Universal Device for Measuring and Determination of Parameters of Passive and Active Radio Electronic Elements and Code Signals ALSC

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Abstract: The development of a measuring device that has many functions and simultaneously performs different tasks leads to a reduction in precious time, allows the continuity of research, energy saving in application, efficiency in solving, ready-made dead reckoning results and other useful actions. The differences between such devices from others are that they are reprogrammable, allowing improvement in the applied directions and industry. Such universal devices are used in specialized branches of technology, which require testing and finding inoperative assemblies of elements and devices. Modernization of the transistor tester according to the program and schematic methods made it possible to determine the units of measurement and pinout of active and passive elements, measure the DC voltage, the frequency of conventional signals and pulse-width modulation signals, supply pulse signals, check and determine contactlessly about the state of the railway auto-blocking sections by automatic locomotive signaling (ALS), i.e. code signals ALS block of railway track sections. Sometimes, incorrect connection of the device to the measured objects will damage this device. To eliminate or protect such actions in advance, elements and protection circuits are installed against short circuits, high currents, and over-limit voltages. In such cases, the device goes over to quick self-defense.

Keywords:measuring device, transistor tester, microcontroller, incremental encoder, socket, pin, automatic shutdown control, speed in measurement, recognition, in-circuit programming port, voltmeter, frequency meter, pulse-width modulation signal generator, universal measuring device UMD-1, automatic locomotive signaling, automatic locomotive signaling of point action, automatic locomotive signaling of continuous operation, receving coils, filter, amplifier, impulse relay, decoder, electropnevmatic valve, locomotive traffic ligh, locomotive speed meter, vigilance handle, electromotive force, account blok, compliance block, code fixing block, speed control relay, vigilance block, code signal.

INTRODUCTION

For the design and assembly of electronic elements, as well as the repair of electronic devices, many measuring instruments and reference books (datasheet) are often required. In the past century, experts in the electronics industry have refined measuring instruments using semiconductor elements to improve measurement results. For example, a transistor tester has been developed to measure semiconductor elements. Today, transistor testers measure not only semiconductor radioelectronic elements, but also passive and various types of combined elements, such as all kinds of sensors and others. In addition, in practice, digital multimeters are widely used, consisting of sets of measuring units of voltage, DC and AC current, capacitance of capacitors, resistance of resistors, measurement of frequency and ambient temperature. Compared to a multimeter with a transistor tester, the multimeter does not have a pinout definition for electronic elements, does not recognize the type of combined elements and some parameters of electronic elements, and there is also a deviation in the measurement. Therefore, a modern transistor tester has a great advantage over the use of multimeters.

The widely used transistor tester in the final version based on the AVR microcontroller is a project and ideas of specialists Markus Frejek and Karl-Heinz Kubbeler, who called the devices "AVR-Transistor tester and a minimum of additional elements" [1]. The latest version of the transistor tester based on the ATmega microcontroller families such as ATmega8, ATmega168, ATmega328, ATmega644, ATmega1284, ATmega1280 and ATmega2560 creates an extension of the ability to measure, identify and recognize electronic and combined elements, as well as other useful ideas [2].

MATERIALS AND METHODS

According to the project of Markus Frejek, Markus Frejek, the transistor tester is assembled on the basis of the ATmega8 microcontroller. The disadvantages of this circuit are high current consumption, low calculation speed for a specific task, there is no protection against interference from the power supply, there is no signaling about the state of charge of the battery if the battery is connected to the circuit (Figure 1).

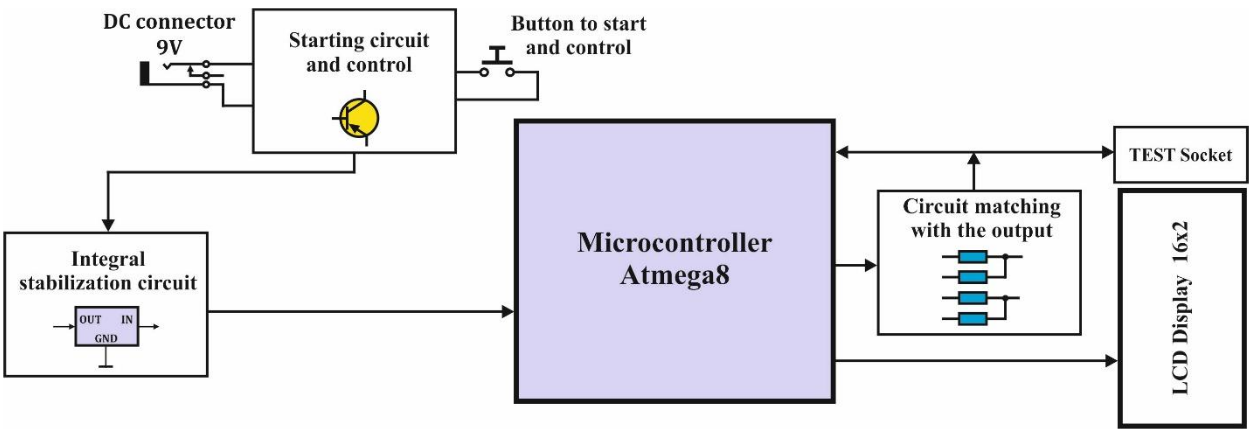

Figure 1. Block diagram of the transistor tester "AVR-Transistor tester" Markus Frejek Markus Frejek

In the modified circuit, the transistor of the "LCR-T4 Nostripgrid" type tester consists of the following electrical circuits to solve the above disadvantages: electrical circuit for monitoring automatic shutdown; RC anti-interference circuit; "Battery low" signaling circuit; integral stabilization circuit; button for starting and controlling; chain matching with the output; increasing the speed of measurement, detection and recognition of electronic elements, in-circuit programming port (in-system programming - ISP) (Figure 2) [3, 4, 5, 6, 7, 8, 9, 10, 11].

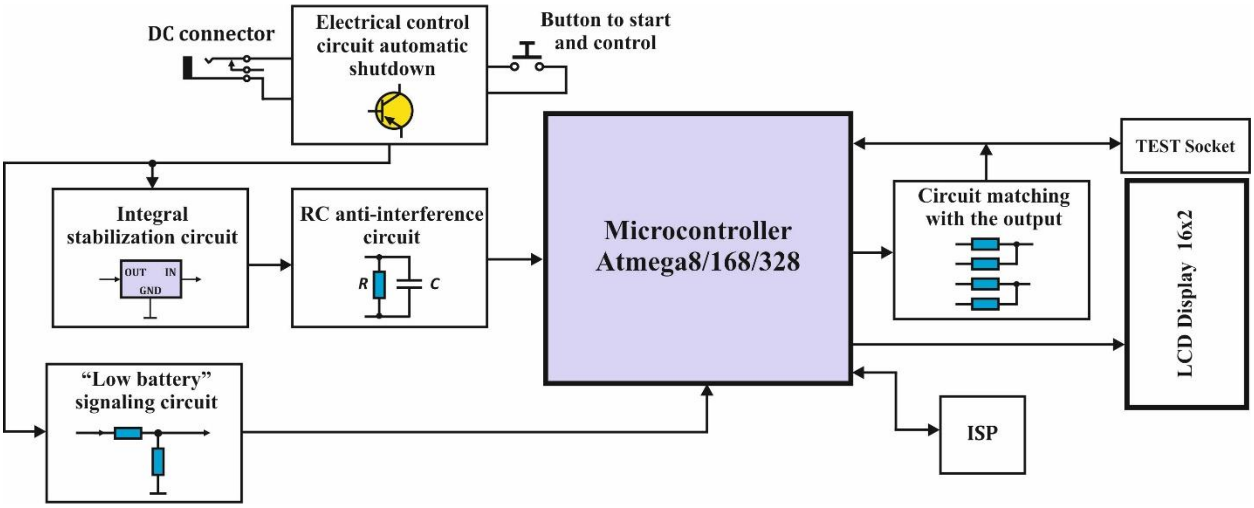

Figure 2. Structural diagram of the transistor tester type "LCR-T4 Nostripgrid"

During continuous use of the tester, the device consumes unnecessary power consumption. This is observed by the enabled states of the tester when the device is not being used. It is possible to solve this problem in the microcontroller circuit by applying a low power mode after the test is completed, and simply wake it up from sleep mode again at the next test using the start and control button. There is also a problem here that the voltage regulator continues to work, even the microcontroller is in sleep mode, and does not consume so little power, for example, in this mode, the integral stabilization circuit requires about 3 mA. This will drain the battery after one week. To solve this problem, an automatic shutdown control electrical circuit is connected to the integral stabilization circuit before the 9 V voltage is applied. With this circuit in the mode, the current consumption is ~ 10 nA (0.01 μA or 0.00001 mA). The circuit allows, goes into standby mode within 10 seconds. You can change the response time of the mode by changing the value of the resistance of the resistor, which is connected to the base and emitter of the transistor. In this way or in a circuit way, the problem of excess power consumption of the device is solved [3, 4, 5, 6, 7, 8, 9, 10, 11].

The automatic shutdown circuit is susceptible to electromagnetic interference and as a result the tester will start in an unauthorized manner. To solve this disadvantage, an RC noise protection circuit is connected in the circuit. If a battery is connected to the transistor for the tester, then the control of the power supply of the circuit is required, and in order to display too low voltage ("Battery discharged") on the LCD monitor, the signaling circuit "Battery discharged" is connected to the common circuit. To ensure a stable power supply to the device, namely the microcontroller and the LCD monitor, an integral stabilization circuit is connected.

In the transistor tester of the "LCR-T4 Nostripgrid" type using the ATMEGA328p microcontroller, the measurement speed is increased when determining and recognizing electronic elements, and the device has the ability to reprogram via the ISP port [3, 4, 5, 6, 7, 8, 9, 10, 11].

To continue expanding the capabilities of the "LCR-T4 Nostripgrid" type transistor tester, the following circuit solutions have been developed (Figure 3): a circuit using a rotary incremental encoder for fast and smooth control of the device menu; circuit for measuring direct current up to 100 V (voltmeter); circuit for measuring frequency 1 Hz ÷ 8 MHz (frequency meter); pulse-width modulation signal generator; universal socket for connecting various types of radio-electronic elements; microcontroller protection circuit for high currents and voltage based on SRV05-4 element; battery power supply with charging devices. Taking into account the above, a universal measuring device of the UMD-1 type has been developed, which performs not only the measurement and determination of the parameters of passive and active radioelectronic elements, but also the use as a DC voltmeter up to 100 V, a frequency meter of signals up to 8 MHz.Most in technical branches, according to the control system, it is required to measure only these denominations of units, including control systems of automation and telemechanics in railway transport [3, 4, 5, 6, 7, 8, 9, 10, 11].

RESULTS

Let's take a closer look at the diagram of a universal device of the “UMD-1” type (Figure 4). To install an element of a rotary incremental encoder, the outputs of the encoder contacts SW-4 and SW-5 are connected to the bases of transistors Q1 and Q2, earlier the transistor tester model used a conventional button to control the automatic shutdown and control the instrument menu. In order not to press the button each time to switch the menu type selection, the encoder contacts DT-1 and CLK-3 are connected to the pin's of the microcontroller PD1 (pin No.31) and PD3 (pin No. 1) through resistors R5 and R6, as well as to these contacts of the encoder through the resistors R3 and R4 are connected to the power supply circuit of the integral stabilization output.

In the design of the device of two socket's connectors, one of them is made as a universal socket. This is a “TFXTOOL” socket. The socket connector has an input pins 1, 2, 3 for radio electronic elements, in addition to this, a voltmeter-1, a frequency meter-3 and a common ground COM-2 are connected to the contacts. Thus, the universal socket for connecting radio electronic elements of the DIP, DPAK type is fixed in the socket of the “TFXTOOL” type, and for the radio electronic elements of the SOT23, SOT223, TO220, TO252, TO263 types, it is fixed in the socket of the SMD type.

The pulse-width modulation signal generator is received through the socket 2 and COM-2 connectors. To measure DC voltage up to 100 V and use it as a voltmeter, the cords are connected to socket’s connectors of the “TFXTOOL” type, outputs Voltmeter-1 and COM-2. To measure the frequency and use the device as a frequency meter within 1 Hz ÷ 8 MHz, the cords are connected to the outputs of the Frequency Meter-3 and COM-2 socket.

To create a circuit for the voltmeter input, a resistor trim R24 is connected to the circuit, the middle leg of the resistor is connected to the pin of the ADC6 microcontroller (pin No.19), and the other leg of the resistor to the minus, the third leg is connected to the “TFXTOOL” type socket volmeter-1 ... For the frequency meter, resistors R25, R26 are connected in series, one end of this circuit is connected to the plus (5 V supply), and the other to the minus, the midpoint of the serial connection of the elements is connected to the RC circuit, the capacitor C13 and the resistor R26, as well as the midpoint between the serial connections resistors are connected to the pin of the PD4 microcontroller (pin No.2).

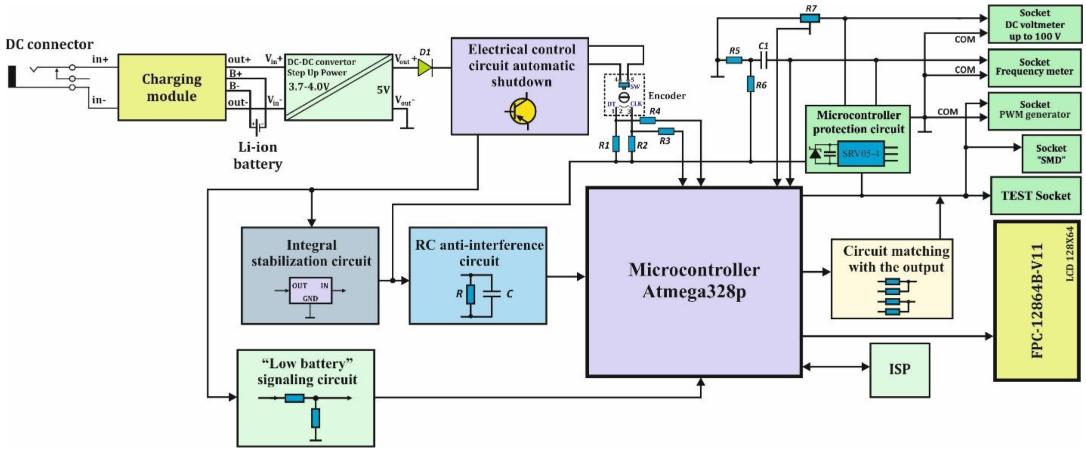

Figure 3. Block diagram of a universal device of the "UMD-1" type

Erroneous connection of a charged capacitor or connection of a DC power supply of more than 100 V through connectors (socket) of the "TFXTOOL" or SMD type according to the ordinal pins of pins is one of the reasons for the failure of the microcontroller. To avoid these errors or to ensure the safety of the microcontroller, a circuit for protecting the microcontroller from high currents and voltages is installed based on the SRV05-4 element.

As mentioned above, continuous use of a universal device leads to the consumption of the device more current than needed. To solve this problem, the device has a device standby mode. In addition, the circuit uses battery power with charging devices and a voltage converter, which consists of a charge controller module, a 3.7 V, 1200 mA lithium-ion battery, a DC-DC converter that converts 3.7 V voltage to a stable 5 V and diode D1 for current limiting and short-circuit protection.

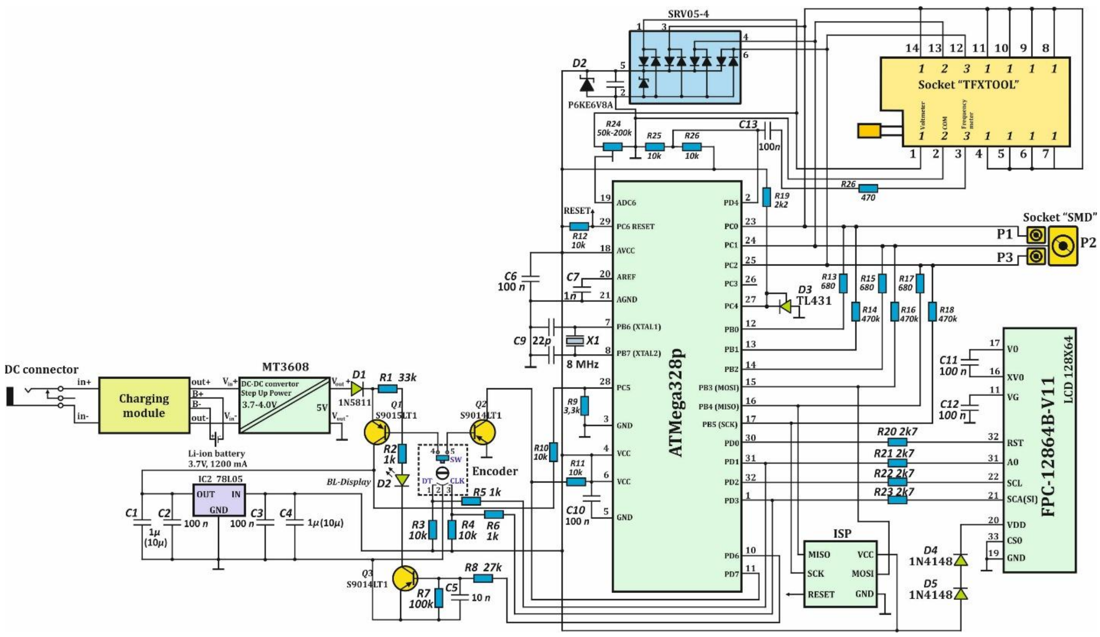

Figure 4. Schematic diagram of a universal device of the "UMD-1" type

Let us consider the use of a universal device of the “UMD-1” type in an automatic blocking system in railway transport. To ensure high throughput, traffic safety on trunk lines, as well as to increase productivity and improve working conditions for railway workers, automation and telemechanics are used. These include a set of devices for interval train control: automatic blocking (AB), automatic locomotive signaling (ALS), automatic speed control (ASC), automatic brake control system (ABCS), frequency dispatch control (FDS) [5]. ALS is an alarm system on rail transport that transmits signal readings to the control room of the rolling stock (for example, to the cabin of a locomotive, multiple-unit train, railcar, etc.). The ALS system includes floor transmitting devices, receiving and decrypting devices on the rolling stock, as well as devices that match ALS with other signaling and blocking components, indicators, sensors and actuators on the rolling stock [11, 12, 13, 14].

ALS devices transmit information from the track to the locomotive. Depending on the method of information transmission, all ALS systems are divided into automatic locomotive signaling of point action (ALSP) and automatic locomotive signaling of continuous operation (ALSC) systems. According to the principle of operation, point systems ALS are, in turn, subdivided into mechanical, optical, contact, induction. Induction systems can be with a source on the track and a source on the locomotive, which in turn are divided into systems with a source of direct current and alternating current. Continuous ALS systems are electrocontact, inductive, radio relay and radar. In addition, a distinction is made between low-frequency and high-frequency ALSC inductive systems. Today in Uzbekistan, in addition to those listed above, the ALSP system is used only within the boundaries of railway stations, and ALSC of the railway line sections. The main part along the length of the railway is the section. Therefore, the study was carried out in the main sections of the railway tracks [11, 12, 13, 14].

ALSC systems are divided into low-frequency, operating with signal frequency currents in the range of 25-2000 Hz, and high-frequency, in which the signal currents occupy a spectrum above 30 kHz. In systems using the low-frequency range, rail filaments are used as communication lines, through which signal currents are passed, which form a magnetic field around the rails. Receiving coils are installed on the locomotive in front of the first wheelset, in which an electromotive force is induced when the magnetic field generated by the signal current changes. To transmit information to the locomotive, the signal current is sent to the rails in pulses of different duration and sequence - codes. Each code corresponds to a certain indication of the floor signal to which the locomotive is approaching [11, 12, 13, 14].

Other options for transmitting continuous information to the locomotive are also possible: by continuous current of constant frequency; cyclically interrupted current of a certain frequency; alternating transmission of currents of two different frequencies; cyclically interrupted current of different frequencies. Currently, a version of a cyclically interrupted current of a certain frequency has been developed and is being applied. The cycles of the interrupted are set by a special encoder - a code transmitter. Continuous high-frequency ALSC systems transmit information to the locomotive at frequencies above 30 kHz. The use of rail lines in this range is impossible due to the large signal attenuation, therefore, special cable lines are laid between the rails along the sleepers - loops through which high-frequency signal currents pass. The magnetic field generated around the line wires crosses special receiving coils on ferrite cores fixed to the locomotive. The signal taken from the receiving coils is amplified and fed to the decryption device and to the actuators. Information enters the communication line - a loop from the encoder. Most often, a binary code is used, in which "1" corresponds to one frequency, and "0" - another. Information is transmitted by a telegram-combination of zeros and ones [11, 12, 13, 14].

The disadvantages of high-frequency ALSC systems are the easy damage of the cable loop during the repair of the railway track, changing sleepers and rails, welding rails, etc. The loop emits electromagnetic energy and therefore interferes with communication lines. Loop attenuation depends on the thickness of the insulation and the quality of the dielectric. Damage to the insulation leads to an increase in attenuation, and the snow covering the plume in winter increases it significantly. The most widely used systems are ALSC with the use as a communication channel of rail lines fed by a code signal current of a low-frequency range [11, 12, 13, 14].

The safety of train traffic requires unconditional execution of orders by drivers, which are transmitted by signals of track traffic lights. In order for the driver to easily and accurately in any conditions (on curved sections of the track, in fog, heavy rain, snowfall, etc.) perceive signals from track traffic lights, devices are used for continuous transmission of signals from the track to the locomotive traffic light located in driver's cab. These devices are called ALS and are always in addition to auto-locking. ALS devices at stations, as a rule, equip main and partly side tracks, if they provide for non-stop train passage [11, 12, 13, 14].

The signals given by locomotive traffic lights when approaching a track traffic light (checkpoint, entrance, etc.) have the following meanings: green light – movement is allowed (at the track traffic light, which is approaching a train, a green light is on); yellow light - traffic is allowed (one or two yellow lights are on at the road traffic light, which is approaching a train); yellow light with red - traffic is allowed to stop readily (a red light is on at the track traffic light, to which the train is approaching); a white light indicates that the locomotive devices are on, signals from the path to the locomotive are not transmitted [11, 12, 13, 14].

To transmit signals from track traffic lights to the locomotive traffic light of a moving train, automatic locomotive signaling devices of continuous type use rail auto-blocking circuits. Current pulses are sent towards the train along the track circuits, forming code combinations of a numeric code, the same as used in a code automatic blocking. The combinations are received by the locomotive devices and converted into the corresponding locomotive traffic light signals. Automatic locomotive signaling should be complemented by a hitchhiking system with devices for checking the driver's vigilance and controlling the speed of the train. The driver's vigilance is checked when the train approaches a closed traffic light, starting from the moment the green light changes to yellow at the locomotive traffic light, when the driver is required to confirm vigilance once by pressing the vigilance handle. Further, when driving with a yellow light (when a certain speed is exceeded), as well as with a yellow light with red and red lights at a locomotive traffic light, a periodic check of the driver's vigilance comes into effect by pressing the vigilance handle after 30-40 s. In all cases, if the vigilance handle is not pressed in time, the train automatically stops by hitchhiking in front of a closed traffic light [11, 12, 13, 14].

The complex of means of automatic locomotive signaling can be used as an independent means of interval control of train movement. A characteristic feature of such a system is that the movement of trains is carried out only by the signals of locomotive traffic lights, that is, ALS signals are the main means of regulating traffic on the tracks. The haul, as in the case of auto-blocking, is divided into block sections (physical or electrical) and locomotive traffic lights signal to the driver that the block sections in front are free or busy. The use of two ALS systems is envisaged: the main (frequency) one, which is a multivalued ALS system, which transmits the necessary amount of information to the locomotive, and the reserve one - ALS of a numeric code. The reception of trains to the station and departure from the station is carried out according to the signals of the input and output traffic lights, respectively. In this case, the signals of track traffic lights are transmitted to the locomotive cabin by locomotive signaling devices in the same way as with automatic blocking. Signals from the track to the locomotive are also transmitted along the rails. To increase traffic safety, there is also a periodic vigilance check and speed control in case of a yellow light with a red and red light of a locomotive traffic light [11, 12, 13, 14].

All devices that make up ALSC can be divided into track (transmitting) and locomotive (receiving). The travel devices are located in a relay cabinet located near the track traffic light. The track devices (Figure 5) include a coded track transmitter and a transformer. The transmitter is used to convert the signal indication of the road traffic light into the corresponding combination of the number of pulse code, that is, the indication of the road traffic light into the corresponding combination of the number-pulse code, that is, the transmitter periodically sends an alternating current electrical signal (code) to the rail circuit with a certain number of pulses and the pause duration between pulses and pulse trains [14].

The frequency of the code current in sections with autonomous traction or with direct current electric traction is 50 Hz, and in sections with alternating current electric traction - 25 Hz or 75 Hz [14].

ALS locomotive devices (Figure 5) include receving coils (RC), filter filter (F), locomotive amplifier (A) with impulse relay (IR), decoder (D), electropnevmatic valve for hitchhiking (EPV), locomotive traffic light (LTL), locomotive speed meter (LSM), vigilance handle (VH), white light button instead of red (button instead of red - BIR) and also a toggle switch for changing the time interval for periodic checks of the driver's vigilance [15].

With ALS track devices, the code current flows down one of the rail lines towards the locomotive, closes through its first wheel pair and returns to the power source along the second rail line. The flow of alternating current pulses in the rails is accompanied by the formation of an alternating magnetic field around the rails, in which the locomotive receiving coils move, which are suspended in front of the first wheelset on each side by two. The mounting height of the take-up coils above the level of the rail head is 100 - 180 mm. The magnetic field lines, crossing the RC loops, induce in them a variable electromotive force (EF), the value of which depends on the value of the code current in the rails and the height of the coils. So, at a height RC above the level of the rail head of 150 mm and a code current in the rails of 10 A, the value of EF is approximately 0.65 - 0.75 V. To add EF of both coils, they are connected in series. The minimum code current that can be perceived by the receiving coils for different types of traction and type of current is from 1.2 A to 2.0 A [15].

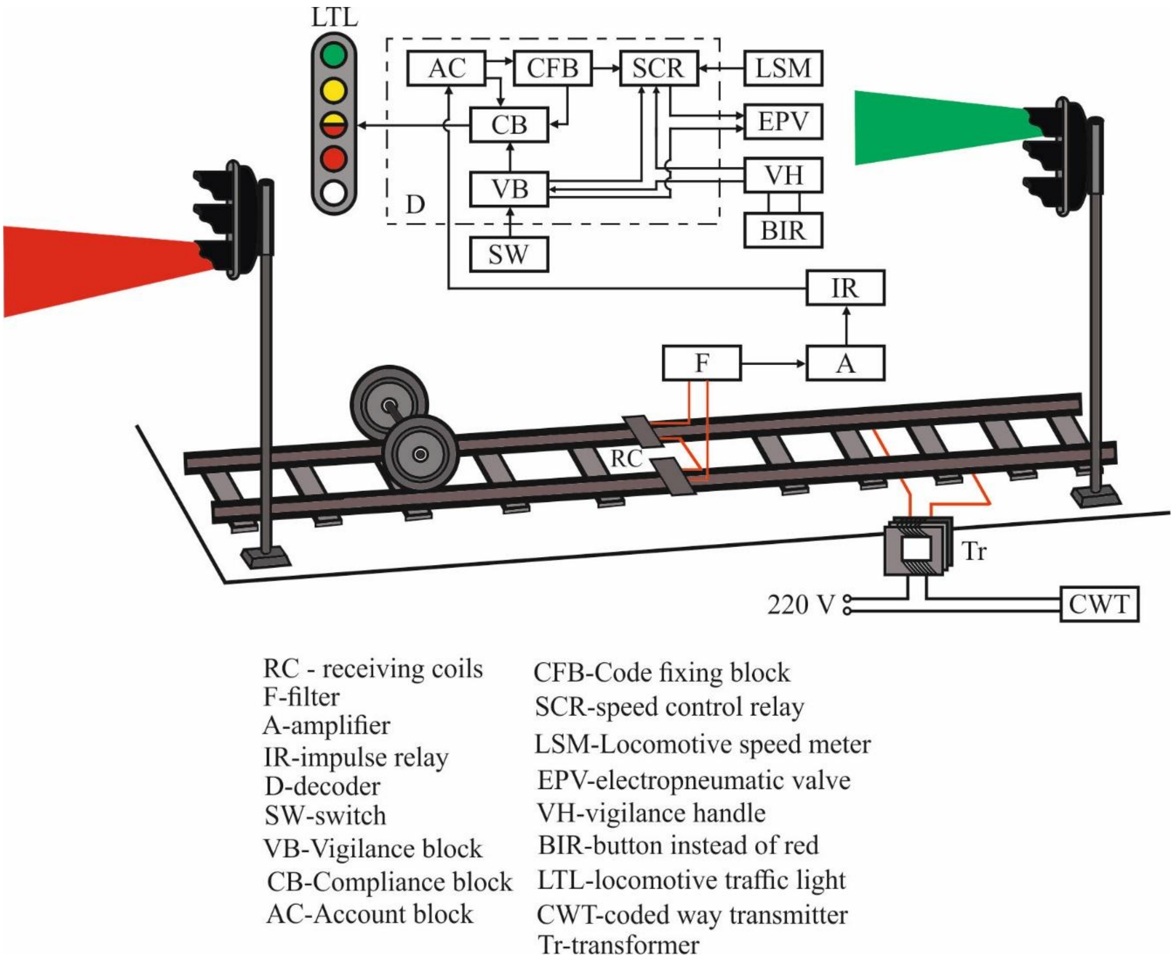

Figure 5. Block diagram of ALSC [11, 12, 13, 14, 15]

Induced into the receiving coil EF through F, enters A. The filter is tuned to the frequency of the code current and does not pass currents of other frequencies into the amplifier, and the amplifier amplifies the code signal to the voltage used in the locomotive control circuits. The amplifier also converts the AC code pulses into DC pulses. The IR included at the amplifier output is a code repeater, sending it to the decoder as an encrypted signal reading [15].

The decoder contains a number of relays, which are combined into several blocks. The account blok (AcB) - includes relay-counters that provide counting of the number of pulses and the intervals between them coming from the code path. Code fixing block (CFB) - includes signal relays of green "G", yellow "Y", red-yellow "RY" color, which create the corresponding power circuits of the signal lamps of the locomotive traffic light. The compliance block (CB) - provides control (comparison, compliance) of the code received from the path and the state of the CFB signaling relays. The correspondence unit periodically after 5 - 6 s connects the signal relays to the relay-counters so that the required light comes on at the locomotive traffic light. Thus, the change of the lights of the locomotive traffic light occurs with a delay of 5 - 6 s. This time corresponds to the reception of three series of code pulses.

A locomotive traffic light duplicating the indications of track traffic lights has the following signal indications [15]:

- green light "G" (a green light is on at the road traffic light, which is approaching a train);
- yellow light "Y" (yellow light at the traffic light);
- yellow light with a red "RY" (red light at the traffic light);
- red light "R" - signal prohibiting movement; appears after passing a road traffic light with a red light;
- white light "W" - indications of track lights are not transmitted to the locomotive.

The red and white lights of a locomotive traffic light correspond to the absence of an electrical signal in the track circuit, as well as continuous current or current pulses supplied at short intervals.

Speed control unit - contains the speed control relay (SCR), which interacts with the locomotive speed meter. Thus, forced braking of the train is made dependent not only on the signal reading, but also on the speed of the train. Vigilance block (VB) - monitors the driver's vigilance. When the light of a locomotive traffic light changes, for example, from green to yellow, the electric power circuit of the EPV coil is interrupted and a sound signal appears, which sounds for 7 - 8 s. Before the expiration of this time, the driver must press RB and thereby restore the power circuit of the EPV coil and stop the sound of the whistle. In the absence of the above actions on the part of the driver, the EPV will perform emergency braking. Thus, RB serves to confirm the driver's vigilance and prevent forced emergency braking caused by EPV [15].

When the locomotive enters an uncoded section of the track, the code presence relay is de-energized in the decoder block CB, which provides a white light at the locomotive traffic light after a green or yellow light and a red light after "RY". At the same time, it is possible, using the VK button, to light a white light instead of a red one at a locomotive traffic light. The toggle switch has two positions - "ALS" and "without ALS". Switching the toggle switch from one position to another changes the time interval for periodic checks of the driver's vigilance.

The ALSC circuit is connected with the locomotive control circuits - when the hitchhiking is turned off, it is impossible to set the locomotive in motion, and when the EPV is triggered for emergency braking, the traction mode is automatically disabled.

Thus, the joint operation of ALSC track and locomotive devices provides [15]:

- continuous transmission to the locomotive traffic light of the indications of the track traffic lights, which are approaching the train;
- a single check of the driver's vigilance when changing the lights of a locomotive traffic light;
- periodic check of the driver's vigilance when following a locomotive traffic light with "K" and a speed of <20 km / s, "RY" or "W" lights; "Y" fire and movement speed over VY, adjusted on the speedometer;
- the ability to change the time interval for periodically checking the duration of the driver when following the sections not equipped with ALSC track devices;
- control of the speed of movement at "RY" and "R" lights of the locomotive traffic light;

- impossibility of turning on the traction when the ALSC devices with hitchhiking are turned off;
- automatic shutdown of the traction mode when the hitchhiking EPK is triggered for emergency braking;
- the ability to turn on a white light instead of a red one at a locomotive traffic light.

In the ALSC system, information transmitted from the track to the locomotive is represented in the form of a specific sequence of alternating current pulses and intervals. The duration of the impulses and the intervals between them are different for different readings of the track traffic lights, which the train is approaching. To transmit several signal readings to the locomotive, a numeric code is used, which is used in the numeric code blocking system. Locomotive signaling codes are repetitive combinations of current pulses. Continuously following series of such pulses are called coded or coded current. ALSC codes differ in the number of pulses per cycle and are therefore called numeric. Three pulses correspond to the green fire, separated from the three pulses of the next cycle by a long interval; yellow - two impulses; yellow with red - one impulse. Red fire corresponds to the absence of alternating current in the rail circuit [15, 16].

Three different combinations of pulses and intervals (codes) are used, which are generated by the transmitter. Structurally, the transmitter is made in the form of an electric motor, on the shaft of which three code washers are installed, which close the contacts of the code current circuit in a certain sequence. Depending on the readings of the track light, the signal relay switches the track circuit to the contacts of one or another code track transmitter. Figure 6 shows all three codes generated by the transmitter, and shows the duration (in seconds) of the pulses and the intervals between them. The duration of a complete cycle (complete revolution of the transmitter shaft) is 1.6 s [16].

When the train follows the green light (code "G") of the track light, the locomotive will receive three pulses per cycle and there will be three intervals between them, during which the pulses will not be received. At the beginning of the cycle, AC pulses are received for 0.35 s, then 0.12 s pulses are not received (interval), then AC pulses are received again for 0.22 s, then again an interval during which no pulses are received, then the pulses arrive for 0.22 s at the end of the cycle there are no pulses for 0.57 s [16].

The yellow light (code "Y") of the locomotive traffic light (the train following the yellow light of the road traffic light) corresponds to two pulses with a duration of 0.38 s with an interval of 0.12 s between them and an interval of 0.72 s after the second pulse.

The red and yellow light (code "RY") of a locomotive traffic light (a train following the red light of a track light) consists of two impulses with a duration of 0.23 s and two intervals between them with a duration of 0.57 s [16].

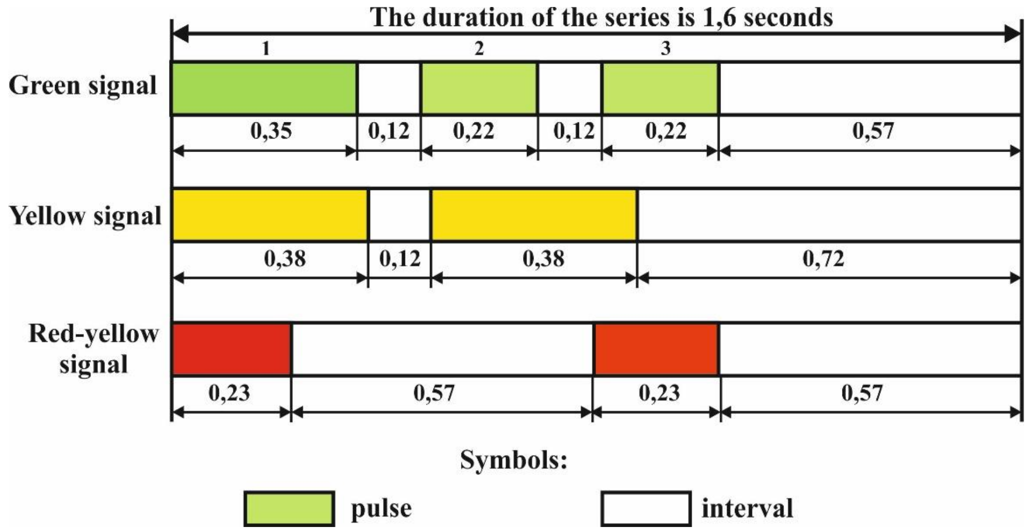

Figure 6. Scheme of ALSC codes [16]

After the installation of track devices of the automation and telemechanics system on new railway tracks and for the repair of existing devices, including in ALS systems, block sections are tested. To this day, different measurement methods have been used to define ALS codes. One of the methods for determining the ALS signal codes in the rail is carried out using an analog tester of the Ts-4317 type. Determination of ALS signals using an analog tester of the Ts-4317 type is performed in the following way, by switching the tester to the position, a voltmeter and connecting the tester cords to the rail, the movement of the arrow is observed, if the arrow slowly moves twice to the aisle of the measurement scale and returns to its original state, then it is considered that the received code is "RY", if the arrow moves abruptly twice and returns to its original state is a code signal "Y", and also if the arrow moves abruptly three times and returns to its original state, then the signal code is considered "G". This corresponds to the interval of the signal codes ALSC, where it is shown in Figure 6. The disadvantages of this method are sometimes false triggering of the analog tester (the digital tester is not able to determine the signal codes from the rail circuit), rupture of the track circuit on railway sections of the electric traction (circuit of the choke transformer break) lead to the appearance of a false or incomprehensible interval of the code signal and this creates problems when using the measuring device.

To eliminate the aforementioned disadvantages, a set of devices for determining the type of signal ALSC has been developed for determining the code signals (Figure 7). To create the ALSC code signals, the classical scheme is used, which shows a simplified view of the circuit in Figure 7, i.e. part of the system part of an ALS system. The ALS system consists mainly of the following devices: choke transformer, coding scheme, coded path transmitter, code transformer, transmitter relay T. type of signal ALSC consists of the following elements: receiving coil, filter filter, amplifier, universal device of the “UMD-1” type.

For testing new railway tracks or checking existing ones for the correctness of the supply of code signals, ALSC can be used as an analogue or the main device of the device to determine the code signals a set of devices for determining the type of signal. Signals from the rail circuit are received from the receiving coil. The received code signals in the form of

EF are received by the filter filter. The filter filter passes the signal by highlighting one of the ALSC codes. The filter circuitry is also tuned by definition from the distorted signal to the natural look of the code signal. If in some way the filter filter does not recognize one of the ALSC code signals, the distorted signal is not passed through. The amplifier amplifier amplifies the code signal and is transmitted through the terminals along the circuit to the "UMD-1" device.

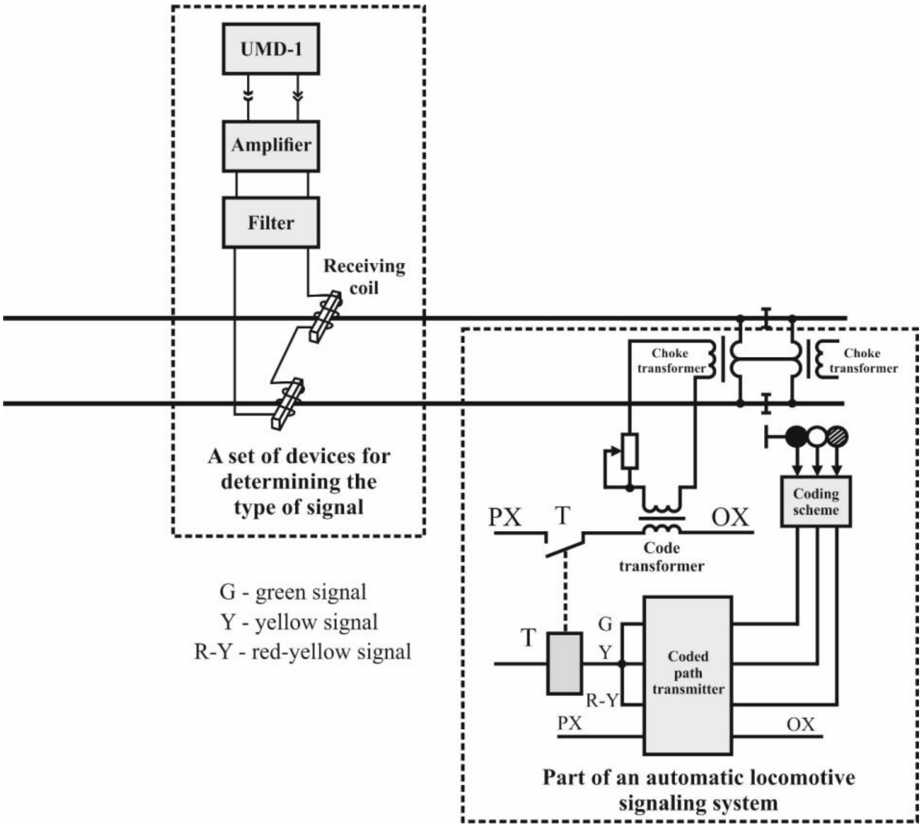

Figure 7. Schematic diagram of the use of a universal device of the "UMD-1" type with additional devices for determining the ALSC codes

The universal device "UMD-1" receives, reads the code signal and reflects it on the screen. This device reads the received signal several times (within 6-8 seconds), having processed it according to certain algorithms in order to make a reliable decision on determining the ALSC code signal. Therefore, the process of determining the type of signal is pre-programmed on the microcontroller.

CONCLUSIONS

Thus, the upgraded transistor tester (universal device "UMD-1") based on the ATmega328 microcontroller has the following capabilities, properties and advantages: control circuit for automatic shutdown, integral stabilization, pulse-width modulation signal generator, fast and smooth control of the device menu using incremental encoder, frequency measurement (within 1 Hz ÷ 8 MHz), microcontroller protection circuits for high currents and voltages, DC voltmeter up to 100 V, measurement and pinouts of active, passive and combined electronic elements, battery power supply with a charger and voltage converter, universal socket for connecting radio electronic elements such as DIP, DPAK, SMD cases. Based on the research, a set of devices for determining the type of signal ALSC has been developed, and this device is portable, easy to use, designed for use indoors and in open places of the railway track, and is also fixed on a light structure which is isolated from the rail.

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