LIMITED LIABILITY COMPANY
RESEARCH AND PRODUCTION ENTERPRISE «EKRA»

EKRASMS

software package

User's manual
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The *EKRASMS* software package is designed to monitor, configure and control IEDs of BE2704/ED7, BE2502/ED5 and BE2702(M) series, and integrate them into the Process Control System (PCS). The package supports all ever manufactured types and versions of the indicated series of IEDs.

EKRASMS software package is a distributed system designed for operation in a network. Nevertheless, it can be fully used on one computer as well.

EKRASMS operation requires a computer running *Microsoft Windows XP* and newer operating system.

In order to install *EKRASMS* on a computer, open *EKRASMS* installation file and follow the instructions of the installation wizard.

> When describing work with *EKRASMS* applications, in order to save paper, screenshots of windows are not provided. Therefore, it is recommended to run applications on a computer in parallel with the study.

CONTENTS

1 INTRODUCTION TO EKRASMS

1.1 APPLICATIONS AND SERVICES

The *EKRASMS* package consists of *applications* and *services*.

– An *application* is a program with which a user interacts through its user interface. You must be logged in to *Windows* to start the application;

– A *service* is a stand-alone program that does not have a user interface that starts automatically with the operating system and does not require logging in to *Windows*.

Services within *EKRASMS* are divided into two types:

– *User-type* – implement a certain part of the autonomous functions of the system, which the user has the ability to configure, maintain, and also enable and disable at will. For example, the function of automatically creating a backup copy of the event database may not be used at all within a particular computer, or it may be used with very specific operating parameters. User services are set up in the *Arsenal* application.

– *System-type* – implement system-wide mechanisms.

> Applications *Communication server*, *Data archiving server*, *Oscillogram server*, as well as all gateways to various PCS standards are fundamentally identical to *user services*, however, while they are implemented as *applications*, not *services*, therefore, in order to work with them, you must log in to *Windows*. These applications are not configured with *Arsenal*. Each of them has its own user interface for configuration.

User services fall into two categories:

– Services that provide some functionality to other services and applications, including over a network. Such services are commonly referred to as *server services*;

– Services that use functions provided by *server services*. Such services are commonly referred to as *client services*.

> This classification is introduced only in relation to *ERKASMS* system, because a service that is a client from the point of view of *EKRASMS* can simultaneously act as a server of some other system (for example, gateways of standard communication protocols) and vice versa.

1.2 SERVERS AND WORKSTATIONS

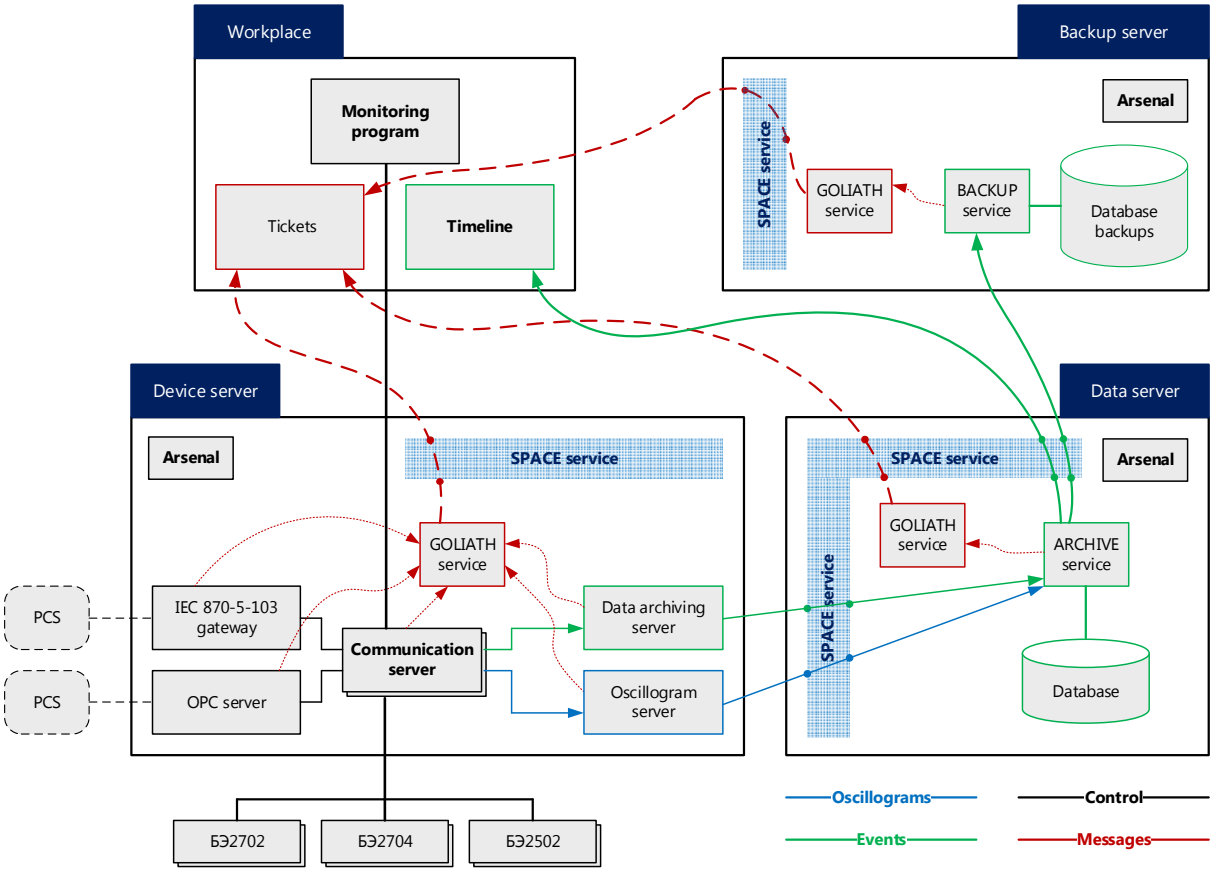
The *EKRASMS* package is a network one, i.e. system functions can be distributed across multiple computers in the network. There are typically two categories of computers: *Servers* and *Workstations*.

– *EKRASMS server* is a computer that, after preconfiguration, works autonomously and continuously. The server runs a certain set of *EKRASMS* services (as well as server applications), the composition of which determines its essence. It can be a device access server, a database server, etc. The server can also perform all the autonomous functions that are part of *EKRASMS*;

– *EKRASMS workstation* is a user's computer where *EKRASMS* applications are started. Depending on the job responsibilities of the user, these can be applications for monitoring IEDs, their maintenance or analysis of the information they collect.

The introduction of the concepts of *Server* and *Workstation* is very conditional and is done for the convenience of presentation. The *EKRASMS* package is always installed on each computer as a whole, so the computer can be used both as a *server* and as a *workstation* at the same time. However, it is recommended to use an industrial PC to act as a standalone server.

The figure shows a possible arrangement of *EKRASMS* with one device access server, one data storage server, one data backup server and one workstation.



2 ARSENAL. SERVICES CONTROL

> The *Arsenal* application makes changes to the operating system settings and, as a result, requires that it be **launched as the administrator**. Therefore, under *Windows Vista and above*, when the application is launched, the *Windows User Account Control (UAC)* window is displayed to confirm or elevate privileges. Under *Windows XP*, the application itself will check the privilege level of the actual user of the operating system and, if there are not enough privileges, will inform you about the need to launch it manually as the administrator.

2.1 FUNCTION

The *Arsenal* application is designed to control *EKRASMS* services.

> Applications *Communication server*, *Data archiving server*, *Oscillogram server*, as well as all gateways to various PCS standards are still implemented as *applications*, not *services*, so their own user interface is used to control them.

2.2 SERVICES PAGE

The *Services* page contains a list of user services. Each service has an *Start/Stop* button. In the stopped state, the service menu button is additionally available, which allows you configuring it, as well as performing other interactive actions related to it. The composition of this menu is different for each service and will be discussed in the sections of their description.

> After the initial installation of *EKRASMS*, in order to simplify work in the most typical use cases, some user services are automatically enabled. If you do not need the functions of these services, please disable them in *Arsenal*.

2.2.1 SENDING E-MAIL

Some *EKRASMS* services and server applications can send e-mail messages (for example, the *Goliath* service can send system notifications by e-mail). In order for them to be able to send messages, you need to configure the *EKRASMS* mail subsystem by clicking on the *Setup mail* button.

The *EKRASMS* mail subsystem can send mail either directly through a mail (SMTP) server or redirect it to be sent from another computer.

> Redirection is necessary when it is required to send messages **via a mail server located on the Internet**, **if the computer** from which the sending is performed **does not have Internet access**. Redirection allows you setting up the actual sending of e-mails **from another computer** in the local network **that has Internet access** and then use it as an intermediary.

2.2.1.1 SENDING VIA MAIL SERVER

To directly send e-mails to a mail server in the *Mail sending options* window, you must select the *Send mail from this computer* option.

The parameters to be configured are the same as those in any mail program and their values depend on the mail server you have selected.

> If a **corporate mail server** is used, the required settings can be obtained **from the administrator of this server**; if a **public server on the Internet** (Yandex, Google, etc.) – **on the corresponding site** in the Help section.

2.2.1.2 E-MAIL REDIRECTION

To send e-mails via redirection, in the *Mail sending options* window, select the *Redirect mail to another computer* option. The parameters specify the address of the computer (for details, see paragraph 3.1.2), which will act as an intermediary in sending mail, as well as the parameters for remote login (for details, see paragraph 2.3) to it.

To organize redirection **on the intermediary computer**, you need to install *EKRASMS*, configure the mail subsystem as described in paragraph 2.2.1.1, and start the *Fork* redirection server in *Arsenal*.

2.2.2 SERVICES LANGUAGE

Services require a language for generating user notifications, composing e-mails, and a number of other uses. It is set in the *Services language* drop-down list at the bottom of the application window.

> After the initial installation of *EKRASMS*, the language of services corresponds to the language of *Windows*. *EKRASMS* only supports **English** and **Russian**, so if *Windows* is running in any language other than **Russian**, *EKRASMS* will run in **English**. Subsequent updates to *EKRASMS* retain the selected language value.

2.3 ACCESS PAGE

Access to *server services* from *client services* over the network, as well as from *applications*, both over the network and within the same computer, requires user authorization. *EKRASMS* provides the ability to configure a list of users to control access to *server services* on the computer.

EKRASMS implements a group model. Users belonging to the same group have their own username and password, but common access rights to *server services*. Access rights to a particular service are discussed in their description sections.

The list of groups and users is the same for all *server services* (and communication server) and is configured on the *Access* page.

Local connections of *client services* and *applications* to *server services* are always possible, while client connections from other computers can be enabled or disabled. To do this, at the bottom of the *Access* page there is a *Remote access* control area.

> After the initial installation of *EKRASMS*, remote access is **denied**. With subsequent updates of *EKRASMS*, the state of remote access is preserved.

3 SERVICES

3.1 SYSTEM SERVICES

3.1.1 SATELLITE

It implements the mechanism of interprocess communications between *EKRASMS* services and applications. It is started automatically when needed. There is no explicit control of the service. It does not require settings.

3.1.2 SPACE

It implements a mechanism for remote access to a computer. The service is controlled in the *Remote access* area of the *Arsenal Access* page.

This is the only *EKRASMS* service that opens a TCP port for listening. The default port value is **11111**. We recommend that you leave this value unchanged.

> When configuring client applications and services, you must enter the IP address or network name of the server in the *Address* field, depending on how your particular network functions. If the *EKRASMS* remote access port on this server is different from the standard one (**11111**), then after the address you need to put the symbol ":" (colon) and add the number of the non-standard port. For example: **192.168.1.1:12000** or **ivanov_ii:11500**

3.2 GOLIATH. DELIVERY OF SYSTEM MESSAGES

3.2.1 FUNCTION

The services do not have their own user interface and run without loading the *Windows* desktop, so when they have any events that need to be reported to the user, they send *EKRASMS* system messages. The mechanism for sending system messages is always available to any service and does not require any actions on the part of the user to activate and configure it.

The *Goliath* service gives the user the ability to receive messages sent by other services in two ways:

– Sending them to specified addresses as e-mails (access to the mail server is required on the server computer);

– Acting as an access server to them (including over the network) for the *Tickets* application, which displays them on the user's desktop.

> The *Goliath* service is only required to **deliver** messages sent by other services to the user. Sending and storing messages is not related to *Goliath*. Therefore, by temporarily stopping the *Goliath* service, you will **not lose** messages that will be sent during its period of inactivity. The exception is the disabling of the *Goliath* service for 3 days or more, because during this time, messages that users have not yet received may expire.

3.2.2 MENU

Item	Description
Mailing list[1)]	Configuring a list of mailing addresses for sending messages by mail

1) – As this is the only menu item, it is executed immediately after pressing the service menu button.

3.2.3 SENDING MESSAGES BY MAIL

> To send messages by e-mail, you must configure the mechanism for sending mail (see paragraph 2.2.1).

When the service is running, all addresses on the mailing list begin receiving e-mail containing the messages sent by the services.

> To avoid spamming target mailboxes, the *Goliath* service pauses between sending e-mails. Therefore, one letter can contain several messages at once.

3.2.4 TICKETS. DISPLAYING MESSAGES ON DESKTOP

The *Tickets* application allows you to collect messages from multiple *EKRASMS servers* at once by connecting to the *Goliath* service on those computers.

Once started, the *Tickets* application is located in the *Windows Taskbar*.

> If necessary, in the application settings, you can enable/disable automatic launch when the user logs into *Windows*.

The application icon menu in the taskbar consists of the following items:

Item	Description
Show	Display the main window of the application
Settings	Setting the notification method for received messages and enabling/disabling the automatic start of the application
Quit	Shutdown of the application

The main *Tickets* window consists of two parts. The list of servers from which messages are being collected is located on the left side, and the messages received from the selected server are displayed on the right side.

The first in the list of servers is *This computer*, which cannot be deleted, but can only be disabled if messages from the services of the local computer are not of interest (for example, if your computer is a *workplace* and no *server services* are running on it).

To add a collection of messages from another server, you must click the *Add* button under the list of servers.

> To connect to the *Goliath* service on another computer, you must provide a username and password. The user must be registered with *Arsenal* on the target computer and be a member of a group that has the ***Read messages*** right in the *Goliath* section.

Each server in the list has a menu button consisting of the following items:

Item	Description
Clear	Clearing the list of received notifications
Disable/Enable notifications	Denying and allowing notifications about new messages from this server
Disable/Enable[1)]	Disabling and enabling the collection of messages from the local computer
Edit[2)]	Editing server login options
Remove[2)]	Removing a server from the list

1) – only for *This computer*
2) – for all servers except *This computer*

3.3 ARCHIVE. ACCESS TO EVENT DATABASE

3.3.1 FUNCTION

The *Archive* service is the *EKRASMS* event database server. Through it, services and applications can add events to the database and read them from it.

It is possible to implement various scenarios for collecting events:

– Each *Device access server* maintains its own local event database. This option is good because the ability to collect does not depend on the state of the local network of the enterprise, because all work takes place within one computer.

– All device access servers send events to a single database on a dedicated computer. This is convenient for subsequent analysis of the collected data, but in case of problems in the local network of the enterprise, the collection of events may be interrupted, which can lead to the loss of events due to the overflow of recorders in the IEDs.

– A mixed scenario is also possible.

3.3.2 MENU

Item	Description
Save database to file	Saving the database as a file (*.archive)
Restore database from file	Restoring a database from a database file (*.archive). The actual database is deleted in this case
Remove old events	Removing events older than some (optional) point in time from the database
Clear database	Clearing the entire database
Import database from file	Import of events from a database saved in an *archive or *.dbbackup file to the actual database
Import oscillograms from Oscillogramm server	Import of oscillograms from the folder (and all subfolders) where they are collected by the *Oscillogram server* into the actual database
Import oscillograms from folder	Import of oscillograms from a user-specified folder (and all subfolders) into the actual database
Actions on old database[1)]	Allows you performing the following operations with the old database: - Import data into the actual database and delete the old database from the disk; - Save old database to *dbbackup file and delete old database from disk - Remove old database from disk

1) - The item is available only if the database of EKRASMS 2.13 (or older) is found on the disk

3.4 BACKUP. BACKING UP EVENT DATABASE

3.4.1 FUNCTION

The *Backup* service allows you to back up *EKRASMS* event databases. It periodically connects to the *Archive* service of the backed up computer and synchronizes the actual state of the database with its backup. It is possible to back up the database of both your own computer and other computers on the network.

> To connect to the *Archive* service from another computer, you must provide a username and password. The user must be registered with *Arsenal* on the target computer and belong to a group that has the ***Read events*** right in the *Archive* section.

The *Backup* service allows you to simultaneously back up multiple databases from different computers in the network. You can also run this service on multiple computers to make multiple backups of the same database.

> If during the next synchronization session it is detected that the database on the computer being backed up has been changed by clearing, removing outdated events, or restoring from a file, the *Backup* service saves the actual state of its backup as a file (*.archive) in the *archive directory*, deletes the backup and restarts synchronization.

3.4.2 MENU

Item	Description
Setup	Setting a list of servers the databases of which should be backed up
Manage	Deleting and saving backups as a file (*.archive)
Archives	Opening the *Explorer* application window in the archive folder

3.5 FORK. REDIRECTION

3.5.1 FUNCTION

The *Fork* service acts as a server for redirecting the execution of tasks. Redirection is needed mainly in cases where the task requires Internet access, which is not available on the computer that must complete the task. At the same time, the required access is on some other computer in the local network. With *Fork*, you can delegate the execution of a task to a computer that, under specific conditions, can successfully complete it.

> Currently, only sending e-mail can be redirected (see paragraph 2.2.1)

The *Fork* service does not require setting.

> To connect to the *Fork* service on another computer, you must provide a username and password. The user must be registered with *Arsenal* on the target computer and belong to a group that has been granted the ***Redirection*** right in the *Fork* section.

3.6 EKRASMS.INI FILE

3.6.1 FUNCTION

The *EKRASMS.ini* file is designed to fine-tune the operation of services. It contains a number of parameters that cannot be changed in the *Arsenal* application.

The *EKRASMS.ini* file must be located in the folder:

```
%ALLUSERSPROFILE%\EKRA\EKRASMS
```

> To navigate to the specified folder, copy the entire string into the *Explorer* application path field and press Enter.

After installing *EKRASMS* on a computer, the *EKRASMS.ini* file is not created in the specified folder, and all parameters that may be in it are considered to be equal to the standard values.

If you need to set a value other than the standard value for some parameter, you must:

– create the *EKRASMS.ini* file in the specified folder (if you have not created it before);

– in the *Notepad* application or other similar text editor, add strings with the required parameter values to the file;

– save changes;

– restart the *Arsenal* application;

– restart dependent services in the *Arsenal* application.

3.6.2 USE

EKRASMS.ini is a text file. Each parameter is described on a separate line in the following format:

```
<Parameter name>=<Parameter value>
```

For convenience, the parameters are divided into sections. The beginning of a new section is described on a separate line in the following format:

```
[<Section name>]
```

Example:

```
[Folders]
ArchiveRoot=D:\Archive
```

> The case of characters in the names of parameters and sections does not matter.
> Lines the first significant character of which is ";" (semicolon), are skipped.

3.6.3 FOLDERS SECTION

In the *Folders* section, you can override the folder paths used by various services to store data. The table lists all supported parameters, each with a description and a standard value that is used if the parameter is not set in the file, as well as the service that uses it.

Parameter	Description	Service
`ArchiveRoot`[1)]	Folder for storing event database Standard value: **`%ALLUSERSPROFILE%\EKRA\EKRASMS\Archive`**	Archive
`BackupRoot`[1)]	Folder for storing backup and archive copies of event databases Standard value: **`%ALLUSERSPROFILE%\EKRA\EKRASMS\Backup`**	Backup

1) – The folder must be located on a fixed local hard drive and **not belong** to the *Windows* user profile under which setting is being performed, otherwise the service may not be able to access it

4 SERVER APPLICATIONS

4.1 COMMUNICATION SERVER

4.1.1 FUNCTION

Communication Server directly interacts with IEDs of the BE2704/ED7, BE2502/ED5 and BE2702(M) series and grants access to connected IEDs for other *EKRASMS* services and applications.

After the *Communication Server* is fully configured, intervention in its operation is usually not required: all settings are saved in the *Windows* registry and configuration files and are automatically applied the next time the *Communication server* is loaded. The C*ommunication server* runs in the background: it is configured and controlled using the commands of the *main menu* of the *Communication server* (accessible by right-clicking on the *Communication server* icon on the *Windows* taskbar, which is usually located in the lower right corner of the screen). If you hover your mouse over this icon, the state of the *Communication server* will be displayed.

4.1.2 USERS AND ACCESS RIGHTS

Users and groups are managed in the *Arsenal* application (see paragraph 2), so the *Main menu – Users* command simply starts *Arsenal*.

When installing *EKRASMS*, the following user groups are automatically created:

Group	Access rights to communication server
RPA engineers	Reading data Change settings Clear oscillogram memory Start oscilloscope Reset alarm
PCS engineers	Reading data Change settings Reset alarm
Operators	Reading data Reset alarm
Generic users	Read data

During the initial configuration of the *Communication server*, you need to create a list of users who will be allowed access to IED data.

4.1.3 CONNECTION OF IEDS

By executing *Main menu – Settings* command, the settings window of the *Communication server* appears. Depending on how the IEDs are connected, the *Connection type* should be set.

Standard options for connecting IEDs:

Connection	Communication type
COM port of computer is connected to **RS232** front port of the IED	**RS232** Select the COM port for connection
USB port of computer is connected to **RS232** front port of the IED *Using the USB/RS232 converter*	**RS232** You should select the virtual COM port that will appear in the system after connecting the converter
USB port of computer is connected to **USB** front port of the IED	**RS232** USB driver for connecting to the USB port on the front panel of the BE2704/ED7 and BE2502/ED5 IEDs must first be installed. You should select the virtual COM port that will appear in the system after connecting the IED
USB port of computer is connected to a network of IEDs connected via **RS485** interface *Using the USB/RS485 converter*	**RS232** You should select the virtual COM port that will appear in the system after connecting the converter
Computer is connected via **Ethernet** to **Ethernet/RS485** converter to which the IED network is connected *Ethernet/RS485 converter in Real COM mode*	**RS232** You should select a virtual COM port that will appear in the system after setting the converter
IED network is connected to a **modem** set to auto answer. The computer establishes a dial-up connection	**Modem connection** Modem used on the computer side must first be installed in the operating system
Computer is connected via **Ethernet** to **Ethernet/RS485** converter to which the IED network is connected *Ethernet/RS485 converter in TCP Server mode*	**Network connection** In the list of network connections, a connection of the TCP client type must be added and the IP address of the converter and the port number must be specified (Local TCP Port in the converter settings)
Computer is connected via **Ethernet** to each **BE2704/ED7** and **BE2502/ED5** IED *Except for BE2704/ED7 V750 and V751 IEDs*	**Network connection** In the list of network connections for each IED, a connection of the TCP client type must be added and the IP address of the IED must be specified (the port number is fixed – 1001)
Computer is connected via **Ethernet** to each **BE2704/ED7 V750** and **V751** IED	**Network connection** In the list of network connections for each IED, a connection of the UDP type must be added and the IP address of the IED must be indicated (the port number is fixed – 1001)

RS232

When choosing the *RS232* communication type, you should select the physical or virtual COM port that will be used for communication with IEDs. The *Properties* button opens the settings window for the selected port. The port rate must match the rate that all IEDs in the network are set to, and the rest of the port parameters are fixed: 7 data bits, parity bit, 2 stop bits (7-E-2). Flow control is disabled.

The *Communication server* updates the list of available COM ports on loading and when the *Main menu – Setting* command is executed. If the desired port is not in the list of available ports, close the *Setting* window, connect the IED or converter, and open the *Setting* window again. If the port still does not appear, launch the *Windows Control Panel*, open the *Device Manager* application and check the list and state of ports in the *Ports* (*COM and LPT*) element.

When the *Communication server* is started for the first time, an attempt is made to initialize the COM1 port. When the message *"Error initializing the serial port. The selected port may be in use by another application"*, you should set the *Communication type* and, if using *RS232*, select the desired serial port.

MODEM CONNECTION

When selecting the connection type *modem connection*, select the modem that will be used to communicate with IEDs. The *Properties* button opens a standard *Windows* modem settings window. It is mandatory to set the modem connection parameters: 7 data bits, parity bit and 2 stop bits (*7-E-2*).

If the list of modems installed on the computer is empty, launch *Windows Control Panel*, open *Modems* application and add a modem, then restart the *Communication Server*.

NETWORK CONNECTION

When selecting the connection type *network connection*, by clicking the *Properties* button, a list of connections should be generated.

If a network connection is used to connect to an Ethernet/RS485 converter, then to set the connection parameters, use the *Add* and *Edit* commands in the *All connections* section.

For each connection, set the following:

– connection type (TCP client, TCP server or UDP);

– remote host (*IP* address or name and port);

– local port.

The selection of the connection type depends on which protocol is used (*TCP* or *UDP*) and how the remote host is configured. If the remote host is in *TCP server* mode, *TCP client* mode must be selected in the *Communication server* and the remote host address must be specified. It is not obligatory to set a fixed number of the local port. Immediately after the *Communication server* is loaded (and after leaving the setting mode), an attempt to establish connection with the remote host is made for each network connection in the *TCP client* mode.

If the remote host is in the *TCP client* mode, then the *TCP server* mode must be selected in the *Communication server* and a fixed local port number must be specified. In the *TCP server* mode the remote host address is not specified.

While setting a *UDP* protocol, as a rule, IP address and the second end port number are specified for each side. As a result, when configuring the *Communication server*, specify a fixed local port number and afterwards specify this port number (and IP address of *Communication server*) during remote host setup.

If a network connection is used to connect directly to BE2704/ED7 and BE2502/ED5 IEDs, then you should use the *Add* and *Find* commands from *To devices* section.

By executing the *Add* command, a new connection appears, for which you need to select the connection type – *UDP* for BE2704/ED7 V750 and V751 IEDs and *TCP client* for all other BE2704/ED7 and BE2502/ED5 IEDs that have LAN ports. Also, for a new connection, you need to specify the IP address of the IED.

The *Find* command automatically searches for BE2704/ED7 and BE2502/ED5 IEDs within the subnet. Found IEDs are added to the list of connections, with their IP addresses highlighted in bold.

Each connection has an indicator to use the connection in the actual configuration.

> IMPORTANT! IEDs do not allow simultaneous establishment of several TCP connections for communication using the internal protocol. Therefore, when configuring network connections in *Communication servers*, you need to make sure that the IP address of each IED is specified in only one *Communication server*.

4.1.4 LIST OF CONNECTED IEDS

The list of IEDs connected to the *Communication Server* is controlled using the *Main menu – Devices* command.

For each IED, you must specify the address, factory number, type, software version, location and the name of the station on which the IED is installed. Additionally, you can specify the name of the IED, which will be used to identify this IED in all applications of the software package.

The factory number of the IED is an integer in the range from 1 to 65,535. The number is assigned to the IED during manufacture and is indicated on the rear panel of the IED.

The IED address is an integer in the range from 1 to 899 when using the internal communication protocol. All IEDs connected to one *Communication server* must have unique addresses.

Using the *Add* button, you can connect the IED to the *Communication server*. At the same time, a window of parameters of the connected IED appears on the screen.

To manage the list of stations, click the button with three dots to the right of the *Station* input field. The name is specified for each station. In case of a modem connection with IEDs, a phone number must be additionally specified for each station. If necessary, you can open a window that allows you to change the dialing settings.

The *Read parameters* command allows you to read the factory number, firmware type and version, IED name and location if there is a connection with IEDs.

The *Write to device* command allows you to write the name values entered in the window (IED name, location, name of the station) to the IED (only for BE2704/ED7 and BE2502/ED5 series IEDs). The need to write names to the IEDs is due to two reasons: firstly, these names are placed in the title of each oscillogram and, when the oscillogram is opened in the *Waves* application, they are displayed on the panel with the main properties of the oscillogram, and secondly, it is easier to reconfigure the *Communication server*, which may be required, for example, when moving a server to a new computer.

> If you want to re-read all the data written to the internal event recorders of an IED, you need to select this IED in the *Devices* window. Then, using the right mouse button, open the context menu and execute the *Reread all events at the next interrogation* command.

4.1.5 AUTOMATIC SEARCH FOR IEDS

The list of IEDs connected to the *Communication server* can be created automatically. To do this, open the IED list window and click the *Scan* button. The IED scan window will appear.

First, press the *Properties* button and specify scanning parameters:

– station (in case of a modem connection with IEDs, before the start of scanning, an attempt is made to establish a connection with the selected station);

– initial and final address;

– number of attempts while addressing each IED;

– response timeout from IEDs (in milliseconds);

– *add to existing device list* (when this box is not checked, the actual list of IEDs is cleared before scanning);

– *request device name* (when the box is checked, the location and name are read directly from the IED, and when it is not checked, after scanning for each IED, open the *Device* window and specify the location and IED name manually).

For BE2704/ED7 and BE2502/ED5 series IEDs that have the ability and need to read the configuration file from the IED, the *Read configuration* box will be automatically checked.

> After writing new user settings to the IED or after configuring the switches, you must force the IED configuration file to be updated. To do this, find the IED in the scan window and check the *Read configuration* box.

4.1.6 DIFFERENT CONFIGURATIONS OF COMMUNICATION SERVER

The *Communication server* that starts without command line parameters has configuration 1. To start the *Communication Server* with configuration 2, you need to create a new shortcut to start the server, open the context menu of the shortcut, and execute the *Properties* command. In the *Target* field, add the */config2* command line parameter:

"C:\Program Files(x86)\EKRA\EKRASMS\esServer.exe" /config2

For the *Communication server* with configuration 3, the */config3* parameter is used, and so on. In total, up to 99 different configurations of the *Communication server* are supported.

Communication Servers with different configurations can work simultaneously.

Typical cases when you should use different configurations of the *Communication server*:

– Several IED networks are connected to several COM (or USB) ports of the computer, united via the RS485 interface. You should configure the *Communication server* according to the number of connected networks, each configuration will select its own physical or virtual COM port;

– The computer is connected via Ethernet to Ethernet/RS485 converters or directly to the IEDs. If the total number of IEDs exceeds 30, it is recommended to divide the IEDs into several *Communication servers* so that each *Communication server* has no more than 30 IEDs. This is especially crucial when using the *Data Archiving Server* for interrogating events and the *Oscillogram Server* for automatically reading oscillograms, since all IEDs connected to one *Communication server* are interrogated sequentially;

– The computer is connected via Ethernet to Ethernet/RS485 converters at different stations. If the total number of IEDs is small, then you can connect them to one *Communication server*. But then a temporary loss of communication with the IEDs of one station (for example, in case of some problems with the network) will lead to a slowdown in the exchange with IEDs at other stations. And if you set up your own configuration of the *Communication server* for each station, then the loss of connection with one station will not affect the rate of exchange with other IEDs.

> If there are 50 or more IEDs in the list of devices of one *Communication server*, then when the *Devices* window is closed, a warning will be displayed that when using the *Data Archiving Server* or the *Oscillogram Server*, it is not recommended to connect such a number of devices to one *Communication server*.

4.1.7 COMMUNICATION SERVER SETTINGS

By command *Main menu – Setting*, the settings window of the *Communication server* appears.

COMMUNICATION SETTINGS

Response timeout. The time during which the *Communication Server* waits for a response from the device. The default value is *standard*. With an RS232 connection, the latency is 100 ms plus the transport time, with a modem connection it is 600 ms plus the transport time, with a network connection it is 300 ms plus the transport time.

When using GSM modems in the modem connection mode, as well as in some cases with a network connection, the *standard* response time is not enough. The value should be set to *increased*. In this case, the response time will be more than 2,000 ms.

It is possible to organize very slow communication channels with IEDs, when even *increased* time is not enough for waiting for a response. In such cases, the value should be set to the *maximum*. In this case, the response time will be more than 1 minute.

Software support for 7-E port parameters. Not all modems are capable of working with *7-E-2* port settings. In particular, this applies to some *GSM* modems. To use such modems, check the *Software support of 7-E port parameters* box. Connection parameters of such modems should be: 8 data bits, parity bit is not checked and 2 stop bits (*8-N-2*).

Pause between receiving and transmitting. Some RS232/RS485 or USB/RS485 converters require a short pause to switch from transmit mode to receive mode for correct operation. In such cases, you should set the value of the *Pause between receiving and transmitting* parameter (default – 0 ms, maximum value – 50 ms).

TCP/IP

TCP port number for Monitoring program. The same port is used to connect the *Oscillgram Server*, *OPC Server*, *Duty Operator AWS* and *IEC 60870-5-103 Gateway*. The default value is 1389 for the first configuration, 1391 for the second, 1393 for the third, and so on.

TCP port number for Data Archiving Server. The default value is 1390 for the first configuration, 1392 for the second, 1394 for the third, and so on.

SYNCHRONIZATION

Time synchronization in devices. Whether or not to synchronize the time of all connected IEDs according to the clock of the *EKRASMS server*. In order for synchronization to take place, the *Time synchronization* parameter must be correctly specified in IEDs. IEDs connected directly via Ethernet are synchronized using the *SNTP* protocol.

Date synchronization period. Interval between commands for date synchronization. When synchronizing the date, a full time stamp is sent to the information network of IEDs – year, month, day, hours, minutes, seconds, milliseconds. The recommended value is 60 seconds.

Time synchronization period. Interval between commands for time synchronization. Time synchronization commands contain only seconds and milliseconds. With a modem connection, only the date synchronization commands are executed. The recommended value is 10 seconds.

EVENT INTERROGATION

Response timeout. Time to wait for a response from IEDs when reading events. The recommended value is 100 ms.

Interrogation frequency without data. The interval between commands for event interrogation in cases when there are no new events in the IED. The recommended value is 1,000 ms.

START

Run on logon. If you check this box, then the actual configuration of the *Communication Server* will be automatically started when the actual user logs in.

Deny restart of this configuration. If the box is checked, the second start of the *Communication Server* with this configuration will be blocked.

DESCRIPTION

Server description. The text that will appear when hovering over the *Communication Server* icon on the *Windows* taskbar. It makes sense to use this setting if different configurations of the *Communication Server* are used to connect to different stations.

4.2 DATA ARCHIVING SERVER

4.2.1 FUNCTION

The *Data archiving server* automatically connects to all local *Communication servers* (that is, those running on the same computer), collects events from IEDs connected to these *Communication servers*, and transfers them to the database by connecting to the *Archive* service.

If you are connecting to a *Communication server*, the type of connection with IEDs of which is a modem connection, then when connecting, you will need to select the station with which the modem connection will be established.

Just like the *Communication server*, the *Data archiving server* runs in the background, and its operation is indicated by the icon on the *Windows* taskbar. The same icon also serves to open the main menu.

During the collection of events, the main menu item *Event interrogation* will be checked. If for some reason you need to stop collecting events forcibly, you need to uncheck the *Event interrogation* box.

4.2.2 SETTING

In order to switch the *Data archiving server* to setting mode, stop interrogating events. By executing command *Main menu – Settings*, the *Data archiving server* settings window appears.

EVENTS

Database server. Select either local or remote database server. To connect to a remote database server, you must either find this server if it is within the subnet, or specify its address manually. Also, to connect to a remote server, you need to specify a username and password.

Run on logon. If you check this box, the *Data archiving server* will automatically start when the actual user logs in.

Place measurements in database. If the box is checked, during the interrogation of events, the IEDs will additionally be requested and the results of recorded measurements will be placed in the database.

Place reports on changes in settings in database. When changing and writing IED settings through the *Monitoring program*, a text file is generated, in which it is recorded which *EKRASMS* user, from which computer, when and which settings he changed. When the box is checked, these files with reports will be added to the database.

Rebroadcast events. This box must be checked when using an *Workspace*, *OPC Server*, or *IEC 60870-5-103 Gateway*. These applications connect to the *Data archiving server* via the specified *TCP port*. The default value is 1388.

NOTIFICATIONS

On the *Notifications* page, you can check boxes for sending system messages about the following events:

– device restart/turning off;

– loss of connection/reconnection with device;

– device failures;

– signaling;

– change of settings;

– control of settings;

– oscillatory binary inputs;

– frequently changing state internal signals.

If the *Control of settings* box is checked, then in the event interrogation mode, a periodic request is made for the actual values of settings of those IEDs for which standard images will be found. The actual setting values are compared with the setting values in the standard image. The setting values in all groups and the values of all IED parameters are compared, except for the position of operational switches.

When changes are detected, a system notification is generated with the following information: series and factory number of the IED, date and time when the standard image was recorded, full user name and organization, date and time when the actual settings were received, and the number of differences found.

Reports on settings control can be sent by e-mail. To do this, check the *Control of settings* box in the *Perform mailing* section and use the *Mailing list* command to generate a list of mailing addresses.

4.2.3 STATE DIAGNOSTICS

By executing command *Main menu – Diagnostics – Server status*, the *Status* window appears.

If the *Data Archiving Server* is configured to connect to a local database server and the *"Inactive service"* message appears in the upper part of the *Status* window, open the *Arsenal* application (see paragraph 2) and enable the *Archive* service.

COMMUNICATION SERVERS

The *Communication Servers* page displays a list of all *Communication Servers* configurations found on the local computer and the state of connection to each of them. If text *"Error 10061. Impossible to establish connection with communication server"* appears in the *Error* column, then most likely this configuration of the *Communication Server* is not started.

DEVICES

The *Devices* page displays a list of all IEDs that are connected to *Communication Servers* with which there is a connection. For each IED, the event receiving state is displayed. The *"reading events"* state means that the IED is currently reading the previously recorded events. The *"events read, interrogation is in process"* state means that all previously recorded events have been read and interrogating is currently being performed to receive new events.

> If there is a need to connect to a specific IED, read all registered events from it, and then save these events, you should configure the connection to the IED in the *Communication Server*, scan devices, and add this IED to the device list. Next, close all configuration windows in the *Communication Server* and load the *Data Archiving Server*. 5 seconds after loading, interrogation of events starts automatically. In the *Data Archiving Server* in the *Status* window, you need to find this IED. As soon as the *"events read, interrogation is in process"* state appears, you can connect to the database in the *Timeline* application and save the events.

4.3 OSCILLOGRAM SERVER

4.3.1 FUNCTION

The *Oscillogram server* is designed to automatically collect oscillograms from IEDs in accordance with the settings and the specified schedule.

Just like the *Communication server*, the *Oscillogram Server* runs in the background, and its operation is indicated by the icon on the *Windows* taskbar. The same icon also serves to open the main menu.

The *Oscillogram server* operates in the following way:

– at the first start, the process of synchronization of oscillograms available on the computer and the oscillograms in the IEDs begins, during which all oscillograms with an acceptable age that are absent on the computer will be read from IEDs. At the end of synchronization, the *Oscillogram server* records the actual numbers of starts and begins operating according to the schedule;

– when new oscillogram appear, synchronization is performed again, as a result of which reading of new oscillograms is performed. The user can turn off the interrogation for a long time; it will not lead to data loss, since synchronization will be carried out immediately after the interrogation is resumed.

Establishing a connection with *Communication servers* and switching to the IED interrogation mode can be done either when the *Oscillogram server* is started, or forcedly using the *Main Menu – Oscillogram Interrogation* command.

When the *Oscillogram server* is switched to the setting mode, interrogation of oscillograms is paused.

4.3.2 SETTING

To configure the *Oscillogram server*, execute the *Main Menu – Settings* command.

COMMUNICATION SERVERS

The *Oscillogram server* connects to one or more *Communication servers* and receives oscillograms from IEDs connected to these servers. The selection of *Communication servers* and IEDs is carried out on the *Main menu – Setting – Communication servers* page.

By means of commands on this page, you can form a list of *Communication servers*: add them manually, search for *Communication servers* in operation in the local network, delete or change parameters of connected *Communication servers*.

SCHEDULE

The *Oscillogram server* collects oscillograms automatically. This means that oscillograms will be received from IEDs as soon as they appear and are detected by the *Oscillogram server*. In order to track the fact of appearance of new oscillograms, the *Oscillogram server* periodically interrogates IEDs. The interrogation mode and parameters are specified by the user and are called the *schedule*. The *Oscillogram server* can serve several facilities at the same time and each can have its own schedule. To configure the schedule parameters, open the *Main menu – Setting – Schedule* page.

Select a station in the station structure and click the *Change the schedule for the station* button. The station schedule setting wizard window will open, which is a sequence of pages for selecting the mode and time for interrogating IEDs.

The first step is selection of interrogation modes:

– *once after the start of interrogation* (in this mode, IEDs will be accessed once immediately upon manual start of interrogation (using the *Main menu – Oscillogram interrogation* command) or upon automatic start (when the *Oscillogram server* is started));

– *periodically* (in this mode, periodic interrogation is performed with a specified time interval);

– *every day* (in this mode interrogation is performed at predefined times during the day);

– *after receiving event Start recorder* (in this mode, interrogation is performed 1 minute after receiving the *Start recorder* event).

The second step is selection of interrogation time (depends on the mode selected during the first step):

– for *once after the start of interrogation* mode – interrogation time is determined by the moment of its start;

– for *periodically* mode – the time interval between interrogations is specified in minutes;

– for *every day* mode – the list of time stamps is specified when interrogating;

– for *after receiving event Start recorder* mode – the time interval between backup interrogations is specified. A backup interrogation will be performed when the *Oscillogram server* is detected as not ready to receive the binary *Start recorder* event. This can happen due to the absence of a signal in the registration mask, if there is no connection with the *Data archiving server*, if the *Data archiving server* is not ready to receive and transmit the event to the *Oscillogram server*.

The third step is to select the parameters of repeated interrogation. If at the time of interrogation the *Communication servers* or IEDs are not fully ready, then the next interrogation may not take place. In this case, it is possible to repeat the interrogation several times at a specified time interval.

By default, the *periodically* interrogation mode is specified with an interval of 1 minute.

For each IED, you can define a priority level for transmitting oscillograms. A higher priority gives the IED the right to transmit oscillograms in the first place. This is useful when, as a result of an accident, several IEDs record oscillograms at once (including IEDs serving neighboring bays), but the user would first of all want to receive oscillograms of IEDs that tripped. The criterion can be the presence of a *Tripping* alarm. In this situation, the *Oscillogram server* queues the IEDs based on their priority.

To change the priority, select the IED in the station structure and press *Change the priority of the device* button:

For the highest priority level, select a binary signal that will become the priority criterion, e.g. *Tripping*. It is also necessary to select the *Data archiving server* through which the emergency event will be received. If, as a result of an accident, the IED recorded an oscillogram, but there was no *Tripping* signal (or it was not received due to the *Data archiving server* being unavailable or not in the registration mask), then the IED will receive a normal priority level.

PARAMETERS

On the *Main menu – Setting – Parameters* page, you can enable the option to save oscillograms in *COMTRADE* format. The format standard, file type, analog value type and encoding are specified. When box *perform substitution in accordance with requirements for signal names* is checked, the original file names and channel identifiers are replaced in accordance with the requirements of a number of standards (see paragraph 5.10). When box *merge frames into one file* is checked, those oscillograms that are divided into frames of 64 KB in the original format are combined into one file in the COMTRADE format.

Reading outdated oscillograms. Determines the age of oscillograms, after which the oscillogram files are considered outdated and will not be read from IEDs.

Enable notifications. Specifies whether to display notifications about reading oscillograms.

Enable mailing. Specifies whether read oscillograms should be sent via e-mail. By command *Mailing addresses*, you should create a list of mailing addresses.

OSCILLOGRAM FOLDERS

On the *Main menu – Settings – Oscillogram folders* page folders are specified where the oscillograms received from IEDs will be placed. The folders for original format oscillograms and COMTRADE format oscillograms may be different. Here you can also set the rules by which the *Oscillogram server* will automatically generate the folder structure.

PLACEMENT OF OSCILLOGRAMS IN EKRASMS DATABASE

In addition to collecting oscillograms in a designated directory, the Oscillogram server also places them in EKRASMS database.

> To access the database (*Archive* service), the settings of *Data archiving server* are used

START MODE

On the *Main Menu – Settings – Start mode* page, you can enable the *Oscillogram server* to start automatically when you log in to *Windows*, as well as enable automatic start of oscillogram interrogation according to the schedule immediately after starting the *Oscillogram server*.

SETTINGS FILES

On *Main menu – Settings – Settings files* page you can enable reading settings files of the BE2704/ED7 and BE2502/ED5 IEDs in the internal sfr format and save them to disk according to the specified schedule. You need to specify the folder where the settings files will be placed. New settings files appear only after a change in the values of any settings has been detected.

When box *save settings as XML file* is checked, in addition to the settings file in sfr format, settings will be saved in the format intended for transferring setting values to third-party software (see paragraph 11).

DESCRIPTION

Description of oscillogram server. The text that will appear when hovering over the *Oscillogram server* icon on the *Windows* taskbar. This setting makes sense if you use different *Oscillogram server* configurations to connect to different facilities.

> Different configurations of the *Oscillogram server*, if necessary, are created in the same way as different configurations of the *Communication server* (see paragraph 4.1.6).

4.4 OPC SERVER

4.4.1 FUNCTION

OPC Server is designed to integrate IEDs available in *EKRASMS* into PCS according to the OPC standard.

The application is described in more detail in document ЭКРА.00002-01 90 03 “OPC Сервер”.

4.5 IEC 60870-5-103 GATEWAY

4.5.1 FUNCTION

The *IEC 60870-5-103 Gateway* is designed to integrate IEDs available in *EKRASMS* into PCS according to the *IEC* 60870-5-103 standard.

The application is described in more detail in document ЭКРА.00002-01 90 02 “Шлюз 60870-5-103”.

5 MONITORING PROGRAM

5.1 FUNCTION

The *Monitoring program* is designed to configure and monitor IEDs available in *EKRASMS*.

5.2 STATION STRUCTURE

The station structure is a list of IEDs available at stations and a list of *Communication Servers* that provide access to these IEDs. The station structure is stored in a text file called a *station structure description file*.

When you first start the *Monitoring program*, a message will appear stating that the station structure description file was not found. To create a station structure, execute the *Station – Create station structure* command.

The list of communication servers initially contains only the local communication server, which should be used if the *Monitoring program* and the only *Communication Server* are running on the same computer. You can add other configurations of *Communication Servers* or *Communication Servers* running on other computers to the list. To do this, in the *Communication Servers* group, click the *Add* button. For each *Communication Server*, you must specify its name, which is used only by the *Monitoring program* and can be arbitrary.

The *Find* button in the *Communication Servers* section allows you to automatically search for all operating *Communication Servers* within the primary domain of the local network. After the search for *Communication Servers*, the search for devices connected to these servers will be performed automatically.

If the list of *Communication Servers* is generated, then to search for devices connected to them, click the *Find* button in the *Devices* section.

If the station structure has been successfully created, then upon completion of the *Monitoring program*, you will be prompted to save the station structure as a file. By default, it is proposed to save the structure to the *Station.stt* file in the station description files folder.

You can generate multiple station structure files and load the required ones as needed. The last used station structure file is applied automatically when the *Monitoring program* is loaded.

The station structure is displayed as a *tree* in the *Monitoring Program* window in the left part. IEDs are grouped by stations and locations. By default, separate elements for sttations are not created in the tree. For each IED, *Actual values*, *Adjustable parameters*, *Fault oscillograms*, *Fault signaling* elements are created.

> If the structure contains IEDs located at different stations, you can execute the *View – Properties* command and on the *General* page check the box to *create elements with station names in tree*. In the same place, you can check the box to *sort station structure elements* – then in the tree the elements at the level of stations, locations and devices will be sorted alphabetically.

The right part of the *Monitoring program* window displays the contents of the selected station tree element.

5.3 ESTABLISHING CONNECTION AND ACQUIRING DATA

If the *Communication – Establish connection automatically* menu item is checked, then the connection with the corresponding *Communication Server* will be established automatically when an IED is selected in the station tree, otherwise, to establish a connection, execute the *Communication – Establish connection with actual server* command. The *Actual server* is the *Communication Server* to which the IED selected in the station tree is connected. If the attempt to establish a connection fails, an error message and corresponding recommendations will appear on the screen.

Once the connection is established, you will be prompted for a username and password, which are specified in the *Arsenal* application. Access to internal databases of IEDs can be obtained only after successful login to the *Communication Server*.

When navigating through the station tree, the data corresponding to the selected element in the station tree will be automatically requested.

You can force an update of the data in the currently selected tree element using the *Device – Update information (F5)* command. The data acquisition process can be interrupted at any time using the *Device – Stop (Esc)* command.

5.4 ADJUSTABLE PARAMETERS, EDITING SETTINGS

When navigating through the station tree, only the values of those parameters that are included in the node selected in the station tree are requested. Using the *Parameters – Read actual parameters (F3)* command you can read the values of all adjustable parameters of the actual device. By default, the automatic reading of parameters mode is enabled – when you enter the *Adjustable parameters* node of any device for the first time, all adjustable parameters of this device will be read.

In order to change the value of any parameter, just double-click the left mouse button on the parameter name. If you need to change the values of several parameters, select the required parameters with the mouse or keyboard keys and press the *Enter* key or execute command *Parameters – Edit parameters – Edit selected parameters*.

If the values of any adjustable parameters are changed, then the *Parameters – Write edited parameters (F2)* command will become available. When writing parameters, a *password for remote access to device* will be requested. The password for remote access to the IED is requested in the following cases:

– when editing settings;

– during remote alarm reset;

– during remote oscillogram memory reset;

– when saving the image.

The password for remote access to the IED can be changed using the *Device – Change device password* command, possible password values are from 1 to 9999. By default, the password for remote access to the IED is as follows:

– “1” for IEDs of BE2704/ED7 and BE2502/ED5 series;

– “2716” for IEDs of the BE2702(M) series.

> The password for remote access to the IED should not be confused with the password for writing the settings, which is requested when editing the settings using the buttons on the front panel of the IED.

Some settings of BE2704/ED7 and BE2502/ED5 IEDs (for example, settings 9-2) are written in a special way. When changing the values of such parameters, they must be written to the IED using the *Parameters – Write edited adjustment parameters* command.

For IEDs of BE2702(M) series, you can change the parameters of analog inputs (numbers of input sensors, primary and secondary values) in accordance with the *WConfig.NNN* configuration file. To do this, execute command *Parameters – Edit parameters – Edit by configuration file*.

> In order to edit the settings, the user must have the appropriate access right to the *Communication Server* enabled.

5.5 IED IMAGE

To save all IED settings in a file, execute the *Parameters – Save image* command. The image file will include a configuration file, a copy of the IED's actual settings, and user settings (table of names and programmable logic of the IED). The IED image can be used to service the IED in the *Mix* application, the image can be opened by *Atlas* settings analysis application to view and compare settings, and the image can be used to restore the IED parameters in the *Monitor program*.

> Please note that the saved image will not include the IED firmware. To get a backup copy of the IED, i.e. full image along with the firmware, put the IED into service mode and use *Mix* application.

The *Parameters – Fix standard image* command allows you to save the image with additional information about the user who performed the operation. Standard images are used by the *Data Archiving Server* to automatically control settings.

The *Parameters – Save setting parameters* command allows you to save only the IED setting parameters in a file with the *ADJ* extension.

Commands *Parameters – Restore parameters from file* are intended for restoring previously saved parameters. You can restore parameters from *MIX* IED image files, from *DFR* oscillogram files, from *SFR* settings files, as well as from files with *ALL, ADJ, PR, OSC* extensions saved by previous versions of the *Monitoring program*. To write the restored values to the IED, execute the *Write edited parameters* command.

After specifying the settings and parameters of the IED, it is recommended to save the IED image.

If you need to edit the user settings of the IED, you should save the image of the IED, open this image in the *Mix* application, make the necessary changes, save the image in the *Mix* application, and, finally, in the *Monitoring program*, execute the *Parameters – User settings – Write* command.

5.6 SETTING GROUPS

Some types of IEDs of BE2704/ED7 and BE2502/ED5 series have versions with several groups of settings. Commands *Parameters – Setting groups* are designed to work with adjustable parameters that have versions in different groups.

The *Select setting groups* command allows you to specify the groups that will be displayed on the screen. You can select only the working setting group, you can select all setting groups, or you can explicitly specify which setting groups you want to display.

The *Transfer protection parameters* command allows you to copy protection settings from one group to another.

5.7 ACTUAL VALUES AND VECTOR DIAGRAMS

The mode of reading actual values is specified on *Actual values* page of the parameter setting window of the *Monitoring program*. In the cyclic reading mode, the actual values included in the selected group are reread with the period specified in the settings. In read-once mode, values are requested once and updated with the *Update information* command.

Commands *Actual values – Display actual values – in primary values (in secondary values)* allow you to display the values of analog signals either in primary or secondary values. For some versions of IEDs commands *in primary values (in secondary values)* are replaced by commands *in absolute values (in relative values)*.

The *Actual values – Vector diagram* command allows you to draw vectors of the first harmonic of selected currents and voltages of the actual IED. The drawing is made relative to the *base vector* of the IED. The appearance of a window with a vector diagram does not block the execution of other application functions. Simultaneous display of multiple vector diagrams from different IEDs is possible.

5.8 OSCILLOGRAMS

If the connection to the *Communication Server* is established, and the *Fault oscillograms* element is selected in the station tree, then the IED directory will be read and a list of oscillograms written by the IED will appear. Oscillograms can then be saved as *DFR* files or deleted.

When the *Oscillograms – Copy…* command is executed, the selected oscillograms will be copied to the specified folder. When the *Copy* command is executed, the selected oscillograms will be copied to the previously selected folder. Folder naming options allow you to organize oscillograms by stations, locations, IEDs, and dates.

The copied oscillograms in the list will be marked with a flag. The *Copy missing* command allows you to select all unread oscillograms and start copying them.

If you double-click the oscillogram name with the left mouse button (or press the *Enter* key), then, depending on whether this oscillogram is on the computer or not, the *Waves* application (if it is installed in the system) will be opened or the oscillogram copying will begin. If settings files are shown in the list of files along with oscillograms, then selecting the settings file and executing the *Open* command will open the *Atlas* application.

To delete selected oscillograms from the memory of the IED, execute the *Delete* command.

> In IEDs BE2704/ED7 and BE2502/ED5 of the latest generation, it is not possible to delete individual oscillograms from the IED memory. Only complete clearing of the oscillogram memory is available if the user has the appropriate access rights to the *Communication Server*.

You can sort the list of oscillograms by name, size or date, for which just left click on the title of the corresponding column or execute the *Oscillograms – Sort* command.

Apart from commands to copy, delete and sort oscillograms, *Oscillograms* menu includes a number of commands for oscilloscope operation:

– *Start oscilloscope* (by this command, the oscilloscope starts for the time specified by the setting of the oscilloscope for the duration of the post-fault recording);

– *Format CompactFlash* (for IEDs of the BE2704/ED7 series, in which oscillograms are recorded on a *CompactFlash* memory card, this command is used to format the memory card; the command is executed by password);

– *Clear oscillogram memory* (for IEDs in which oscillograms are written in electronic memory, this command resets the electronic oscillogram memory; the command is executed by password);

– *Format floppy disk* (for IEDs of BE2702(M) series this command is used to format a floppy disk; the command is executed by password).

While copying or deleting oscillograms, a message may appear indicating that file operations are being performed by another user. This is due to the fact that simultaneous access of several users to the directory or files of one IED is not possible. In this case, you should try to perform the required operation again later.

5.9 OSCILLOGRAMS IN COMTRADE FORMAT

5.9.1 SELECTING STANDARD

IEDs of BE2704/ED7 and BE2502/ED5 series save fault oscillograms in the internal format, as files with the *DFR* extension. But when reading oscillograms, the files can be converted to COMTRADE format. This happens in the following cases:

– when reading oscillograms using the *MMS* protocol in accordance with the IEC 61850-8-1 standard;

– when automatically reading oscillograms using the *Oscillogram Server*, if the corresponding option is enabled in the settings.

When generating oscillograms in *COMTRADE* format, file names and channel identifiers can be brought into line with the following standards:

– **STO 56947007-29.120.70.241-2017** company standard, amended on 11.12.2019 ("Technical requirements for microprocessor relay protection devices");

– **GOST R 58601-2019** ("Relay protection and automation. Autonomous emergency event recorders. Standards and requirements");

– **STO 59012820.29.020.009-2016** company standard ("Relay protection and automation. Automated collection, storage and transmission to control centers of SO UES JSC of information about emergency events from electric power facilities equipped with digital devices for recording emergency events. Standards and requirements");

– **STO 59012820.29.020.006-2015** company standard ("Relay protection and automation. Autonomous emergency event recorders. Standards and requirements").

To select a standard, use command *Oscillograms – Specify names in COMTRADE files*.

5.9.2 STO 56947007-29.120.70.241-2017

When selecting **STO 56947007-29.120.70.241-2017** company standard you must specify the following parameters in accordance with the requirements of the standard:

– company code (you should select a numeric and alphabetic code);

– supervisory object name;

– short supervisory bay name;

– voltage class;

– RPA panel number;

– short functional name of the device.

The *Generate channel parameters* command automatically generates the *ch_id* (channel identifier) and *ccbm* (circuit component) fields for all analog and binary channels.

5.9.3 GOST R 58601-2019

When selecting the **GOST R 58601-2019** standard, you must specify the following parameters:

– company name of the legal entity;

– supervisory object name;

– name of the autonomous fault recorder.

Identifiers and circuit components for analog and binary channels must be specified manually.

5.9.4 STO 59012820.29.020.009-2016

When selecting **STO 59012820.29.020.009-2016** company standard, you must specify the following parameters:

– supervisory object name;

– name of the device.

Identifiers and circuit components for analog and binary channels must be specified manually.

5.9.5 STO 59012820.29.020.006-2015

When selecting **STO 59012820.29.020.006-2015** standard, you must specify the following parameters:

– supervisory object name;

– name of the autonomous fault recorder.

Identifiers and circuit components for analog and binary channels must be specified manually.

5.9.6 WRITING DATA TO IED

By the *Write* command, data for *COMTRADE* files are written to the IED's memory. This data will be used by the IED when generating *COMTRADE* files for transmission via *MMS* protocol in accordance with the IEC 61850-8-1 standard.

The *Read* command allows you to read data for *COMTRADE* files from the IED's memory for control or editing.

5.9.7 SAVING DATA AS FILE

The *Save* command saves data for *COMTRADE* files to a service file linked to the factory number of the IED. This file will be used by the *Oscillogram Server* when generating *COMTRADE* files.

The *Restore* command allows you to load data for *COMTRADE* files from a service file for control or editing.

5.10 FAULT SIGNALING

To get the actual state of alarm indicators, select the *Fault signaling* element in the station tree.

Remote reset of the fault signaling is carried out by the *Device – Reset signaling* command. Execution of this command requires entering a password for remote access to the IED and that the user has the necessary access rights.

5.11 BINARY SIGNALS AND OUTPUT RELAYS

If the actual IED belongs to BE2704/ED7 or BE2502/ED5 series, then commands *Binary signals* and *Output relays* will be available in the *Parameters* menu. When the *Binary signals* command is executed, a table of binary signals will appear on the screen.

The table of binary signals allows you to select the signals that will be used to start the oscilloscope and that will be recorded.

The *Update* and *Write* buttons allow you to synchronize the values in the table with the values in the connected IED (they work similarly to the read and write commands for adjustable parameters in the main window of the *Monitoring program*).

> Masks of binary signals in *Start recorder when switching from 0 to 1* and *Start recorder when switching from 1 to 0* are mutually exclusive. In the *Recording mask for binary signals* section, no more than 48 or 128 signals can be selected depending on the IED version.

The table provides a context menu that allows you to quickly enable or disable all values in the selected column.

The *Parameters – Output relays* command displays a table similar to the table of binary signals, designed for quick configuration of output relays, LEDs, and assignment of a binary signal to the *Control output*.

5.12 BE2704/ED7 V900 CONFIGURATION

Creation of the configuration of inputs of BE2704/ED7 V900 type IED of versions 042 and 200, reading of the previously created configuration, as well as changing the configuration and writing changes, are carried out by BE*2704/ED7 V900 Configurator* application.

> For BE2704/ED7 V900 type IEDs **versions 040 and 041**, it is necessary to use the application *Wizard for setting recording BE2704/ED7 V900 type IEDs*. For IEDs of BE2704/ED7 V900 type, **versions 300 – 303**, the names of channels and circuits are specified in the *Mix* application by editing the name table.

5.12.1 CREATING NEW CONFIGURATION

A new configuration of IED inputs is created by the *Monitoring program* menu command *Parameters – 2704V900 Configuration – Create*. At the same time, a new configuration is created according to the table of sensor versions installed in the IED. This command starts the *Configurator* with default parameters. Next, input circuits are configured, and after the work is completed, the *Configurator* writes a new configuration to the IED.

5.12.2 EDITING PREVIOUSLY CREATED CONFIGURATION

A previously created configuration can be retrieved from the IED using the *Monitoring program* menu command *Parameters – 2704V900 Configuration – Edit* or loaded from a file with the *RCF* extension using menu command *Parameters – 2704V900 Configuration – Restore from file*. Next, input circuits are configured, and after the work is completed, the *Configurator* writes a new configuration to the IED.

5.12.3 SETTING INPUT CIRCUITS

Input circuits are configured using a five-step wizard.

SETTING BINARY INPUTS OF IED

The first step is to specify the names of IED's binary inputs:

– full name (up to 28 characters) used for display in *EKRASMS* applications and services;

– short name (up to 11 characters) used for display on the IED and in oscillograms.

SETTING THREE-PHASE CIRCUITS

The contents of the *Configurator* window in the second step allow the user to configure three-phase circuits of the IED. Depending on the version of the IED, up to five three-phase circuits can be organized from analog inputs. Three-phase circuits make it possible to operate with phase and line values, as well as symmetrical components.

You can create three-phase voltage and current circuits. For each three-phase circuit, the following are specified:

– full name (up to 28 characters) used for display in *EKRASMS* applications and services;

– short name (up to 16 characters) used for display on the IED and in oscillograms;

– phases *A, B* and *C* that indicate analog inputs forming a three-phase circuit;

– transformation ratio of instrument transformers to which the analog inputs are connected, forming this circuit.

SETTING ANALOG INPUTS

The setting of analog inputs that have not been assigned to any of the circuits is carried out in the third step. In addition to analog inputs, which have not been grouped into three-phase circuits, up to eight DC sensors can be installed in the IED, which cannot be used to form three-phase circuits. For each input, the full name, short name, and transformation ratio are specified.

SETTING GROUPS OF THREE-PHASE STARTING ELEMENTS

For the first two three-phase circuits, the IED allows you to calculate phase-to-phase values, symmetrical components, as well as their increments, which are considered as three-phase starting elements. The set of three-phase starting elements, taken along one of the circuits, constitutes a group of three-phase starting elements. Setting the parameters of groups of three-phase starting elements is carried out at the fourth step.

For each group of three-phase starting elements, the following are specified:

– three-phase circuit that will be used to calculate the above starting parameters;

– blocking *Uab,min* from the current input, which is used to block the three-phase starting element of the group by line voltage *Uab,min* in the event of a current failure at the

selected current input. If the current circuit is selected as the three-phase circuit, this parameter is not supported.

The information bar below the table shows the actual and possible number of groups of three-phase starting elements. The possible number of groups of three-phase starting elements is determined based on the number of organized three-phase circuits, and cannot be more than two.

POWER SETTING

At the fifth step, the three-phase bay powers are configured. The IED allows you to calculate the active and reactive power of three-phase bays. These values can be observed in *EKRASMS* applications and services or on the IED display.

The following is specified for each power:

– three-phase voltage circuit, which is described by the inputs connected to instrument voltage transformers of the given bay;

– three-phase current circuit, which is described by the inputs connected to instrument current transformers of the given bay.

The information bar below the table shows the actual and possible number of three-phase powers. The possible number of capacities is determined based on the number of current circuits and in the limiting case (12 current sensors with four voltage sensors) is 4.

The power names in the *EKRASMS* applications and services and on the IED display correspond to the names of the corresponding current circuits.

5.13 SETTING

The *Properties* command on the *View* menu allows you to open the *Monitoring program* setting window.

On the *General* page, you can set the parameters that control the time of receiving or updating data, the type of data display in the station tree, and the generation of the device configuration.

On the *Actual values* page, you can specify the reading mode and format for presenting actual values.

On the *Parameters* page, the modes of reading, displaying, saving and reading adjustable parameters are configured.

On the *Oscillograms* page, the modes of reading and displaying oscillograms are specified. You can also set the root directory for saving oscillograms and specify the rules by which the *Monitoring program* will generate the folder structure within the root directory.

5.14 COMMAND LINE PARAMETERS

Valid command line parameters when loading the *Monitoring program*:

– */station*=<station structure description file>

– */device*=<factory number of the device selected when loading>

– */username*=<user name>

– */password*=<user password>

– */interface*=<program interface version number>

– */?*

The */device* parameter requires the */station* parameter. The */username* parameter requires the */station* and */device* parameters. The */password* parameter requires the */station*, */device*, and */username* parameters.

> If the command line parameter contains spaces, then such parameter must be enclosed in double quotes.

Example:
"C:\ProgramFiles(x86)\EKRA\EKRASMS\esClient.exe" "/station=C:\My Data\Station.stt"

5.15 ERROR MESSAGES

5.15.1 ESTABLISHING CONNECTION WITH COMMUNICATION SERVER

When establishing a connection with the *Communication Server*, an error situation may occur for several reasons:

– messages may appear: *"Computer with IP address of communication server specified in station structure description file not found", "Route to communication server not found", "Failed to determine IP address of communication server by specified computer name", "Communication server by specified address not available"*. In this case, you should make sure that the computer with which you want to establish a connection is working and check that the name or *IP* address of this computer is specified correctly.

– it may turn out that a computer was found at the specified name or *IP* address, but the *Communication Server* on this computer is not started or uses a *TCP* port that is not specified in the *Monitoring program*.

5.15.2 ABSENCE OF CONFIGURATION FILES

When loading the station structure, only those IEDs of BE2704/ED7 and BE2502/ED5 series will be included in the tree, for which the correct configuration files will be found in the configuration files folder. If any configuration files are not found, an error message will appear. In this case, you should scan the IEDs connected to *Communication Servers* and, if necessary, read the missing configuration files. Next, in the *Monitoring program*, execute the *Station – Edit station structure* command and click the *Find* button in the *Devices* section.

5.15.3 ABSENCE OF ACCESS RIGHTS TO INFORMATION

The name under which the user connected to the *Communication Server* determines which operations will be available in the actual session. Before any operation is performed, it is checked whether the operation is allowed. If execution is not allowed, a corresponding message will appear on the screen.

5.15.4 ACCESS TO INTERNAL DATABASES OF IEDS

When accessing the IED, message *"Timed out waiting for response from device"* may appear, which means that the IED does not respond to requests via the communication channel. An interruption in communication over the communication channel may be temporary and may be caused, for example, by a change in adjustable parameters or by starting the oscilloscope. It is recommended that you perform the desired operation again after a few seconds. If

communication with the IED is not restored, then you should make sure that the IED is operating, check the IED address and the speed of the communication channel.

Message *"Timed out waiting for response from communication server"* may be caused by a failure of the computer on which the *Communication Server* is running, or by a failure of the *Communication Server* itself. If this message appears, you should repeat the interrupted operation, break and establish a connection with the *Communication Server*, make sure that the *Communication Server* is running.

When reading or writing adjustable parameters, when working with oscillograms, messages *"Parameters read by user XXXX", "Parameters written by user XXXX", "File operations performed by user XXXX"* may appear. These messages appear because several users cannot perform certain operations at the same time. In this case, perform the required operation later.

6 TIMELINE. EVENT ANALYSIS

6.1 FUNCTION

The *Timeline* application is designed to analyze events collected by means of *ERKASMS* into a database. It allows you to open a selection from the data source in the form of a table, and provides a number of tools for its analysis.

The data source can be:

– Database (via the *Archive* service), both locally and remotely;

– File with events.

6.2 RECEIVING OF EVENTS SELECTION

6.2.1 RECEIVING OF EVENTS FROM DATABASE

In order to make events selection from the *EKRASMS* database, you must execute the *Connect to database* command from the main menu. You will need to specify the address of the database server and enter the parameters for logging into the server. Next, a connection will be made to the *Archive* service on the specified server and general information about the database will be received.

> To connect to the *Archive* service, you must specify a username and password. The user must be registered with *Arsenal* on the target server (even if the connection is made locally) and be a member of a group that has the ***Read events*** right in the *Archive* section.

The screen will show paginated elements for limiting the amount of data to select:

– *Calendar* – entering of time limits;

– *Types* – selection of only event types of interest;

– *Devices* – selection of only devices of interest.

> The *Timeline* application allows you to work with selections containing up to 1,000,000 events, which, as a rule, is redundant for a qualitative analysis of the situation. It is recommended to limit the selection as precisely as possible before it is formed, in order to reduce the amount of unnecessary information in it (which will still bother you), as well as the time required to acquire it (especially over the network) and pre-processing.

After all limits are configured, click the *Continue* button. The application will proceed to the process of acquiring a selection from the database, taking into account the limitations you have entered, after which the data of the acquired selection will be presented on the screen in the form of a table.

> When working with a database, the *Refresh* command is available in the *Selection* menu, which allows you to quickly see what new items that satisfy the selection parameters have appeared in the database since the last update.

6.2.2 OPENING DATA FILES

To open a file, you must execute the *Open file* command from the main menu.

When opening a data file, as well as when connecting to a database, selection must be made. The only difference is that the data is not taken by connecting to the *Archive* service, but directly from the specified file.

After selecting the necessary data file, its preliminary analysis will take place. The time taken for this operation depends on the file format and the number of events in it. After the analysis, the elements of the selection limitation will be shown on the screen, and then everything follows exactly the process described in the previous paragraph.

Timeline supports the following data file formats:

File mask	Description
*.db	Database format that stores data of one of the types acquired from *BE2704/ED7* and *BE2502/ED5* IEDs for one calendar month. It was used as the only data storage format until the release of *EKRASMS 2.9*. Supported event types: *Internal events*, *Binary signals* and *FLOC*. To open files in this format, it is desirable to have device description files (*.dcf/*.ccf), the events of which you are interested in. Otherwise, you will see only the numbers of binary signals, without names, and information about the device will be limited to its serial number.
*.datapak	*EKRASMS* 2.9 – 2.13 selection format. The file may have been acquired by saving the selection in the *Timeline* application of these versions of the packet.
*.dbbackup	A compressed copy of the *EKRASMS* 2.9 – 2.13 database. The file may have been acquired using the *Arsenal* application of these versions of the packet.
*.archive	A compressed copy of the *ERKASMS* 2.14 database and newer. The file can be acquired in *Arsenal* by saving the database as a file in the *Archive* service menu or from a backup via the backup management window of the *Backup* service.

> Also, the *Open file* command allows you to open selections previously saved in the application in files (*.timeline). This is the application's own selection format, in which, in addition to the data, all settings made are also stored. This allows later to continue analyzing the data from the state in which they were at the time the file was saved. The opening of such files occurs without the stage of selection limitation.

6.3 WORKING WITH SELECTION

The *Timeline* application allows you to view events as a table, sorted by the time of their occurrence in ascending order.

6.3.1 SELECTING COLUMNS TO DISPLAY

Using the list from the *View* > *Columns* menu, you can select which columns will be shown in the table.

The following columns are available:

Name	Description
No.	Number of the event in the table
Date	Date of event occurrence by the device clock
Time	Time of event occurrence by the device clock
To next event	Time until the next event in the table
Type	Type of the event (internal, binary signal, etc.)
Category	Category within the type that the event belongs to (not all types are categorized)
Event	Name of the event
Value	Value of the event (if the event has one)
Index	Index of the event in the device recorder (if the event has one)
Device	Factory number of the device
Series	Series of the device
Firmware	Information about the device firmware
Hardware	Hardware version of the device
Device name	Name of the device
Location	Location of the device

Using the *View > Columns > Remember table layout* command, you can save the composition of selected columns and their widths. This view will be automatically applied when opening new selections in the future, with the exception of selections from *.timeline files, which themselves store all information about their appearance.

6.3.2 SETTING TIME REFERENCE POINT

In the *Timeline*, you can control the reference point when displaying time in the *Time* column. By default, this column shows the absolute time the event occurred, but by setting the reference point to a specific event, you can force the application to display the time elapsed since or before that moment. This is convenient, for example, when analyzing a process, when absolute marks are not of great importance, but time intervals from the beginning of a process to a specific event are important.

To set a reference point, place the cursor on the line that you want to take as the origin of the reference and execute the *Set reference point* command in the *View* menu or the context menu of the table.

To reset the reference point and return to displaying absolute time values, execute the *Reset reference point* command in the *View* menu or the context menu of the table.

To quickly search for a line on which a reference point is set, execute the *Find reference point* command in the *View* menu or the context menu of the table.

6.3.3 INTRODUCING TIME SHIFTS BETWEEN DEVICES

Devices generate events based on their own clock. In general, the clocks of different devices, the events of which transferred to the same database, may not be synchronized, which

is unacceptable when the analysis of the situation requires simultaneous use of events from several devices.

Timeline allows for each selection device to enter a numerical time shifts in the range of +/- 100 hours.

To enter shifts, you need to execute the *View* > *Time shifts* command, which will display a window with a tree of devices, for each of which you can specify a shift by double-clicking on the device line in the *Shift* column.

The window for specifying shifts contains a device search line by name or number, which is convenient when there are dozens or even hundreds of devices in the selection.

> The time shift between the clocks of two devices, in the absence of global synchronization, the value is not constant. As a rule, due to the discrepancy between the parameters of quartz oscillators, the difference increases with time, so the shift determined for a certain point in astronomical time may be completely inapplicable to points in time that are several hours and sometimes minutes away from it. Thus, the necessary shift must be determined from the events of each process that is to be analyzed.

6.3.4 TABLE NAVIGATION

Selections may contain hundreds of thousands of events. In order to move faster through this amount of data, the *Timeline* has a number of special mechanisms.

SWITCHING TO DATE

If the selection contains events for more than one calendar day, a calendar bar is displayed above the table to quickly jump to the beginning of the day of interest by clicking on it. This calendar displays only those days for which there are events.

View > *Calendar* menu commands allow you to control visibility of the calendar bar.

SEARCHING FOR REPETITIONS OF SAME EVENT

By placing the cursor on the line with the event of interest, you can quickly find previous or subsequent occurrences of the same event. To do this, use the *Find same event earlier/later* commands from the *Search* menu or context menu of the table.

SEARCHING FOR EVENT BY NAME

In the right part of the menu bar there is an entry field for searching an event by name. Enter the required part of the name in the bar, press *Enter*, and if there is an event in the table after the actual bar that contains the entered text in the name, the cursor will move to it. If you want to continue searching further, press ***F3***. When the end of the table is reached, the search moves to its beginning.

6.3.5 BOOKMARKS

Timeline allows you to bookmark the actual table row so that you can quickly return to it later. Multiple rows can be bookmarked. Bookmarks are named. By default, the bookmark is given the name of the event, the row of which it marks, but you can also specify your own names that are convenient for you. Rows with bookmarks are displayed in yellow.

The *Bookmarks* menu is designed for working with bookmarks.

CREATING BOOKMARK

To create a bookmark, place the cursor on the required row of the table and execute the command of choice:

– *Create* from the *Bookmarks* menu;

– *Add bookmark* of context menu of the table.

SEARCHING FOR BOOKMARK

To search for a bookmark, you need to open the *Bookmarks* menu and double-click on the bookmark of interest, focusing on its name and time stamp.

EDITING BOOKMARK NAME

Ways to edit the bookmark name:

– Place the cursor on the row with which it is associated and execute the *Edit bookmark* command of context menu of the table;

– Find the bookmark in the *Bookmarks* menu list and select *Edit*.

REMOVING BOOKMARK

Ways to delete bookmarks:

– Place the cursor on the row with which it is associated and execute the *Remove bookmark* command of context menu of the table;

– Find the bookmark in the *Bookmarks* menu list and execute the *Remove* command;

– To remove all bookmarks, select the *Remove all* command from the *Bookmarks* menu.

6.3.6 FILTERING EVENTS

Timeline allows you to temporarily hide (filter) events in the table.

You can hide individual events, entire devices, as well as events related to certain types and categories.

The *Filter* menu commands are used to perform filtering functions.

The filter is most fully configured in the *Filter* window, which is called by the *Filter > Setup* command.

FILTERING BY EVENT TYPES AND CATEGORIES

The *Types and categories* page of the *Filter* window contains a tree of event types and categories. By unchecking the items in this list, you hide the events of the corresponding types and/or categories. Types and categories, the events of which are not in the selection, are not available for checking and are displayed in gray.

FILTERING BY DEVICES AND INDIVIDUAL EVENTS

In the left part of the *Devices and events* page of the *Filter* window there is a tree of devices. By unchecking the elements of this tree, you hide all events of corresponding devices.

The right side of the page contains a list of events of the device selected in the device tree that are present in the selection. By unchecking the items in this list, you hide specific events for this device.

Above the device tree and above the list of events there are search bars by name (and for devices by number).

FILTERING BY NAME

On the *Names* page of the *Filter* window, you can enter a fragment, or several fragments separated by the *";"* symbol (semicolon) of the event name. Only events the names of which contain the entered fragments will be displayed in the table.

ADDITIONAL COMMANDS FOR WORKING WITH FILTER

In addition to direct filter operation in its settings window, *Timeline* contains several more commands that change it, but work in the context of the actual table row and allow you to quickly hide individual events or devices. These commands are available from the *Filter* menu and from the context menu of the table.

The *Hide all events except current* command allows you to quickly leave only the occurrences of the current event in the table.

The *Hide current event* command, on the other hand, allows you to quickly hide all occurrences of the current event.

The *Hide all devices except current* command allows you to quickly leave only the events of the device that generated the current event in the table.

The *Hide current device* command, on the contrary, allows you to quickly hide all events of the device that generated the current event.

LIMITING DISPLAYED TIME RANGE

On the *Time range* page of the *Filter* window, you can explicitly limit selection by time, both from the beginning and from the end. In addition, the menu has a number of commands that allow you to perform this operation faster.

The *Hide all before/after current timestamp* commands available both in the *Filter* menu and in the context menu of the table allow you to quickly narrow the time interval of displayed events. Select the event the time stamp of which you want to make the limit of the displayed time interval and execute one of these commands.

The *Filter > Reset visible time range* command allows you to disable previously entered time limits.

DISABLING AND RESETTING FILTER

If the filter is active, then below, under the table of events, a yellow line is displayed with a reminder of this. This line also contains the *Filtered only* and *All events* buttons, which allow you to quickly switch between a filtered set of events and a full set of events.

The *Filter > Reset* menu command allows you to completely reset the previously configured filter and return to the full set of events.

6.3.7 LINKED FILES

An event can be linked with a file (for example, a oscillogram), while an arrow appears to the right of its value in the *Value* column, clicking on which opens the menu for working with the file. From here, the file can be *Saved* to disk or *Opened* in a program designed to work with files of this extension.

6.4 WORKING WITH THE DIAGRAM

The diagram panel is located in the lower part of the selection window and is intended for drawing time diagrams of events. After creating a selection, the diagram is empty, but it can be filled with events as needed.

> The diagram has its own menu bar. Further in this section, all commands, unless otherwise noted, refer specifically to this menu.

6.4.1 EDITING EVENT COMPOSITION ON DIAGRAM

Using the *Events* window, which opens when you execute the *Diagram > Select events* menu command, you can check the boxes for events that you want to see on the diagram.

The *Diagram > Select events from table* menu command allows you to add events to the diagram that fall within the range selected with the mouse in the table. The command puts the table in the event range selection mode and temporarily hides the diagram. In this mode, it is necessary to select the range of events of interest by two successive clicks on the rows of the table and click the *Execute* button in the yellow line at the top. After that, all events that fall into the selected range will fall on the diagram. If you have selected the wrong event range, click the *Reset* button, which will allow you to mark the range again.

> It is important to understand that in the context of this command, the Range term has nothing to do with a time interval. The diagram shows events for the full time interval of the entire selection.

The *Diagram > Show all events from table* menu command allows you to quickly add to the diagram all events that in the table now.

Using the *Add to diagram* command from the context menu of the table, you can add events to the diagram one at a time. A similar action can be performed by dragging the desired row of the table onto the diagram.

You can quickly remove an event from the diagram by clicking the cross in its right part.

6.4.2 CURSOR AND ACTUAL MOMENT

On the diagram there is a concept of the *actual moment*. It is specified by the *cursor* (vertical red line), which is always present in the display area of the diagram graphs and which can be moved along the time axis. The cursor title displays the time stamp of the actual moment. The actual moment is used to display the value of the event on the diagram.

Ways to move the cursor:

– *Drag with mouse*. At the same time, a yellow trail follows the cursor, which indicates the offset in milliseconds relative to the previous position;

– *Left click* in the event graph display area moves the cursor to the point in time corresponding to the click location;

– *Left* and *Right* keys move the cursor left and right one step;

– *SYNC* button turns on the mode in which the cursor in the diagram follows the selected line in the event table.

6.4.3 TIME SCROLL

Ways to scroll the diagram by time:

– Using the time scrollbar (at the bottom of the diagram window);

– *Shift + Mouse scroll*;

– Keyboard:

Keys	Action
Shift + Left	Smooth scrolling to the left
Shift + Right	Smooth scrolling to the right
Shift + Page Up	Page scrolling to the left
Shift + Page Down	Page scrolling to the right
Shift + Home	Scrolling to the beginning of the diagram
Shift + End	Scrolling to the end of the diagram

6.4.4 TIME SCALING

Time scaling methods:

– The *Zoom in/out time* buttons of the toolbar;

– *Ctrl + Shift + Mouse scroll*;

– Keyboard:

Key	Action
Ctrl + Left	Zoom in
Ctrl + Right	Zoom out

– The *MAX* button (*Set the maximum time scale*) in one click sets the maximum possible time scale;

– The *MIN* button (*Set the minimum time scale*) in one click sets the minimum possible time scale.

– The *AUTO* button (*Fit to window*) in one click sets scale, allowing you to fit the entire time range in the width of the window.

6.4.5 SCROLLING EVENT LIST

Ways to scroll the list of events:

– Using the vertical scrollbar of the list;

– *Mouse scroll*;

– Keyboard:

Key	Action
Up	Smooth scrolling up
Down	Smooth scrolling down
Page Up	Page scrolling up
Page Down	Page scrolling down
Home	Scrolling to the beginning of the list
End	Scrolling to the end of the list

6.4.6 MOVING EVENTS

To move an event, you need to grab its name with the mouse and move it to a new location. While moving, a blue horizontal line represents the insertion point.

6.4.7 SORTING EVENTS

The *Diagram > Sort* menu command allows you to quickly arrange events on the diagram in ascending order of devices factory numbers and in alphabetical order within one device.

6.4.8 MARKERS

Named markers can be added to the diagram to mark points in time that are important for analysis.

To work with markers, use the *Markers* menu.

ADDING

Ways to add a marker:

– The *Markers > Create* command adds a new marker to the actual position of the (red) cursor;

– *Shift + Left click* adds a new marker to the position with a time point corresponding to the place of the click.

MOVING

The marker can be moved along the time axis by grabbing it with the mouse. When the marker is moved, a trail follows it, showing the offset in milliseconds relative to the previous position.

If you capture the marker while holding down the *Shift* key and start moving, then the marker itself remains in place, and the newly created marker moves and the trail, which at the same time stretches behind the new marker, shows an offset relative to the original marker. This feature is useful when you want to add a new marker that is a certain amount of time away from the existing one.

SEARCHING

To search for a marker, you need to open the *Markers* menu and double-click on the marker of interest, focusing on its identifier and time stamp.

EDITING PARAMETERS

Ways to open the marker parameters window:

– *Markers > Edit* command. In this case, the required marker must be selected from the list that appears. In the list, a marker is represented by its identifier;

– *Edit* command of context menu of the marker;

– *Double click* on the required marker.

REMOVING

Ways to remove the marker:

– *Markers > Remove* command. In this case, the required marker must be selected from the list;

– *Markers > Remove all* command. Removes all markers added to the diagram at once;

– *Remove* command of context menu of the marker.

6.4.9 INTERVAL TABLE

The *Intervals* button allows you to enable or disable the display of the table of intervals between the markers placed on the diagram.

6.4.10 EXPORT TO COMTRADE

The diagram can be saved in *Comtrade* format for joint analysis with oscillograms in *Waves*.

> Only *binary signals* are exported as *Comtrade*. All other types of *EKRA* device events cannot be described by means of this standard.

To perform an export, execute the *Diagram > Export* menu command and select the required version of the *Comtrade* standard in the submenu. Additionally, in the *Export parameters*, you can specify the encoding of the configuration file and the format of the data file. The sampling rate of the resulting file is 1000 Hz.

You can export in *Comtrade* file for not more than 5 minutes, so the export parameters have fields that specify the *Begin* and *End of range* using markers.

6.5 PRINTING EVENT TABLE

The *Selection > Print* command allows you to print the table of events. When the command is executed, a preview window opens.

The *Printer settings* button allows you to select a printer, configure printer settings, specify page parameters, and select a print mode. The *Print parameters* button allows you to specify a number of additional design options. The results of parameter changes can be immediately seen in the preview area.

Only those events that are currently visible in the table are printed. Events hidden by filtering are not printed.

By default, the entire selection range is printed, but it can be limited by setting two (one, if it is necessary to limit on one side only) bookmarks that set the limits and selecting them in the *Printing parameters* window.

6.6 SAVING SELECTION

The selection is saved in the application's own format, **.timeline*. All selection events are saved, as well as all display and filtering settings made during the analysis. Therefore, when you later open such a file, you will continue working from the point where you interrupted it at the time of saving.

To save an open selection, use the *Save* and *Save As* commands from the *Selection* menu.

The *Save as* command always prompts you to specify the path and name of the file in which the save will be made.

The *Save* command works either the same way if the selection is from a database or data file and has never been saved before, or it saves the file under the actual name if the selection is opened from a **.timeline* file or has been saved at least once before.

The application allows you to save to the **.timeline* file only filtered events, those that are currently visible in the table. This allows you to get a more compact file, without everything that turned out to be superfluous in the process of analyzing a certain situation. To perform such a save, you must execute the *Selection > Save filtered* command.

6.7 EXPORTING SELECTION TO CSV

To export the event table in CSV format, which can later be opened in *Microsoft Excel* or processed by your own programs, you must execute the *Selection > Export CSV* command. Only those events that are currently visible in the table are exported. Events hidden by filtering are not exported.

6.8 MERGING SELECTIONS

Timeline allows you to merge multiple selections into one. In this case, a new independent selection is formed. To perform a merge, you must open all the selections you want to merge and execute the *Merge selections* command from the main menu. In the window that appears, check boxes of selections which need to be merged and, if necessary, check the *Merge only filtered events* box if you want only filtered events in the merged selections to be included in the merger.

> A selection cannot contain more than 1,000,000 events, so if the total number of events in the selections to be merged exceeds this figure, the merging will fail. If you encounter a similar situation and still want to merge, you need to apply filtering and merge only filtered events.

6.9 GLOBAL SETTINGS OF APPLICATION

The *Settings* command of the main menu allows you to customize the appearance of the application for new selections.

The *Associate files* command allows you to rebind the extensions of the event files processed by the program if the binding created during installation was reset or changed for some reason.

7 ATLAS. SETTING ANALYSIS

7.1 FUNCTION

The *Atlas* application allows you to view the settings of BE2704/ED7 and BE2502/ED5 series IEDs saved in files of the following formats: *SFR, DFR, MIX, ALL, PR, ADJ, OSC, BIN, UBN, UBN2.*

7.2 WORKING WITH APPLICATION

The application allows you to open several settings files at the same time: each settings file will be displayed on a separate page.

It is possible to *compare* two loaded settings files: names, descriptions of settings and their values are compared. Based on the results of the comparison, a report is issued.

Also in the application there is an *Export* function, which allows you to save the settings as an HTML document.

> An *HTML* document can be opened for editing in *Microsoft Word*. To do this, you need to start *Word*, execute the *Open* command and select the created *HTML* document with settings. After editing, you can save the result in native *Word* format. To do this, you need to execute the *Save as* command and select the saving format you are interested in in the dialog.

8 MIX. SERVICE MAINTENANCE OF IEDS

Service maintenance of BE2704/ED7 and BE2502/ED5 series IEDs is a responsible process: incomplete or incorrect execution of actions in the servicing process can lead to incorrect operation of the IED, therefore, before starting service, you should carefully read this section and understand the concepts and processes that are described in it.

8.1 WHAT IS "SERVICE MAINTENANCE"

Service of BE2704/ED7 and BE2502/ED5 series IEDs includes the following actions:

– updating *firmware* in the IED;

– editing the image (settings, name table, programmable logic etc.) in the connected IED;

– acquiring a full *backup of the IED* and restoring the IED from the backup;

These actions are performed using the *Mix* application. In this case, the IED is taken out of the normal operation mode and switched to the *service mode*.

8.2 BASIC CONCEPTS

In order to fully work with IEDs of BE2704/ED7 and BE2502/ED5 series in the service mode, it is necessary to understand the definitions and concepts that are outlined in the following sections.

8.2.1 FIRMWARE

IEDs of BE2704/ED7 and BE2502/ED5 series can contain one or more processor units. Each unit runs its own internal microprogram. Each such microprogram on the computer is represented as a file with the *bin, ubn* or *ubn2* extension (depending on the IED hardware platform). *Firmware* is a set of microprograms for all units of the IED.

In all IED service scenarios that involve the use of firmware (for example, updating firmware in the IED), a full set of microprogram files included in this firmware is **always** required. Replacing the microprogram in only one unit and refusing to replace the microprogram in other units **will result in incorrect operation of the IED**.

8.2.2 IED IMAGE

The *IED image* contains a copy of the data of all regions of the IED memory.

The image is a file with the *mix* extension.

The image can be generated on a computer based on the firmware or read from the IED itself.

If the image is generated based on the firmware, then the settings in this image will have *default* values, the name table and the programmable logic will initially be empty.

If the image is generated by reading from the IED, then such an image will be an exact copy of all regions of the IED's memory.

8.3 WHAT IS "FIRMWARE UPDATE"

Firmware update refers to the process of replacing internal microprogram in all processor units of the IED, as well as preparing the settings existing in the IED, name table, the programmable logic etc. for correct operation with the new firmware.

Due to the peculiarities of implementation of BE2704/ED7 and BE2502/ED5 series IEDs, it is impossible to replace only the firmware itself and continue using the IED. The old and new firmware may have different sets of binary signals. In addition, a signal with the same number can change its purpose; new settings may appear, the parameters of existing settings may change (e.g. ranges). The name table and the programmable logic will cease to function if you simply change the firmware in the IED. Therefore, the conversion of the existing contents of the IED to the new firmware is required. This conversion process is called *adaptation*.

8.4 SWITCHING IED TO SERVICE MAINTENANCE MODE

In order to switch the IED to service mode, it is necessary to supply power to it by holding down buttons ← + ↑ + → on the front panel.

Service maintenance of the IED should be carried out through the USB port on the front panel.

> In order to connect to a USB port, you need to install the virtual serial port driver from the site https://dev.ekra.ru.

8.5 SERVICE MAINTENANCE SCENARIOS

8.5.1 UPGRADING FIRMWARE

To update the firmware, you need to start *Mix*, execute *Upgrade device firmware* command in the initial window and follow the instructions of the wizard. During the wizard operation, the actual image will be read from the connected IED and adapted to the new firmware, after which *Mix* will display the image window, which is ready to be written to the IED. At this stage, it is **highly recommended** to review all memory regions and check the results of adaptation. After you are sure that the new image is correct, you must execute the *Write to device* command and follow the wizard's instructions.

8.5.2 EDITING DEVICE CONTENTS

Mix allows you editing the settings, name table and programmable logic in the connected IED without changing the firmware. You need to start *Mix*, execute *Edit device contents* command in the initial window and follow the instructions of the wizard. After *Mix* reads all the necessary information from the IED, the image window of this IED will be displayed on the screen.

> It should be remembered that in some types of IEDs, the name table and the diagram of programmable logic are combined into a single *User settings* region.

A number of *actions* are available for each memory region. If the memory region allows editing, then the corresponding command will be available in the action menu, which opens the editor window. Memory region editors are described in more detail in the following sections.

Some memory regions also allow *importing* data from files of outdated formats.

After editing is completed, you can write the changes back to the IED: to do this, you need to execute the *Write to device* command and follow the instructions of the wizard.

8.5.3 BACKING UP AND RESTORING IED

Using the *Backup device* command, you can create an image file that will be a complete and exact copy of all regions of the IED's memory. This image can then be used to restore the IED using *Restore device* command.

The *Mix* backup and restore wizard will sequentially connect to all processors units of the IED and read all memory regions available in these units.

8.6 EDITING MEMORY REGIONS

Each editor has a *Close editor* command. Running this command will return you to the IED image window. If changes were made in the editor, then they, at will, can be made to the image or canceled.

All editors have infinite undo and redo capabilities. Only the settings editor, for technical reasons, does not have this capability.

8.6.1 EDITING SETTINGS

In the left part of the editor there is a tree with a hierarchy of parameters, and in the right part there is a list of parameters in the selected of the tree node. To change the value of a parameter, double click its actual value (or press the *Enter* or *F2* keys). The changed parameter value is displayed in bold; in addition, icons may appear on the right and left of the cell with the parameter value, indicating that the value is read-only or that it is out of range. Hover your mouse over the icon for a hint.

Some parameters may have values in primary and secondary values. When you change one of the values, the second one is recalculated automatically. When changing the transformation ratios, the dependent values are also automatically recalculated.

The *Setting groups* menu, available for IED images containing multiple setting groups, allows you to control the visibility of setting values in different groups. The editor can show values only in the working group, only in the selected group, or in all groups at once.

8.6.2 EDITING NAME TABLE

Parameters of some configuration elements of the IED can be renamed. New names are stored in the *Name table* memory region.

The IED firmware developer determines exactly which configuration elements are available for renaming.

As a rule, one can assign the element a new Name, which is used in EKRASMS applications and services, a name for the indicator, which is displayed on the IED display, and, in some cases, names of the possible values of the selected parameter.

To change a parameter, press *Enter, F2*, or double click it. Specify a new value. Some character spaces may not be editable – they are displayed in red.

If a new value is specified, then a button with an arrow will appear in the line, clicking on which you can return to the original value.

8.6.3 EDITING PROGRAMMABLE LOGIC

> By adding a programmable logic to the IED, you assume responsibility for its correct operation.

The editor window is divided into three areas:

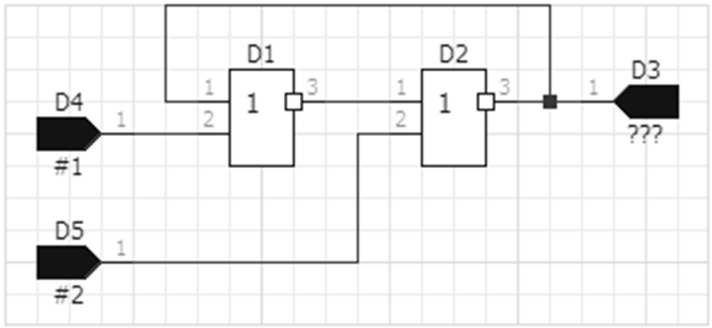
– in the left part of the window there is a library of logic elements; using the mouse, they can be dragged to the scheme workspace;

– on the right there is a scheme workspace; the size of workspace can be increased using the corresponding toolbar command;

– there is a message window in the lower part: in case of errors in processing the scheme, corresponding messages will be displayed here; if you double click a message, the error element on the diagram will be selected.

The IED uses the method of synchronous execution of the logic scheme, i.e. in one working cycle, it calculates all logic elements sequentially, element by element. For the correct calculation of all elements by the IED, the *Mix* application, in the process of drawing a scheme, *ranks* the elements of the diagram: each element is assigned a *rank*, then the elements are sorted in ascending order of their ranks. The sequence of elements formed in this way is transmitted to the IED. The "input port" elements are assigned a rank of 0; the assignment of ranks to remaining elements is done in such a way that the state of *i* element is calculated only after the states of all elements that are connected to the inputs of *i* element are calculated.

If there are *closed circuits* (*feedbacks*) in the circuit, the complete ranking of the circuit becomes impossible. Consider an example, the diagram of which is shown in the figure.

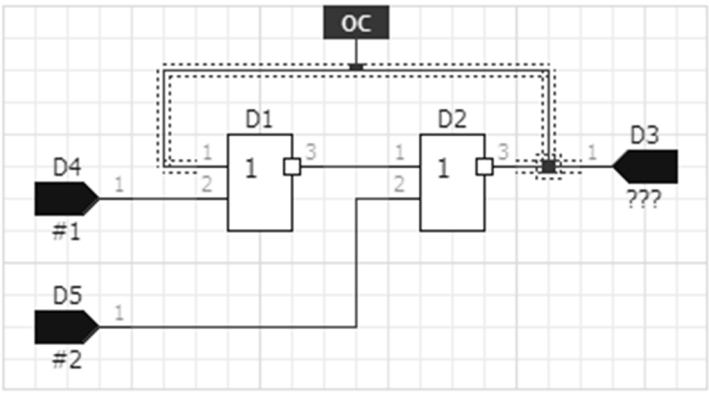


The system of *unranked* logic equations for this diagram is as follows:

$$D2 = \text{NOT } (D1 \text{ OR } D5)$$
$$D1 = \text{NOT } (D2 \text{ OR } D4)$$
$$D3 = D2$$

It is not possible to determine the *ranks* of elements D1 and D2, since the states of both elements depend on each other. In this case, the message *There is one or more unmarked "feedbacks" among elements D1, D2, D3* will be added to the *Messages* panel at the bottom of the *Mix* application window.

To enable such diagrams, *conditional ranking* is used: the closed circuit is broken, and the rank of 0 is assigned to the break point. In this case, it is necessary to specify some initial condition at the break point. In IEDs of BE2704/ED7 and BE2502/ED5 series, such a condition at the initial moment of time is a *logical zero*. Using the *Mix* application, conditional ranking is implemented as follows: it is necessary to designate the broken circuit as *feedback (FB)*. To do this, select the appropriate tool from the main or context menu and place it on the network to be broken:



The circuit that is connected to the *FB* element is highlighted with additional dotted lines. Then the *ranked* logical equations for the feedback circuit will look like this:

$$D1 = \text{NOT}\ (D2\ \text{OR}\ D4)$$
$$D2 = \text{NOT}\ (D1\ \text{OR}\ D5)$$
$$D3 = D2$$

At the initial moment of time, the state of the circuit marked by the FB element and formed by the output of the *D2* element is assumed to be logical zero. Then it becomes possible to calculate the state of the *D1* element (since the states of all its inputs are known), and then *D2*. This will remove the corresponding warning about unmarked feedback from the *Messages* panel.

The principles of working with the graphic editor of the programmable logic are similar to those used in most modern graphic editors of diagrams, however, there are the following features:

– to transfer an element from the library to the workspace, you just need to drag the desired element onto the workspace. The element will automatically receive a certain sequence number (numbering of all circuit elements is performed automatically according to the principle from *left to right* and *from top to bottom*);

– double clicking on a logic element opens the window of element's properties. Properties have time delays (they need to specify a time delay value in milliseconds) and binary signal input/output ports (they need to be assigned a binary signal, and output ports can also be assigned a new name for this signal);

– simple intersection of two separate conductors does not automatically connect them into one circuit – to do this, you need to place *Junction* at the intersection;

– in the process of drawing a scheme, the number of elements and links used is constantly monitored. If any counter exceeds the maximum number (see the table below), a corresponding warning is added to the *Messages* panel.

Element type	Maximum quantity
Operation time delay	50
Release time delay	50
Two-input logic	256
Three-input logic	256
Output	256
Links between elements	512

There is also a limit on the amount of memory occupied by the programmable logic in the ROM of the IED, which is 1,024 bytes. Therefore, even without exceeding any restrictions on the number, on some diagrams, you may encounter the impossibility of placing the created programmable logic in the device. The actual memory usage is also displayed at the bottom of the program in real time.

9 DUMP. APPLICATION PERFORMANCE ANALYSIS

9.1 FUNCTION

EKRASMS services and applications keep a log of their work. This log is necessary to analyze abnormal situations that occur with programs and search for errors.

The *Dump* application is designed to view the *EKRASMS* log. After opening the application, the local log opens automatically.

> The information in logs is only relevant to developers, so there is no description of how to interpret it.

9.2 LOG TRANSFER TO DEVELOPER

If you encounter problems related to the operation of programs of *EKRASMS* package, you should send an e-mail to dev@ekra.ru, in which you describe the problem in as much detail as possible, including attaching the necessary screenshots or video files. It is also necessary to attach a system log file for the period when the problem was discovered.

To get a log file (*.dump), you need to execute the *Save* command and specify the time period for which you want to get the log.

10 WORKSTATION. DUTY OPERATOR AWS

10.1 FUNCTION

Workstation is designed to create and configure graphic screens of an automated workstation (AWS) of a duty operator and monitor the actual mode of operation of a power facility (station or substation) on which BE2704/ED7, BE2502/ED5 and BE2702(M) IEDs are installed.

The application is described in more detail in document ЭКРА.00004-01 90 01 *"АРМ Дежурного"*.