actuators are placed in the ECU housing in a way that ensures good heat dissipation to the environment. Most ECU components are manufactured using SMD technology (surface-mounted device - surface-mounted boards). Traditional wiring is used only in some batteries and connectors.

The control unit consists of several main parts.

The input circuit receives electrical signals from sensors or generators within the expected range of values. The ECU receives electrical signals from the sensors through the vehicle's wiring and connectors. These signals can be analog, digital, and pulsed (Pic. 3).



Pic. 3. Control unit diagram:

H - high level; L - low level; FEPROM - programmable memory (read-only memory); EEPROM - read-only memory (RM); RAM - random access memory (RAM); A / D - ADC; CAN - data block.

Digital input signals. These input signals have only two states - "high" and "low". Examples of digital input signals are digital sensor signals such as on/off signals or Hall sensor pulses. Such signals are processed directly by the microprocessor.

Analog input signals. Analog input signals accept voltage values within a specified range. Analog data transmission is the most common method of exchanging information between a sensor and a control unit. The information is transmitted using the amplitude of the signal. An analog-to-digital converter (ADC) in the ECU microprocessor converts these values into digital signals, which the microprocessor then performs calculations.

One type of analog signal is a rapidly changing voltage signal, called a pulse input signal. The pulse input signals from the inductive sensors, which contain information about the speed of rotation and the position of the shaft (in terms of sign), are processed in the ECU in its own circuit. Here, false pulses are suppressed and the pulse signals are converted into digital square wave signals.

The microprocessor receives the data (bytes), processes it, and determines the output signal, for example, the appropriate duration of fuel injection. Using the received data, the microprocessor sends back a byte of information confirming its receipt.

Signal generation. The ECU uses protection circuits to limit the voltage of the input signals to the maximum permissible value. Using filtering devices, the superimposed noise signals are often separated from the useful signals, and if necessary, amplified to the level of the received ECU input signal.

Signal formation in sensors can be full or partial, depending on their level of integration.

Signal processing. The ECU is the control center of the system and is responsible for the sequence of functional operations. Control functions with and without feedback are implemented in the microprocessor. Input signals generated by sensors, generators with expected parameter values, and interfaces to other systems serve as input coordinates. They are additionally checked for accuracy on the computer. Input signals are processed by special shapers or converted into digital form by input analog-to-digital converters (ADCs). After the control signals with the required parameters (frequency, duty cycle, duration, etc.) are formed, they are sent to output switches (drivers), which provide current amplification and direct control of various actuators (injectors, relays, solenoids, electromagnetic devices).

The output signals are calculated using programs, characteristics and programmable matrices. The microprocessor is synchronized by a quartz oscillator. The output switches are made on the basis of powerful transistors of the p-p-p transition structure, in most cases these are composite Darlington transistors, and direct control of various actuators (injectors, relays, solenoids, etc.) is carried out by switching the output switch to the open state to activate a specific component included in the collector circuits of the output switches (this control method is sometimes called "ground switching").

Programmable (rewritable memory). To operate, a microprocessor requires a program stored in programmable memory (read-only memory - ROM or EPROM / EPROM).

This memory is intended for reading only. It also contains special data (individual data, characteristic and programmable matrices, values of correction factors and data necessary for the processor to calculate the duration of the injector control pulses, ignition timing, etc.). This is data that cannot be changed during the process. Rewritable memory is non-volatile, i.e. all data entered into it is stored until the power supply is turned off.

Data that should not be lost (for example, immobilizer codes and fault code information) should be permanently stored in read-only memory (EEPROM). In this case, even if the battery is disconnected, the data in the permanent memory will not be lost.

This is the main element of the system, which contains the firmware of the control module. If necessary, this module can be reconfigured, that is, reprogrammed, which can lead to an increase in the power and dynamics of the car or create an environmentally friendly and economical operating mode.

Random access memory (RAM) is required to store volatile data, such as digital values of signals. This module contains basic information about recently detected errors by the electronic system in the operation of various components. For proper operation, RAM requires constant power supply. When the ignition or start button is turned off, the ECU turns off and therefore loses all memory (the so-called "evaporative" memory). The "adaptive values" of the quantities, i.e. values that are "learned" by the system during operation and are associated with the engine operating modes, must be restored when the ECU is turned on.

Current control unit. The ECU is equipped with a monitoring circuit built into a specialized integrated circuit (ASIC - Application Specific Integrated Circuit). ASICs are equipped with expanded RAM (additional RAM) and can generate and transmit advanced input and output blocks and pulse width modulation signals. The microprocessor and the

monitoring unit monitor each other, and after detecting a malfunction, one of them can turn off the fuel supply independently of the other.

The output circuit converts the information byte into a signal that is compatible with the actuator. Once the information byte is converted into analog signals, the actuator is activated.

The microprocessor uses the output signals to activate the main stages. The actuator output signals are usually strong enough to directly control the relays. The process stages are protected against short circuits to ground or battery, as well as against electrical overloads. Such operational disturbances, such as circuit breaks or sensor malfunctions, are detected by the main stage controller and this information is transmitted to the microprocessor. The output signals can be switching and pulse width modulation signals.

Switching signals are used to turn actuators on and off, for example, an electric fan for an engine cooling system.

Pulse Width Modulation (PWM) signals. Digital output signals can be in the form of pulse width modulation signals. These are rectangular signals with a constant period, but with a time-varying waveform (Figure 4), which can be used to actuate electromagnetic drives, for example, an exhaust gas recirculation valve.

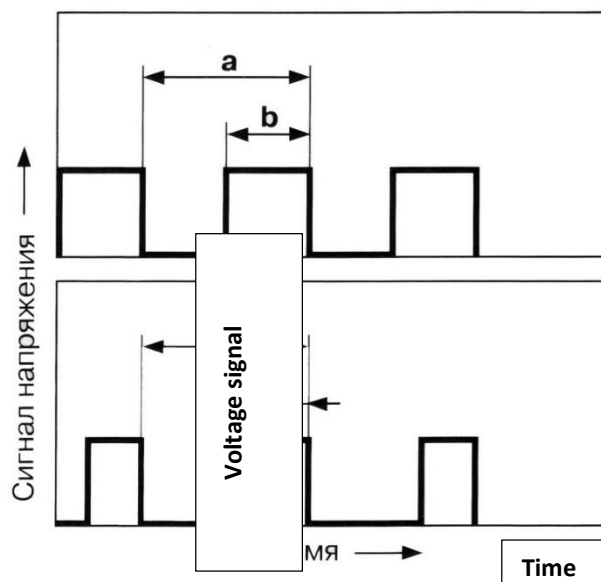


Fig. 4. Pulse width modulation signals. a - constant period; b - signal duration

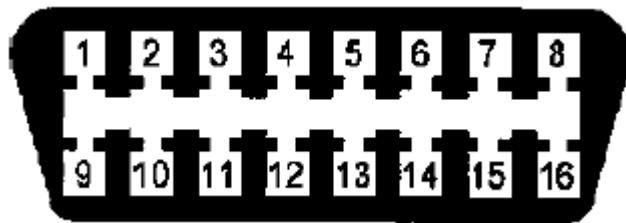
Built-in diagnostics. One of the important functions performed by the control unit is continuous self-diagnosis of the input and output circuits of the components, as well as some functions of the internal state of the system. In modern control units, the implementation of self-diagnosis functions accounts for 50% of the microcomputer resources. If there are any malfunctions in any circuit (for example, the absence or non-compliance of the specified signal level of any sensor), the microcomputer writes a digital code corresponding to this error to a special area of memory; to obtain information about this, depending on the nature of the malfunction, the code must be "read" from the computer memory.

ECU o'zining barcha tarkibiy qismlarining xizmat ko'rsatish imkoniyatini doimiy ravishda kuzatib boradi, ammo xato, uning axborot qiymatiga qo'shimcha ravishda, holat bayrog'ini olib yuradi, ya'ni xatolar statik (joriy) va tasodifiy (sporadik, to'plangan) bo'lishi mumkin.

The ECU constantly monitors the serviceability of all its components, but the error, in

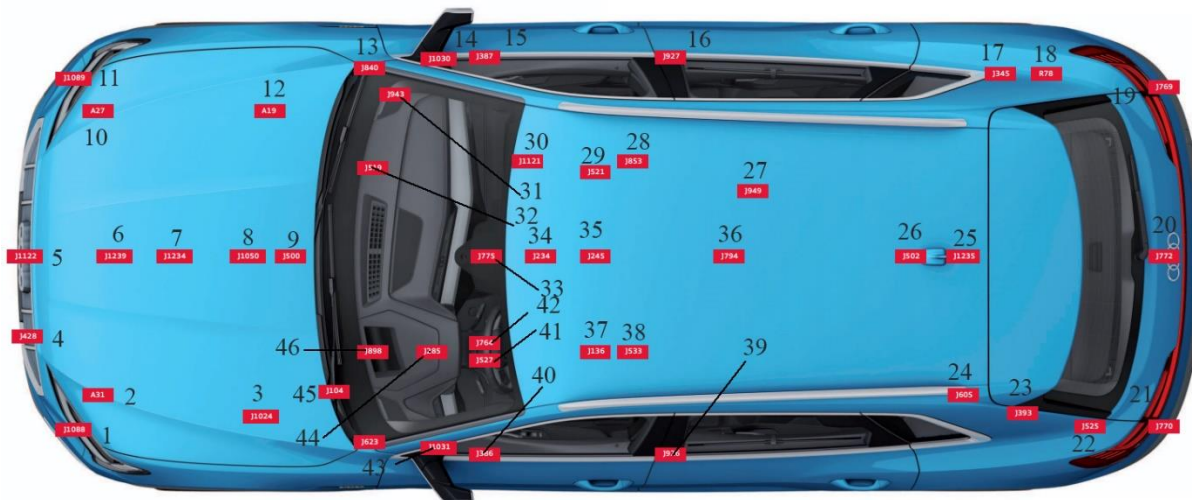
addition to its information value, carries a status flag, that is, errors can be static (current) and random (sporadic, accumulated). One of the important functions performed by the control unit is constant self-diagnosis of the input and output circuits of these components, as well as some functions of the internal state of the system. In modern control units, the implementation of self-diagnosis functions accounts for 50% of the microcomputer resources. If there are malfunctions in any circuit (for example, the absence or mismatch of the specified signal level of any sensor), the microcomputer writes a digital code corresponding to this error to a special area of memory; to obtain information about this, depending on the nature of the malfunction, the code must be "read" from the computer memory.

The ECU constantly monitors the serviceability of all its components, but the error, in addition to its information value, carries a status flag, i.e. errors can be static (current) and random (sporadic, accumulated). Reading data from complex software is carried out through the diagnostic connector using a special device - a scanner, which, in fact, replaces the central control unit. The monitored parameters and fault codes are read directly from the electronic control unit through the diagnostic connector (Fig. 5), and the codes are not only read, but also decrypted.



Pic 5. Standard diagnostic connector.

A modern car and electric vehicle can have dozens of ECUs (Pic. 6).



Pic. 6. ECU layout in a modern electric car.

1 - front left ECU with radar sensor for object detection; 2 - left LED headlight ECU; 3 - temperature control ECU; 4 - active cruise control ECU; 5 - laser range measurement ECU; 6 - high-voltage battery charging control unit 2; 7 - front axle electric drive control unit; 8 - high-voltage battery charging control unit; 9 - Power steering control unit; 10 - right LED headlight output module 1; 11 - front right radar sensor control unit for object detection; 12 - voltage converter control unit; 13 - battery regulation control unit; 14 - exterior mirror control unit 1; 15 - front passenger door control unit; 16 - passenger side rear door control unit; 17 - trailer detector control unit; 18 - TV tuner; 19 - lane change additional control unit; 20 - rear view

camera control unit; 21 – lane change additional control unit 2; 22 – digital audio system control unit; 23 – comfort system central control unit; 24 – tailgate control unit; 25 – rear axle powertrain control unit; 26 – tire pressure monitoring system control unit; 27 – Emergency call module control unit and connections; 28 – night vision system control unit; 29 – front passenger seat adjustment control unit with memory; 30 – driver assistance systems control unit; 31 – engine sound generator control unit; 32 – on-board network control unit; 33 – battery regulation control unit; 34 – airbag control unit; 35 – sunroof adjustment control unit; 36 – BU 1 electronic information system; 37 – seat and steering rack memory adjustment control unit; 38 – tire diagnostic data interface; 39 – driver's side rear door control unit; 40 – driver's door control unit; 41 – steering column control unit; 42 – electronic steering column lock control unit; 43 – exterior mirror control unit 2; 44 – information panel cluster control unit; 45 – ABS control unit; 46 – head-up display control unit.

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