

HOUSTON CONTROL CENTER SOFTWARE PACKAGE

MANUAL

Version 17

Moscow 2022

ANNOTATION

This document contains the manual for the Houston control center software package used for monitoring and managing the Sputnix`s internal satellite systems.

VERSION HISTORY

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TERMINOLOGY

Term	Description
ASC	Automated control system
CCU	Control computer unit
HA software	Houston Application software
HS software	Houston Server software
SP	Software package
CVS	Concurrent Versions System
DTD	Document Type Definition
Houston CC	Houston Control Center
SSID	Service Set Identifier

1 HOUSTON CONTROL CENTER SOFTWARE PACKAGE

The Houston Control Center software package – is a package of applications for monitoring and managing the Sputnix's internal satellite systems (hereinafter – Houston CC SP).



1.1 General description

The Houston CC SP allows:

– receive telemetric information and other messages from satellite systems at the ground station;

– to form control commands on the ground station in a Unican format for satellite systems;

– send commands in message Unican format over the radio channel or another channel to the satellite CAN cable network.

The Houston CC SP consists of a client part Houston Application (hereinafter – HA software, client) and server part Houston Server (hereinafter – HS software, server). Communication between them is provided by TCP / IP protocol, and one server can maintenance several clients.

To connect to the satellite CAN network, USB-CAN converters are used. The following devices are supported:

– Sputnix CANverter v.2.0 with firmware version from 1.06 (http://www.fischl.de/usbtin/);

– Duotec DTM-CAN sniffer with firmware version from 0002 (http://www.duotec.ru/#!blank/c1e3p);

– other interface USBtin compatible devices.

Figure 1 shows the Houston CC SP typical wiring diagram to the satellite CAN bus.

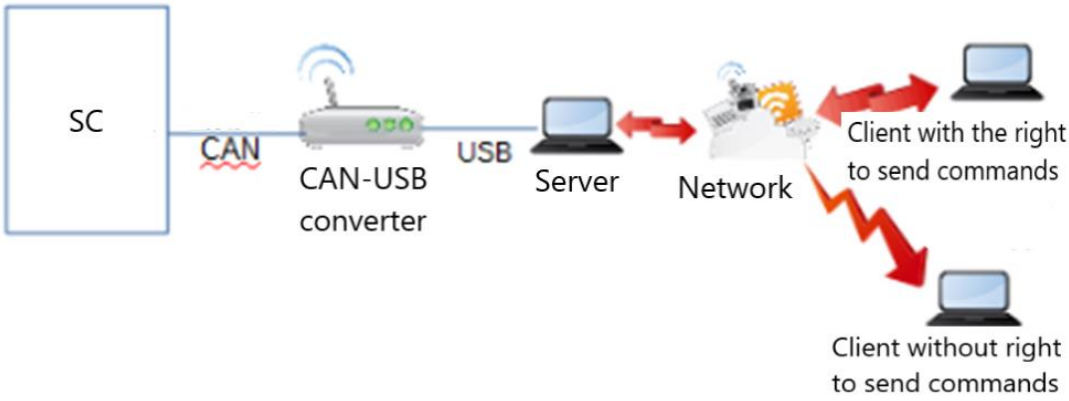


Figure 1 – The Houston CC SP typical wiring diagram

The Houston CC SP ensures reliable operation of the HS software and the full range of HA software functions for working with telemetry information and generating command – messages for satellite systems.

To ensure stability, it is recommended to form and send commands from one workstation. To increase reliability, some more workstations should be connected in observer mode, which will be a hot reserve.

The HS software has limited, thoroughly tested functionality. The operation of the HS software is independent of the performance of the HA software clients.

With the help of the HS software, a centralized log of Unican messages is maintained, which guarantees the safety of the entire exchange history with the satellite. It is provided to maintain local logs on each client using HA software.

1.2 Performance

When HS software interacts with the satellite CAN bus at speeds up to 1 Mbit/s, there may be situations when server performance does not allow processing all incoming data. The current version of the server in this case will skip some packages to ensure the stability of the system. This problem occurs because of the need to receive a large flow of information while simultaneously writing the log to the medium and sending the data to the clients.

This situation is revealed by synthetic tests that create a CAN bus load of 100%, in which the CAN bus is not able to function. The maximum load on the CAN line, which allows it to remain operational without additional arbitration measures (not

used in Unican), is no more than 30%. In the conditions of satellite cable network, the load does not exceed 1%, with such a load, the testing did not reveal any cases of packet skipping.

If a situation with the skipping of packages is detected, please send an e-mail message to the developer to zharkih@sputnix.ru.

2 SOFTWARE

This section describes the composition of the Houston Control Center software package and processed data.

2.1 Software

The Houston Control software package includes the following applications:

– Houston CC Application – client program that performs the functions of visualizing data received from the server side, and forming commands for devices connected to the satellite network. Description of the structure of the satellite CAN-bus and device operation protocols are set using xml-file. (Repository on fossil: https://gitlab.sputnix.ru/houston/SX-Houston-app/).

– Houston CC Server – server side of the application, provides communication with satellite CAN-bus, mutual CANopen and Unican package, continuous log messaging, user data exchange (Repository on fossil: https://gitlab.sputnix.ru/houston/SX-Houston-server).

– WmHelp XmlPad – XML editor from WmHelp company. Used for easy xml-files editing with satellite CAN bus descriptions and device operation protocols in accordance with the schemes in the xsd format.

2.2 Installation

The software package is distributed as an archive in the .zip format. Programs Houston CC Application and Houston CC Server do not require installation and are ready to work after unzipping the corresponding folders.

It is not recommended to place program folders by long names.

2.3 Hardware Description Files

The program Houston Application is designed to work with an arbitrary set of devices on the CAN bus in accordance with the xml-file descriptions of the protocols

of the devices and their hierarchy on the satellite CAN bus.

Correct preparation of xml description files is very important, because according to their data, control commands are formed and the telemetric information packets of the devices are decrypted. The following types of xml files are used:

– Device Protocol Description – contains a description of the protocol for one device (in this case, several such devices at different addresses can be present on the satellite bus). It has a tree structure listing all information packets generated by the device, data fields of these packets and, if necessary, restrictions on the values of these fields.

– Satellite network map – determines the composition of devices and their addressing on the bus. Devices are logically integrated into modules and satellite systems.

For correct Houston Application software operation, it is recommended to generate and use a map file for each satellite launch.

For editing and checking (using the F7 button) xml-files it is recommended to use the XmlPad editor, which is part of the package.

2.4 Xml-file schemas

To control the integrity and formatting of xml files, a tool defined by the xml standard is used - XSD description schemes. XSD description schema files are created by the developer separately for device xml files and xml files map type:

– Unican_device_schema.xsd – for device protocol description files;

– Unican_map_schema.xsd – for satellite network maps.

XSD files are not intended for editing by users. Critical to the stable operation of HA software is the compliance of all xml-files with a description of the device type to the corresponding XSD scheme. This check is performed in the XmlPad program. In addition to control, XSD schemes greatly simplify the creation and editing of xml files, allowing you to add and remove entries in XmlPad in graphical mode.

2.5 Configuration files

In addition to hardware description files, software HA and HS also uses its own parameter settings files – Unican_config.xml and server_config.xml. An Unican_config_schema.xsd scheme is provided for these files (one for both files).

The contents of the configuration files are described in detail in Appendix A and B.

2.6 The license files are required for HA and HS

The license file contains actual license properties: expiration period, available function and available devices list. The license file is supplied by the software developer using unique identification code of the user PC. The identification code is automatically generated by the HA if the license file is missed and should be provided to software developer for license file generation.

3 HOUSTON APPLICATION SOFTWARE

3.1 General Description

The Houston Application software provides the user with a visual interface for interacting with devices connected to the satellite CAN bus

Main HA software features:

- receiving and sending Unican packages by CAN-bus via HS software with saving to a log file;
- recognition of recipients and contents of Unican packages by xml-files of satellite map and device protocols;
- filtering when displaying information of incoming packages;
- data visualization using dashboards;
- customization of appearance and set of panels.

The HA software has no restrictions on the composition of connected devices. Support for exchanging data with specific devices is implemented using xml files with a description of device protocols. Without such a description, working with the device is possible only in the reading mode of "raw" hexadecimal codes of Unican packages. Work with non-Unican packages is not supported and is blocked at the HS software level by the analysis of the package composition, by individual fields and checksum. In the unlikely but possible event of a random checksum match, an attempt to analyze the packet with random data may lead to an unpredictable result.

HA software created with the expectation of the subsequent development of functionality. The principle of building HA software involves three categories of customization:

- user: work with release versions, setting up command queues, dashboards and the appearance of the main HA software window, editing a file with parameters (unican_config);
- admin: editing satellite map xml files and device protocols;
- programmer: working with source code in Qt, creating

additional panels and other functionality in compliance with the general architecture of the program.

3.2 Software Houston Application Installation

At the first start-up, a message is displayed about the absence of the toolbar placement file default_layout.lot inside the main HA software window. To create this file, you should place the panels in a convenient way and save the layout of the panels using the menu item "File - Save layout ...", at resources\layouts\start_layout.lot.

3.2.1 Release version

The release version of the HA software does not require installation, the folder with the program contains the necessary libraries to run under Windows x64. Windows 7 and Windows 10 startup tested.

HA Software folder structure:

- houston_app.exe - main executable file of the program;
- platforms\ - Qt library folder for HA software;
- resources\ - configuration files folder;
- license\ - licensing files folder;
- devices\ - folder of device operation protocol description xml files;
- .xml - device protocol description files;
- devices-not-used\ - folder of the device protocol xml-scheme and xml files of the description of the device operation protocols optionally installed on satellites;
- unican_device_schema.xsd – xml schema file for editing device log files;
- icons\ – HA software interface image folder;
- layouts\ – folder with files of positions and appearance of panels;
- .lot – panel position and appearance information files;

– .tar – tree configuration;

– start_layout.lot - default program appearance file;

– maps\ – satellite map file folder;

– .map – satellite maps card files;

– queues\ – default folder for command queue files;

– schedules\ – default folder for command schedules

– .que – user message queue files;

– racks\ – default folder for dashboard files;

– .hir – user dashboard parameter files;

– schedules\ – default folder for cyclogram files sent for execution on board the satellite;

– queues.example.sch – cyclogram sample file;

– server_logs\ – folder of automatically created exchange log files in the Unican Protocol format;

– error_log.txt – program log file;

– .csv – automatically generated log files;

– .dll – Qt library files for program operation;

– unican_map_schema.xsd – xml-scheme for editing satellite map;

– unican_config_schema.xsd – xml-scheme for editing the configuration file;

– unican_config.xml – configuration file.

3.2.2 License installation

At the first launch of the program (as well as at subsequent launches if the license file is not installed), a message about an incorrect license file will appear.

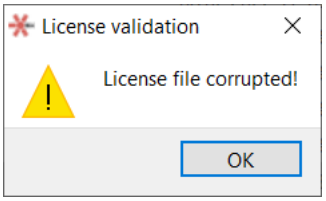


Figure 2 – License validation window

Next, a window will appear with a unique workplace identifier, which should be copied and sent to the software developer to generate a personal license file.

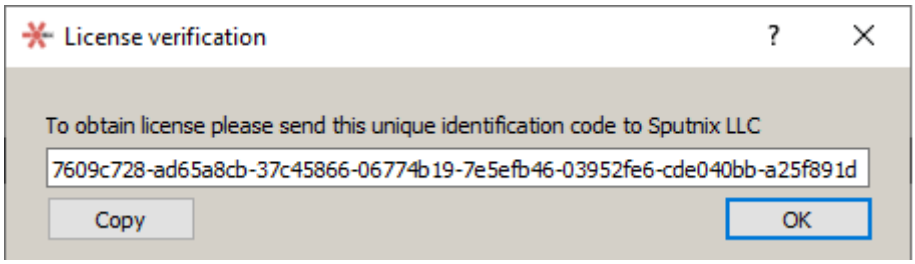


Figure 3 – Window with a unique workplace identifier

The following files should be received from the software developer:

license_xxxxxxxx.xml, here x is a symbol «0»-«9» or «a»-«f»,

public.pem,

and then must be placed to the license folder of the HA software and the HS software. Next, restart the HA software and the HS software. If the license files are correct, the software will function normally. If the license files are incorrect (incorrect PC unique identifier, the license has expired, unauthorized changes have been made to the license file), a corresponding message will be displayed and the software will be blocked.

3.3 Interface

The window structure allows you to completely rebuild the appearance of the main HA software window at the request of users. Supported features:

- hide / show the panel (both standard and user);
- resize panels;
- change panel locations;
- «disconnect» panels from the main window;
- display panels as tabs.

Changes in the appearance of the main HA software window can be saved to a file and downloaded at any time. The initial appearance is set in the configuration file unican_config.xml in the resources folder.

An example of the main window of the HA software is shown in the figure 4.

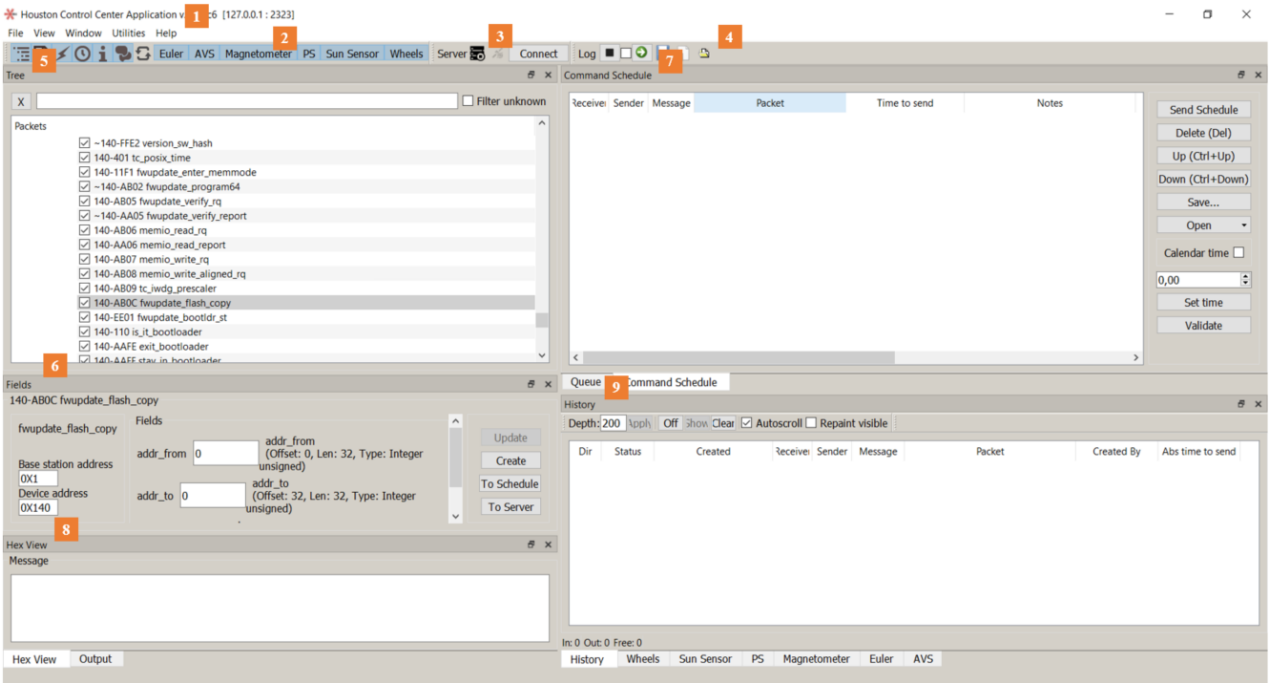


Figure 4 - Main window of HA software

The numbers in the figure indicate:

1 Main menu of HA software;

2 Toolbar;

3 Connection status bar;

4 Log file status panel;

5 Satellite map;

6 Command editor panel Fields;

7 Command Shedule;

8 Viewer of raw hexadecimal data of Unican package.

9 History;

The main menu provides basic options for controlling the appearance of the main HA software windowas well as access to help. Description of the main menu items is presented below.

3.3.1 Main menu item File

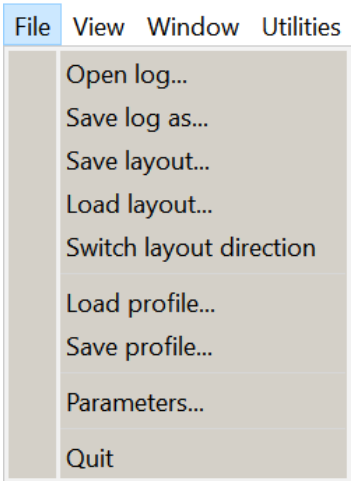


Figure 5 - Functions of the main menu item File

When you select an item File from the main menu, you have access to the following functions:

- Open log… - select a log file to view;
- Save log as... - select the name and locations of the log;
- Save layout - saving the main window view parameters;
- Load layout - loading the main window view parameters;
- Switch layout direction – switching the alignment of the menu position on the right or left edge of the main HA software window;
- Load profile… - load the selected device profile;
- Save profile… - save the selected device profile;
- Parameters – viewing and editing HA software parameter values;
- Quit - exit from HA software.

When you select a log file, save and load the parameters of the main window view, a standard Windows OS window opens for selecting a save or load file. The window for viewing and editing HA software parameter values is shown in the figure 6. At the end of editing the parameters, click OK. By clicking the Cancel button, the results of changing the parameters will be canceled, and the Parameters window will

be closed.

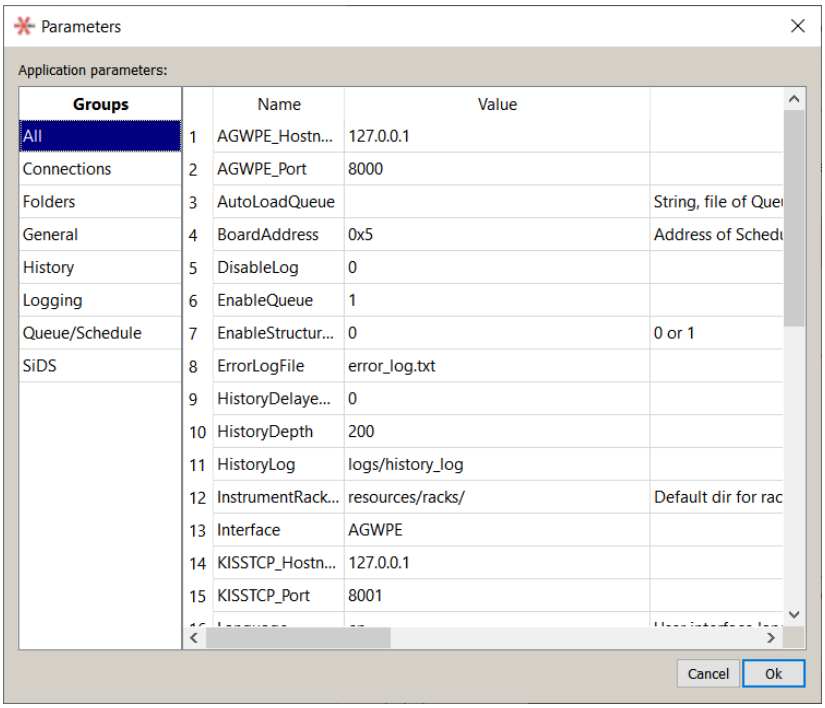


Figure 6 – HA software parameters window

3.3.2 View main menu item

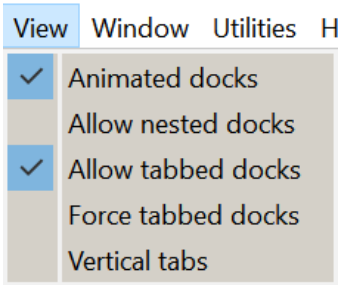


Figure 7 - Functions of the View main menu item

When you select the View main menu item, you have access to the following sub-window management functions:

– Animated docks - not used in current version;

– Allow nested docks - allow windows to be placed next to each other, and not just along the borders of the main window;

– Allow tabbed docks - allow tabs from windows;

– Force tabbed docks - force tabs, preventing new windows from taking up space inside the main window;

– Vertical tabs - display tab list vertically rather than

horizontally.

3.3.3 Window main menu item

When you select the Window main menu item, you are given access to the windows for editing the properties of HA software panels, the properties of previously created dashboards and the functions of creating and deleting a panel. In Figure 8 the list of panels open in the main HA software window is displayed in the left pop-up window; the set of properties of the panel selected in the left window is displayed in the right pop-up window. Panel properties are set or disabled when they are selected with the mouse.

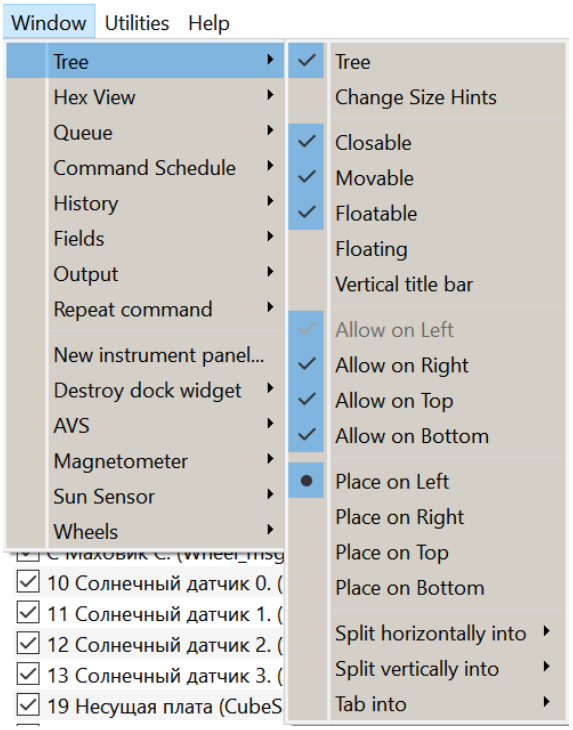


Figure 8 - Functions of the window main menu item

The following options are available in the panel properties window:

– panel name (in the example Tree);

– Raise – bring the panel to the foreground;

– Cnange Size Hints – setting limits on permissible panel sizes (figure 9);

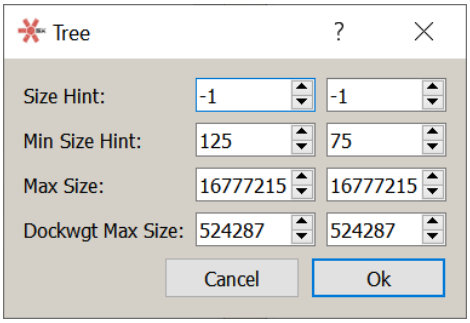


Figure 9 – Window for setting limits on permissible panel sizes

– Closable – the panel can be closed;

– Movable – the panel can be moved;

– Floatable – panel resizing;

– Floating – «disconnect» from the main window;

– Vertical title bar – vertical layout of the panel name and control buttons;

– Allow on Left – left shift allowed;

– Allow on Right – right shift allowed;

– Allow on Top – upward shift allowed;

– Allow on Bottom – down shift allowed;

– Place on Left – place on the left side of the main window;

– Place on Right – place on the right side of the main window;

– Place on Top – place on top of the main window;

– Place on Bottom – place on the bottom of the main window;

– Split horizontally into – place the panels in a row horizontally, in the list that opens, specify which panel to install the current panel;

– Split vertically into – place the panels in a row vertically, in the list that opens, specify below which panel to install the current panel;

– Tab into – to include the panel in the set of bookmarks, in the list that opens, specify to the right of the bookmark which panel

to set the bookmark of the current panel.

– Modified – editable panel.

Changing the properties of dashboards is similar.

When you select New instrument panel, the steps to create a new dashboard begin (see p. 3.8.2).

The Destroy dock widget item is used to remove the panels that are active at the time of selecting this item.

3.3.4 Utilities main menu item

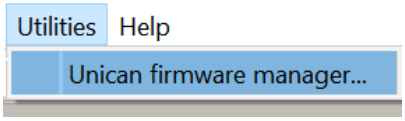


Figure 10 - Functions of the Utilities main menu item

When you select the Utilities main menu item (figure 10) the following options are available:

– Unican firmware manager – Unican bus firmware management.

When you select the Unican firmware manager function, the firmware configuration window opens (figure 11).

On the Write memory settings panel, the parameters for recording the firmware, which is performed for the first time, are entered. The Select button displays a window for selecting the firmware parameter file. If there is a file, the firmware parameters are read from the file with the entered values displayed in the input lines of the Unican firmware manager window. If there is no parameter file, their values must be set in the corresponding input lines.

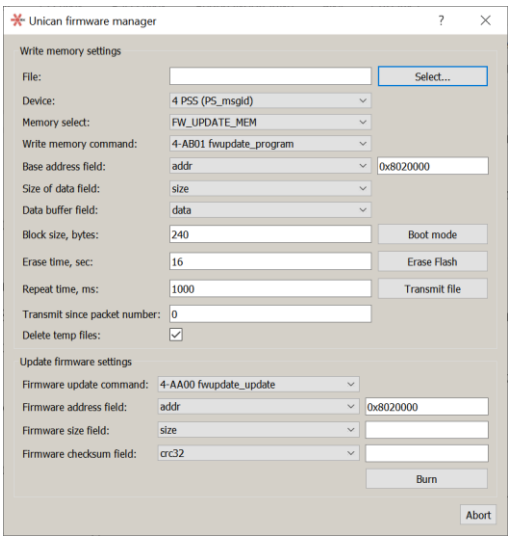


Figure 11 – Unican bus firmware control window

In the Device input line the device connected to the Unican satellite bus should be installed. The list of devices opens by clicking the icon (figure 12). The Memory select input line sets one of the possible memory types FW_UPDATE_MEM, FW_MAIN or FLASH_BASE.

In the input line Write memory command a memory write command is set (figure 13).

In the input lines Base address field, Size of data field and Data buffer field from the opened lists the values addr, size and data are set. In the additional line for Base address field the address value in the hexadecimal system is entered from the keyboard.

In the input line Block size, bytes use the keyboard to enter the size of the data block when writing in bytes.

In the input line time, ms enter the repetition time when writing to the memory in milliseconds.

Setting the Delete temp files flag sets the mode for deleting temporary files after recording ends.

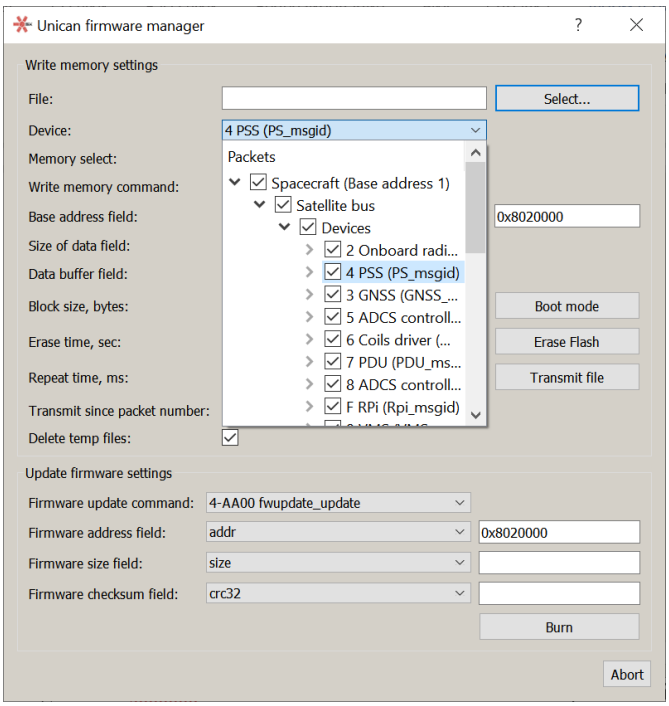


Figure 12 - Unican bus firmware control window with an open selection list of devices

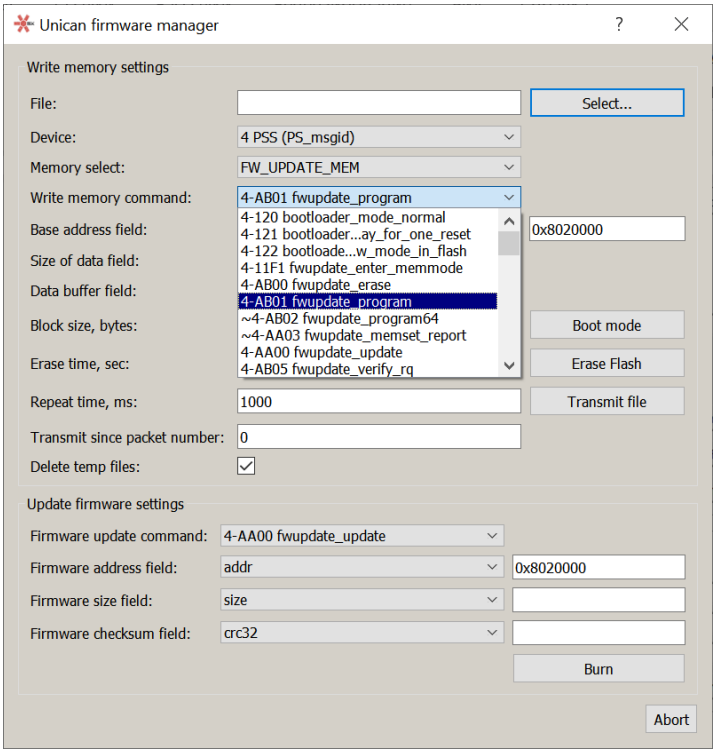


Figure 13 - Unican bus firmware control window with the open memory write command selection list

The Boot mode button sets the boot mode.

The Erase Flash button disables the flash.

The Transmit file button transfers the file for recording.

Parameters for updating the firmware settings are entered in the Update firmware settings panel. The input lines Firmware update command, Firmware address field, Firmware size field similar to the corresponding panel lines of Write memory settings. In the additional line for Firmware size field, the size of the memory area is entered from the keyboard. The line Firmware checksum field sets the type of checksum. The additional line displays the value of the checksum of the recorded information, determined during the preparation of the recording.

The Burn button records (burns) the firmware.

The Abort button is used to interrupt the process of transferring the firmware file.

3.3.5 Help main menu item

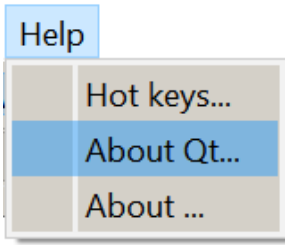


Figure 14 - Help menu item functions

When selecting the main menu item Help (figure 14) the following functions are available:

– Hot keys... – display the shortcut key list window (figure 15);

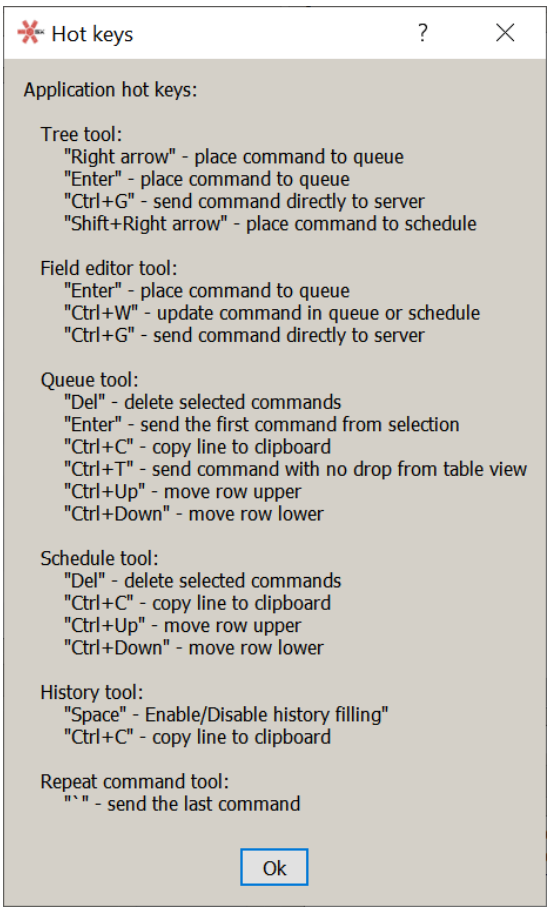


Figure 15 - Shortcut Key Window

– About Qt... - display Qt version information window (figure 16);

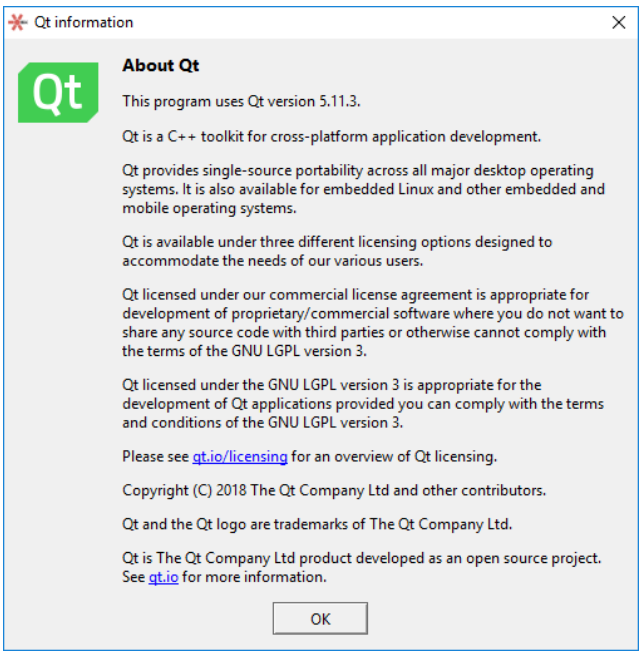


Figure 16 - Qt version information window

– About... – display the HA software version number information window (figure 17).

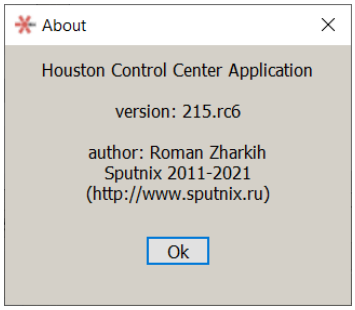


Figure 17 - HA software version number information window

3.4 Configuration

The following xml files are located in the resources folder:

– unican_config.xml - setting general HA software parameters;

– devices*.xml - description of device operation protocols;

– maps*.xml - description of the addressing map of devices connected to the satellite bus, from this folder only the file map.xml is used.

The formation of xml files is determined by the appropriate xsd schemes.

When the program starts, a message log file is created in the folder logs\. Work with log files in HS software is performed similarly.

Table 1 - List of used program parameters

Name	Description	Example of filling
AGWPE_Hostname		127.0.0.1
AGWPE_Port		8000
AutoLoadQueue	String, file of Queue to load with app start	
BoardAddress	Address of Schedule destination device	0x2
DisableLog		0

EnableQueue	Use the queue before sending commands to the server. Turns on when starting HA software 0 - disabled	1
EnableStructuredLog	0 or 1	0
ErrorLogFile	Message log file	error_log.txt
HistoryDelayedTimer	The update period of history	0
HistoryDepth	Maximum number of history records	200
HistoryLog	History file	logs/history_log
InstrumentRackDir	Folder to save the dashboard by default	resources/racks/
Interface		AGWPE
KISSTCP_Hostname		127.0.0.1
KISSTCP_Port		8001
Language		
MinTimeGap_ms	The time between sending	250
Queue_Timer_ms	The retry period for sending a command pending ACK	500
QueuesDir		
SchedulerTimeShiftSec		
SchedulesDir		
serverAddress	Unican Dedicated Server	127.0.0.1
serverPort	Unican Dedicated Server port	2323
SiDS_CallSign		
SiDS_latitude		00.00N
SiDS_longitude		00.00E
SiDS_NORAD_id0		
SiDS_NORAD_id1		
SiDS_SatCallSign0		
SiDS_SatCallSign1		
SiDS_URL_reserve		http://db.satnogs.sputn
StartLayout	Window starting location file	resources/layouts/start
tempFileFolder		temp/
UseLocalTime	Use local time UTC for table	0

3.5 Connection status bar

The connection status bar displays the current connection status of the client and server (icon), and server connections to the satellite cable network (icon). When starting up, HA software attempts to connect to the server using the IP address and port specified in the configuration file (resources\unican_config.xml). User can connect / disconnect manually by clicking on Connect/Disconnect.



Figure 18 - Connection status bar

Possible server connection statuses displayed in a pop-up window when you hover over the icon:

- No connection;
- Pending - connection attempt;
- Connected - connection established;
- Error - connection error.

Statuses correspond to the status of the icons. When a connection is established, the icon becomes active, that displays the connection of the server with the equipment for connecting to the satellite CAN bus. When you hover over the popup window, the following statuses are displayed:

- Connected - connection established;
- Pending - connection attempt;
- Error - connection error.

Settings of server port and address of HA and HS should be the same to enable of connection.

3.6 Log file panel



Figure 19 – Log file status panel

On the log file panel (figure 19) there is a button Start/Stop your log , used to enable / disable log file recording, - enable/disable structured log file, icon start regular log in a new file, which opens the standard save window for selecting a folder and the name of a new log file, icon convert regular logs to structured, icon save current log as a new file, icon copied link of current log file to clipboard.

3.7 Functions of toolbar icons

3.7.1 Tree Icon - Satellite Map

By clicking the icon the Satellite map Tree panel is displayed (figure 20). The input line is used to set filtering conditions for the selection of displayed devices (filtering is performed according to the command names written in Latin letters).

The button removes the filtering conditions. The Filter unknown flag serves to prevent the entry in the history of commands for which there is no description in the .xml files.

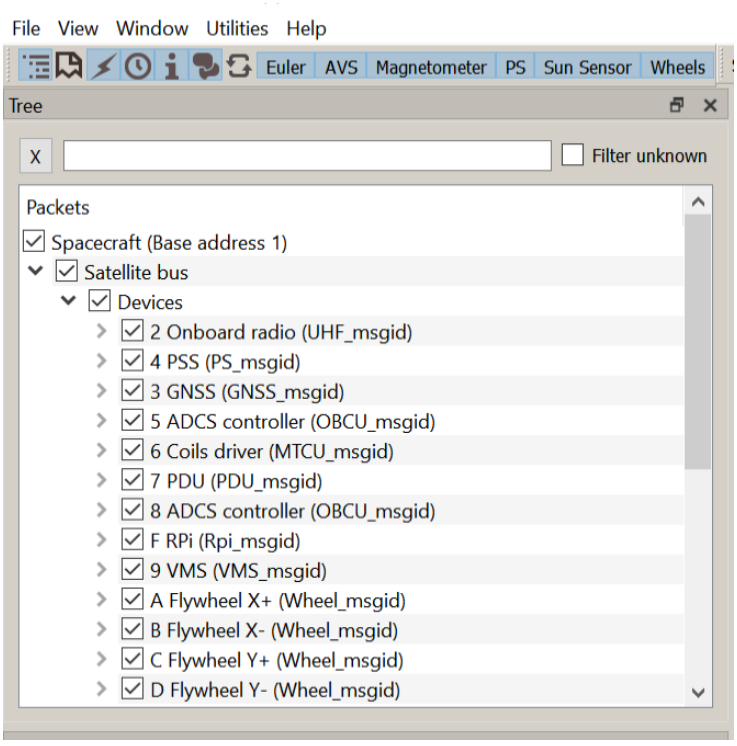


Figure 20 - Tree satellite map display panel

The Tree panel provides the user with a complete description of the satellite

cable network and possible data packets transmitted to devices connected to the network and the well-known Houston CC software. Satellite devices are logically grouped into modules and systems. The satellite map determines the addresses of the devices, the address of the ground station with the right to transfer control to the satellite, as well as the codes of the data packets (commands and telemetry) sent by the satellite to process the HA software.

The tree is built on the basis of description files (xml-files) listed in the configuration file (resources\unican_config.xml). The file specified in the «SputnikMap» parameter is taken as the top level of the hierarchy. It builds a map of the network and devices. Commands for devices are taken from the description files listed in the configuration file in the parameters with the name «DeviceDesk». Parameters «DeviceDesk» (description files) may be several, unlike the parameter «SputnikMap», which should be the only one. Devices in the map.xml satellite map file are associated with field description files <DevModel> of the map.xml file, moreover, the tree may have several devices of the same model, but at different addresses.

Using filtering allows you to determine the content of received messages. With a large amount of information on the bus, limiting the content of received messages allows you to avoid losses when receiving messages and improve the visibility of data display. A sign of permission to receive is set next to each record in the tree; changing a sign on any node changes this sign on all subordinate nodes. The filter can act both on satellite systems, modules or devices, as well as on certain types of messages. By default, when starting the application, all messages on the bus are allowed.

The hot keys include «Right arrow» and «Ctrl+G» - sending a command to the message queue bypassing the field editor. In this case, the command is created with the default field values that are specified in the <FldValue> field of the destination device xml file.

3.7.2 Fields icon – the command editor

By clicking the icon  the command editor panel Fields is displayed, on which

commands are formed for satellite systems in the Unican package format in accordance with the device protocol description and satellite map. The protocol description is read at the device address from the satellite map, after which the description of the header and the command fields are downloaded using the message code.

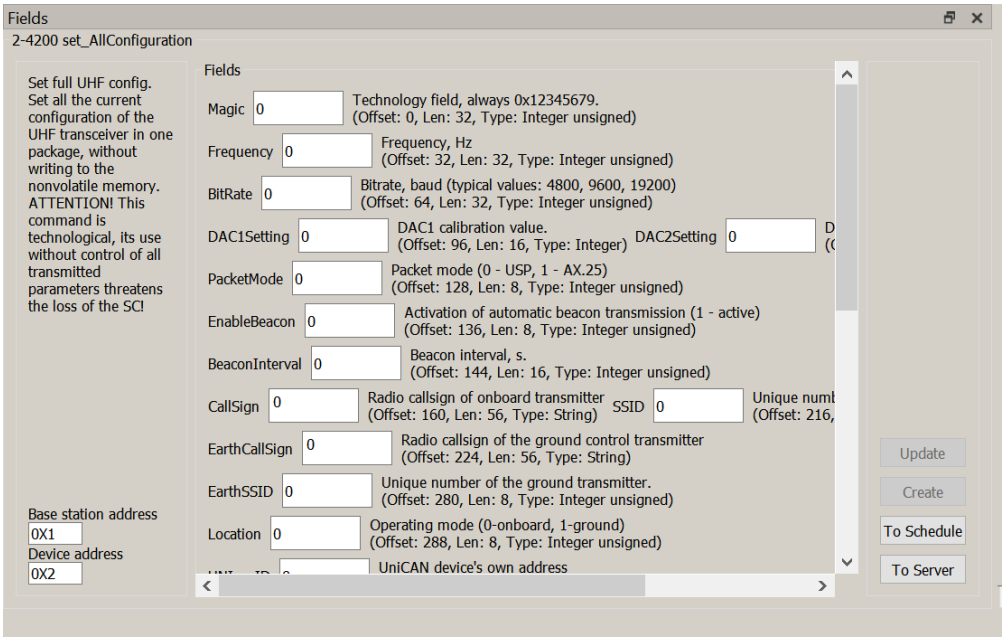


Figure 21 - Command editor panel Fields

The Fields tab (figure 21) consist of:

– command code (2-4200 in the example) and name («set_AllConfiguration» in the example);

– message description (in the example «Set the configuration of the UHF…»);

– base station address;

– device address.

The sender and receiver addresses are downloaded from the satellite network map file and are editable before sending.

In the center are displayed the parameter fields of the command, if any. The input element for the field value depends on the data type specified in the device protocol description file.

A message can be sent to the editor from various sources: the device tree, the history of the history exchange, repetition of the «Repeat Command» commands, and from the «Queue». To «open» a message in the editor, simply select the command with the mouse in any of the listed sources, while for messages from the device tree, the field values are taken «by default» (from the xml), in other cases, the values previously contained in the message remain. When you «open» a message in the editor, a copy of it is created (a new message in the case of the device tree), which enters the queue by pressing the «Create» button.

The Update button serves to update the fields in the «Queue» and «Schedule» table.

The «To Schedule» button is used to include the generated command in the sequence diagram sent to the satellite.

The «To Server» button is used to send the generated command to the server, bypassing the «Queue» command queue.

Messages from the history and messages of the type «datain» (telemetry) can be entered into the Fields panel, but cannot be changed.

3.7.3 Output icon - message output panel

The icon Output  opens the panel for displaying event messages in the HA software (figure 22).

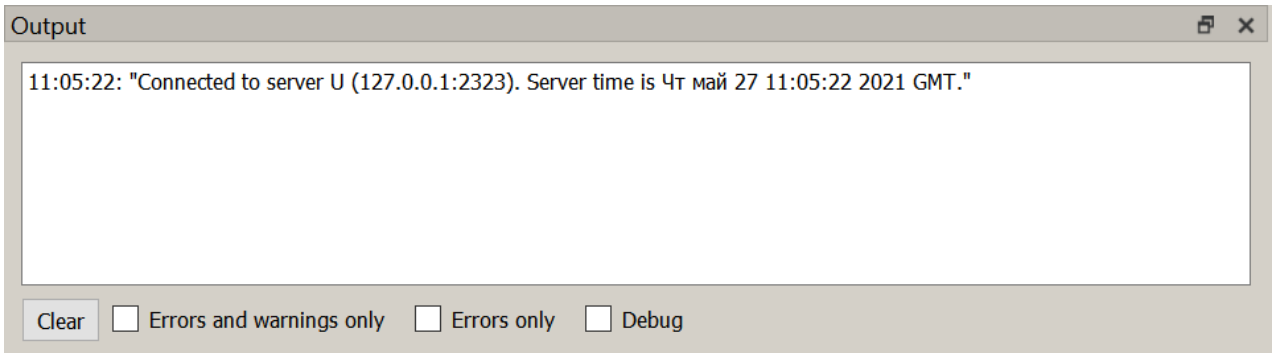


Figure 22 – Output message panel

The Clear button is used to delete all messages from the Output tab.

There are three types of messages in HA software:

– Information - does not require any action from the user,

usually contain confirmation of successful actions;

– Warnings (marked WARNING) - inform the user about changes in the behavior of the system, which should be taken into account;

– Errors (marked ERROR) - non-critical errors, usually regarding the integrity of the downloaded data or access to the disk or server. These errors can significantly slow down HA software..

The number of messages displayed in the Output window is limited.

In addition to the Output panel, all HA software messages are logged in the error_log.txt file (the name is configured in the configuration file), which is created automatically. This file can be used for debugging the program. The error_log.txt file should be sent to the developer if incorrect HA behavior is detected.

3.7.4 Queue icon - the command queue

The command queue allows you to create a logically complete sequence of commands for satellite systems before sending them via the satellite communication channel (figure 23).

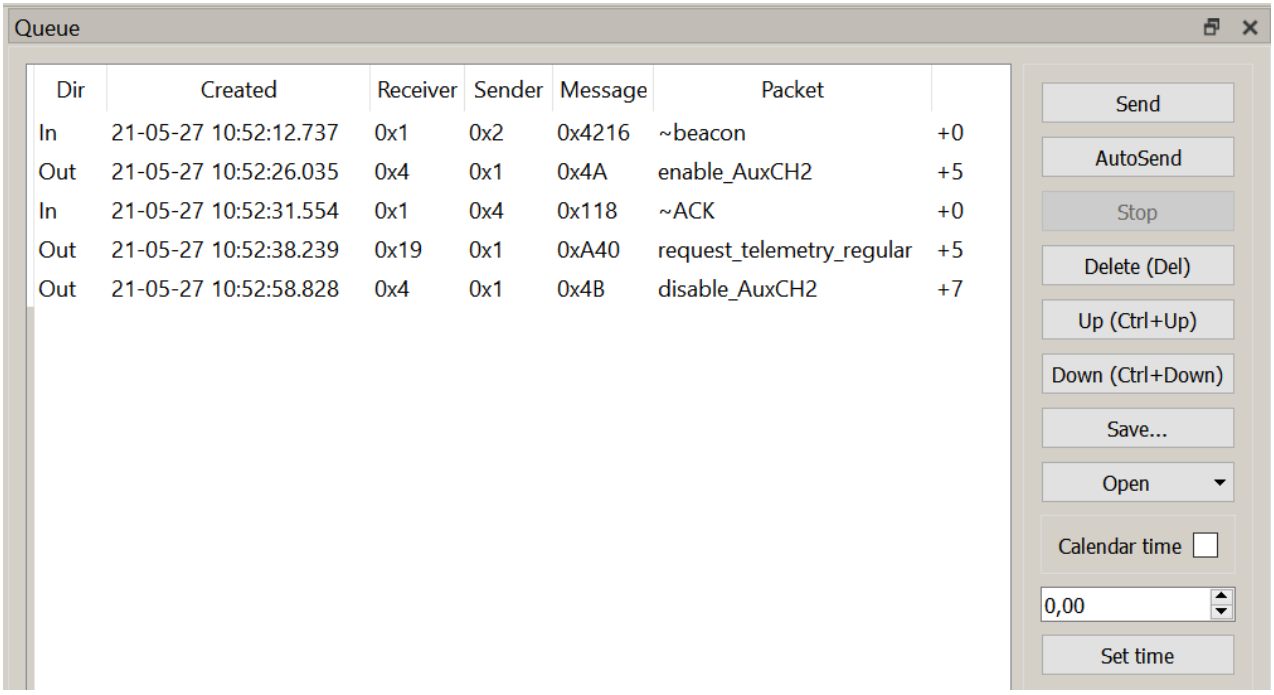


Figure 23 - «Queue» panel

The «Queue» allows to visually verify the correctness of the time schedule of

the entire sequence of commands, edit the commands and control the receipt of each command by the target device of the satellite's onboard network. When checking the time, the correctness of the sequence of dates and intervals is determined (dates must be correct in time and set no earlier than the total intervals). It is possible to save the generated command queue to a file and load a previously formed command queue from a file.

The start of the queue/queue command can be either by specified time/a specified interval, or receiving certain data from a satellite, for example, a beacon or a response to a command.

Attention! In order to avoid endless waiting for a response to a command, it is recommended to use a command with an absolute execution time after the command-response sequence. In this case, when the specified time comes, all the previous commands that were not executed will be skipped.

The Queue panel contains a queue view table and action buttons. The following columns are displayed in the table:

- Direction - transmission direction, In - messages received on the server from the satellite CAN-bus, Out - sent by the server to the CAN-bus from this or another client application;
- Status - message status: Received - successfully received from the CAN-bus, Sending - message sent to the server for sending, Sent - successfully sent by the server to the satellite CAN-bus, Error tx! - error sending from server to satellite bus. Sending status is set only in the HA software of the user from whom the message was sent;
- Created – date and time the message was created / received by the server (the time of the clock on the server is set);
- Receiver - field Destination of the Unican message;
- Sender - field Source of the Unican message;
- Message – Unican message code;
- Packet (for recognized messages) - the name of the

command from the log file;

- Time to send – sending time.
- Notes;
- Abs time – absolute time of sending the packet.

Selecting one or more queue commands executed with mouse. Use the Ctrl+A key combination to highlight all the commands.

To view and edit commands, use the «Fields» window. When a command is selected from the queue, its detailed description with the data of the command fields is opened in the editor panel, the Update and Create buttons become active. For editing, not only the data fields of the command (if any) are available, but also the addresses of the sender and receiver. This allows to create commands for devices at addresses not described in the satellite map (for example, when initializing new devices in a cable network).

The «Send» button and «Enter» key are used to send the selected command to the server. If several commands are selected, the «Send» button will send all selected commands. Only one command is sent by the Enter key; press the Enter key for each highlighted command sequentially.

The «AutoSend» button sends all the commands from the Queue panel.

The «Delete» button or the «Del» key on the numeric keypad deletes the selected command from the queue.

The «Up» (ctrl + «up arrow») and «Down» (ctrl + «down arrow») buttons move the selected command one up or down.

The «Page Up» and «Page Down» buttons move the selected command to the beginning or end of the queue.

The «Save» button saves the generated command queue to a .que file. To select a file name, the standard Windows save window opens.

The «Open» button is used to enter a previously saved queue from a file. Clicking the «Open» button in the drop-down menu opens a list of queues previously saved in the folder «resources\queues\» (folder name is configured in the

configuration file). To quickly open the queue file from the default folder, simply click on the menu item with the name of this file. If the queue is saved in another folder, you can use the From file ... item and select the folder and file in the standard dialog box. If a queue was created by clicking on the Open button in the Queue panel before opening the file, the commands from the file will be added to the end of the existing queue.

There are two ways to determine when to send queue commands to the server:

– setting the date and time the command was sent when the flag Calendar time was set;

– setting the time interval from sending a command to send by pressing the Autosend button until sending a command with the Calendar time flag cleared.

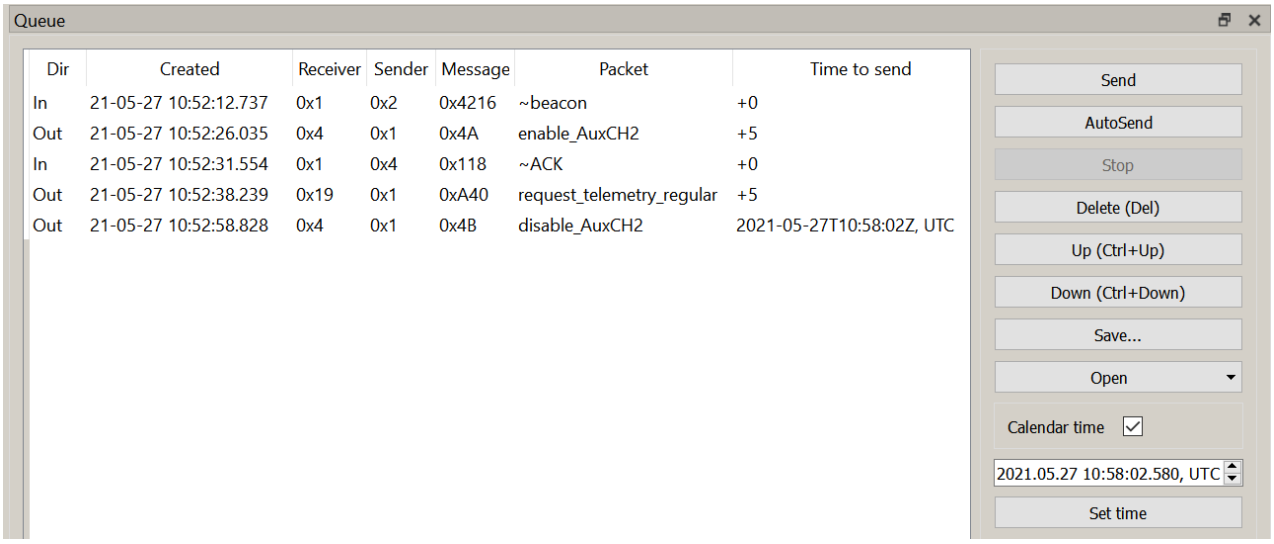


Figure 24 –«Queue» panel with calendar time

If the Calendar time flag is set the date and time are initially set for queue commands by the date and time of the user's machine station in UTC format. The set date and time are displayed in the input line located in the column of control buttons. When you double-click in the field of the Time to send column of the selected command, this column displays the same date and time input line. To change the date and time values, with date and time input line select the parameter to be changed with the mouse and set its value with the increase / decrease buttons. In attempt to send a

queue with an incorrect time, an error message will appear (figure 25).

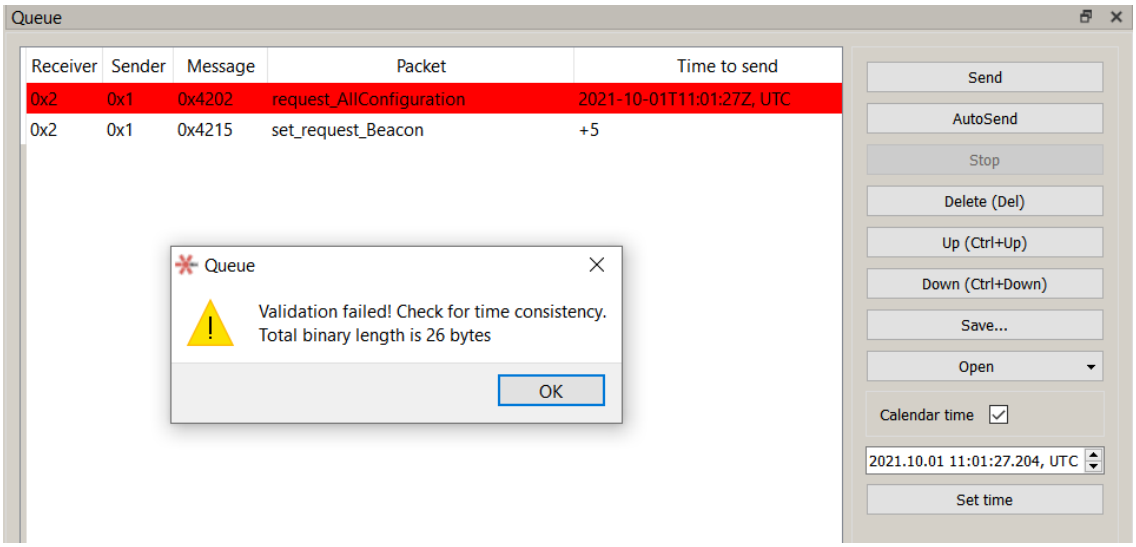


Figure 25 – Error message with incorrect date and time settings

At the end of the setup date and time in the input line of the column of control buttons, press the Set time button. The set value will be displayed in the fields of the Time to send column of the selected command.

In a queue created or opened from a file, lines with an incorrect date/time will be highlighted in red, and commands whose description is not in the satellite map will be highlighted in yellow. Queues with red lines will not be sent by the «Autosend» button.

When the Calendar time flag is unchecked, the time interval is entered from the command to send by pressing the «Autosend» button until the command is sent. The interval value can be set both in the input line of the button column and in the input line that is displayed by double-clicking the mouse in the field of the Time to send column of the selected command. The time interval value is set in seconds with an accuracy of two decimal places (tens of milliseconds).

The «Queue» panel displays both commands and received messages - responses to the transmission of commands. The sign of the response is the ~ symbol in the Packet field. The parameters of the responses can't be edited.

Queue panel hotkeys:

– Delete - remove a command from the queue;

– Enter - sending the next highlighted command to the satellite;

– Ctrl+A – selection of all queue commands;

– Ctrl+C - copy selected commands to the clipboard;

– Ctrl+T – sending the selected command without removing it from the queue.

ATTENTION! It is important to ensure that the queues that are opened are compatible with the used satellite map, otherwise sending them may cause unpredictable behavior. To do this, check the queue after opening the file.

3.7.5 History icon

The icon  in the History panel displays chronologically the messages transmitted via the communication channel with the satellite, including the commands sent from the queue.

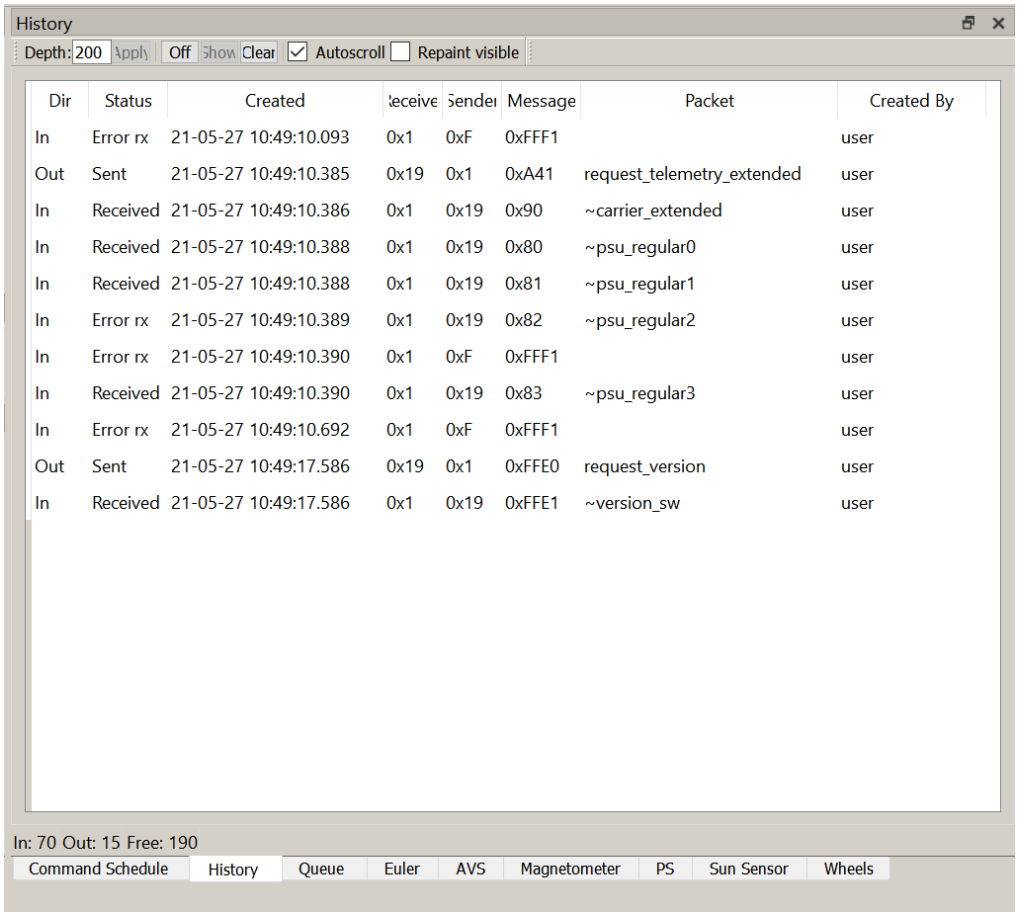


Figure 26 – «History» panel

The «History» panel consists of the settings area, the tabular section and the status bar (figure 26).

The following functions are presented in the settings area:

- Depth - the maximum number of entries in the history table. Available for editing, changes are applied by Apply button. The default value is specified in the configuration file (Unican_config.xml). The value "0" is used to cancel the limit on the size of the history;
- Apply - change the maximum table size according to Depth;
- Off/On - disable/enable history;
- Show – not used in current version;
- Clear - clear the table;
- Autoscroll - show current records in the History window;
- Repaint visible – only visible rows in the table are redrawn.

The following fields are displayed in the tabular section:

- Dir - transmission direction, In - messages received on the server from the satellite CAN-bus, Out - messages sent by the server to the CAN-bus from this or another client application;
- Status - message status: Received - successfully received from the CAN-bus, Sending - message sent to the server for sending, Sent - successfully sent by the server to the satellite CAN-bus, Error tx! - Error sending from the server to the satellite bus. Sending status is set only in the HA software of the user from whom the message was sent;
- Created – date and time of receiving / sending a message by the server (time of hours on the server is set down);
- Receiver - Unican message Destination field;
- Sender - Unican message Source field;

– Message - Unican message code;

– Packet (for recognized messages) - the name of the command from the log file;

– Created by – login of the user who created the message.

The status line displays statistics from the moment the application was launched:

– In - number of incoming messages;

– Out - number of outgoing messages;

– Free - the number of free entries in the history panel, when this amount is reached, old messages will be deleted.

All messages, both incoming and outgoing, get into the history panel. If a message sent to the server by any HA software client is broadcast to all HA software clients connected to this server, then all HA software clients display this message.

If the incoming command is successfully recognized (the destination is found in the satellite map and the message code is in the corresponding protocol file), then the HA software substitutes the command name from the description file in the «Packet» field. For recognized commands, all HA software functions are available (viewing fields, adding to dashboards, etc.).

Filters installed in the Tree panel can be used to filter incoming messages. Filters work only for recognized commands.

ATTENTION! In case of intensive exchange on the bus (more than 25 messages per second), an active history panel with a large Depth value (more than 30) can significantly affect HA software performance. This is due to the peculiarities of redrawing the screen and may lead to the inability of the program to respond to user actions. In order to avoid such situations during intensive exchange, you can take the following actions:

– ***indicate a small Depth value;***

– ***set incoming message filter;***

– ***hide the History panel (by the button on the toolbar or***

behind another panel as a tab);

– ***disable the history with the Off button.***

When history is disabled, all information about the communication channel with the satellite is stored in the message log file and can be displayed as in the Houston CC SP, and other software tools (e.g. Microsoft Excel).

3.7.6 Hex View icon - view Unican hexadecimal code

The Hex View icon shows the view panel of the 16 Unican package code (figure 27). The title and contents of any package in the history or queue can be displayed.

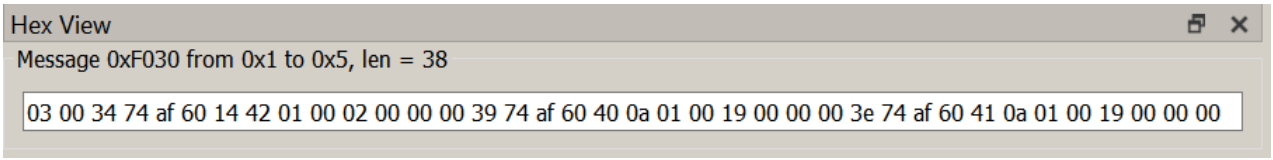


Figure 27 - Hex code view panel

Unlike the Fields editor, unrecognized packages may be displayed in the hex code view panel.

Package header fields are shown as a string, where Message - two-byte message code, from - sender address, to - recipient address, len - data length (in addition to the message code).

Data, if available, is displayed in a single field in the panel in hexadecimal format.

3.7.7 Repeat command icon

The Repeat command icon displays the command repeat bar (figure 28). This panel is a simple way of forming a queue from previously generated commands. Select the command with the mouse and press the Repeat button. The command that is a copy of the selected command, except for the creation date and time, is entered at the end of the queue.

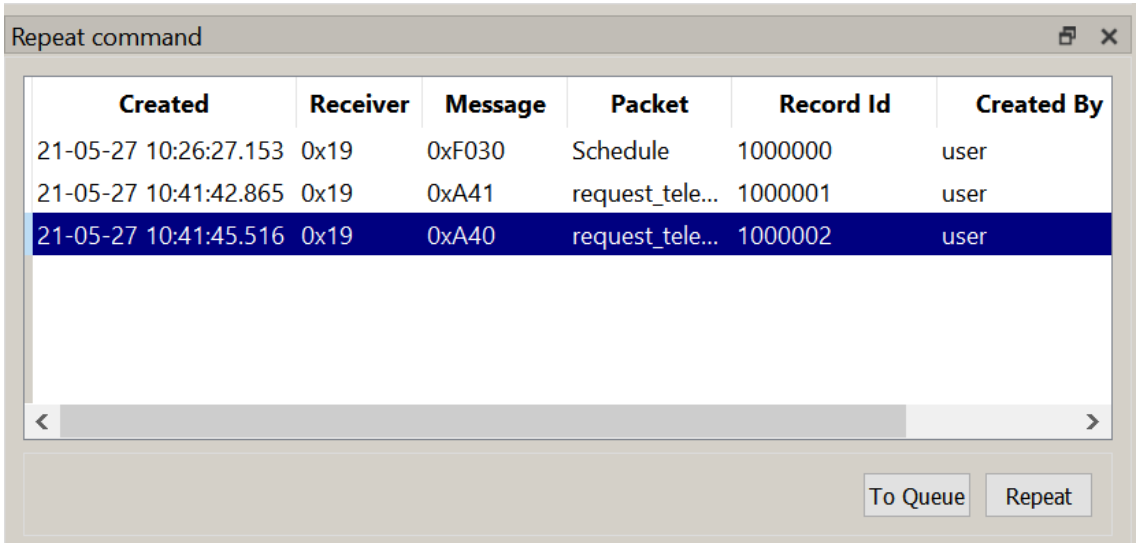


Figure 28 - Command repeat panel

The following fields are displayed on the command repeat panel:

– Created – date and time of receiving / sending a message by the server (time of hours on the server is set down);

– Receiver – receiver, Destination field of Unican message;

– Message - Unican message code;

– Packet (for recognized messages) - the name of the command from the log file;

– Record Id;

– Created by – login of the user who created the command.

3.7.8 Command Schedule panel

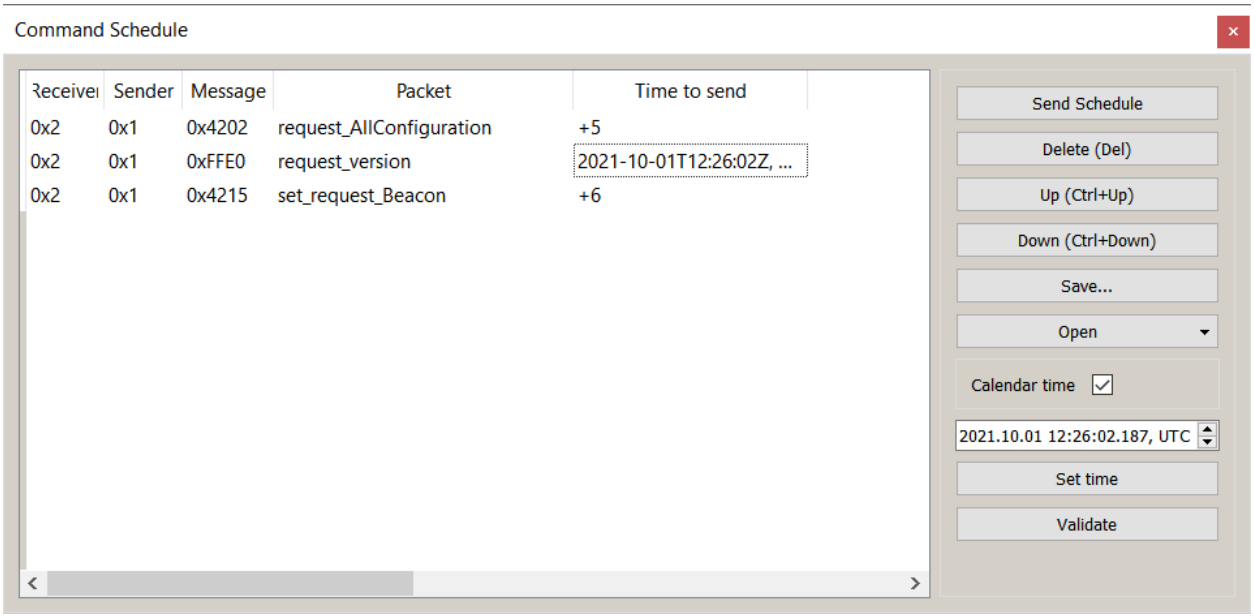


Figure 29 – Command schedule panel

The «Command Schedule» panel (figure 29) contains the schedule view table and action buttons. The following fields are displayed in the table:

– Created – date and time of receiving / sending a message by the server (time of hours on the server is set down);

– Receiver – receiver, Destination field of Unican message;

– Message – Unican message code;

– Packet (for recognized messages) – the name of the command from the log file;

– Time to send – time of sending;

– Notes;

– Abs time – absolute time of sending the packet.

Selecting one or more schedule commands is done with the mouse. Use the Ctrl+A key combination to highlight all the commands.

To view and edit commands, use the «Fields» panel. When you select a command from the schedule, its detailed description with the data of the command fields opens in the editor panel, the «Update» and «Create» buttons become active. For editing, not only the data fields of the command (if any) are available, but also

the addresses of the sender and receiver. This allows to create commands for devices at addresses not described in the satellite map (for example, when initializing new devices in a cable network).

The «Send Schedule» button sends the cyclogram in one data package to the address specified in the Houston App parameters (BoardAddress).

To check the correctness of the compiled schedule and its size, the «Validate» button is used.

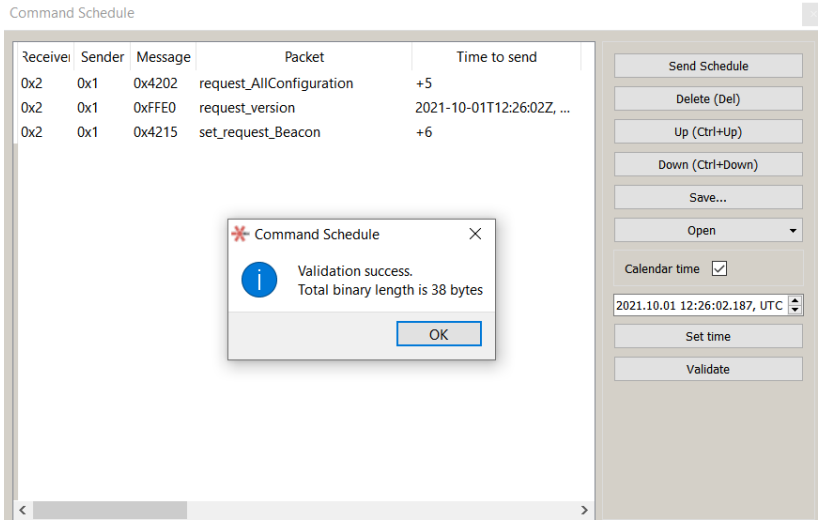


Figure 30 – Schedule validation

The schedule lines with an incorrect time are highlighted in red, the lines with commands that are not in the satellite map are highlighted in yellow. A schedule with an incorrect time will not be sent using the «Send Schedule» button.

Attention! The schedule uses absolute time, so before sending the schedule, it is necessary to check the correspondence of the time on the computer and the on-board time. On-board time and schedule time in UTC.

Attention! The package of commands that is sent by the «Send Schedule» button should not exceed the size of 195 bytes.

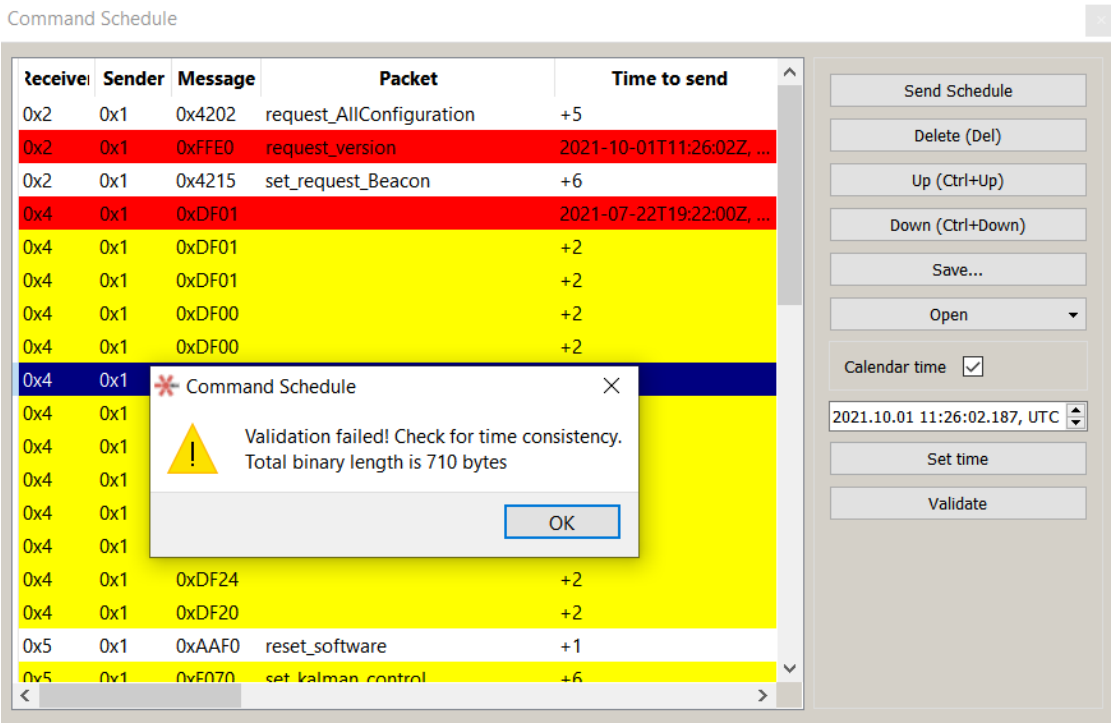


Figure 31 – Schedule error message

The Delete (Del) button removes the selected command from the schedule.

The «Up» (ctrl + «up arrow») and «Down» (ctrl + «down arrow») buttons move the selected command one up or down.

Use the «Page Up» and «Page Down» buttons to move to the beginning or end of the schedule.

The «Save» button saves the generated command schedule to a .sch file or .bin file. To select a file name, the standard Windows save window opens.

The .sch files are used to resend the saved cyclogram via the command schedule panel. Files .bin are used to load saved UHF cyclograms over Ymodem and then running them for execution through the Houston Application by sending 0x4230 tc_cmdschedule_load_from_file command with value corresponding with the schedule .bin file, for example, uhf.bin. Schedule in the format .bin has no restrictions on the length of the transmitted file.

Attention! The first command from the schedule .bin file must start with a command with the absolute sending time in UTC.

The «Open» button is used to enter a previously .sch saved schedule from a

file. When click the «Open» button in the standard Windows dialog box, the «resources \schedules\» folder opens (the name of the folder is configured in the configuration file). If the schedule is saved in another folder, the dialog box can be used to select a folder and file. If any schedule was created using the «Open» button in the «Command Schedule» panel before opening the file, the commands from the file will be added to the end of the existing schedule.

The date and time parameters are defined in the same way as working with the «Queue» panel (see p. 3.7.4).

Hotkeys:

- Ctrl+A – selection of all queue commands;
- Ctrl+C – copy the selected commands to the clipboard.

3.8 Dashboards

The dashboard mechanism allows to create new tabs with an arbitrary set of tools for efficient work with devices connected to the satellite bus.

3.8.1 General description

Dashboards can be configured to work effectively with a specific device. According to the user's preferences, tools can be placed for analyzing telemetry coming from the device and the necessary control commands or sets of commands can be generated for operational control of the device, including without using the command queue window. An example of the appearance of the panel is shown in the figure 32:

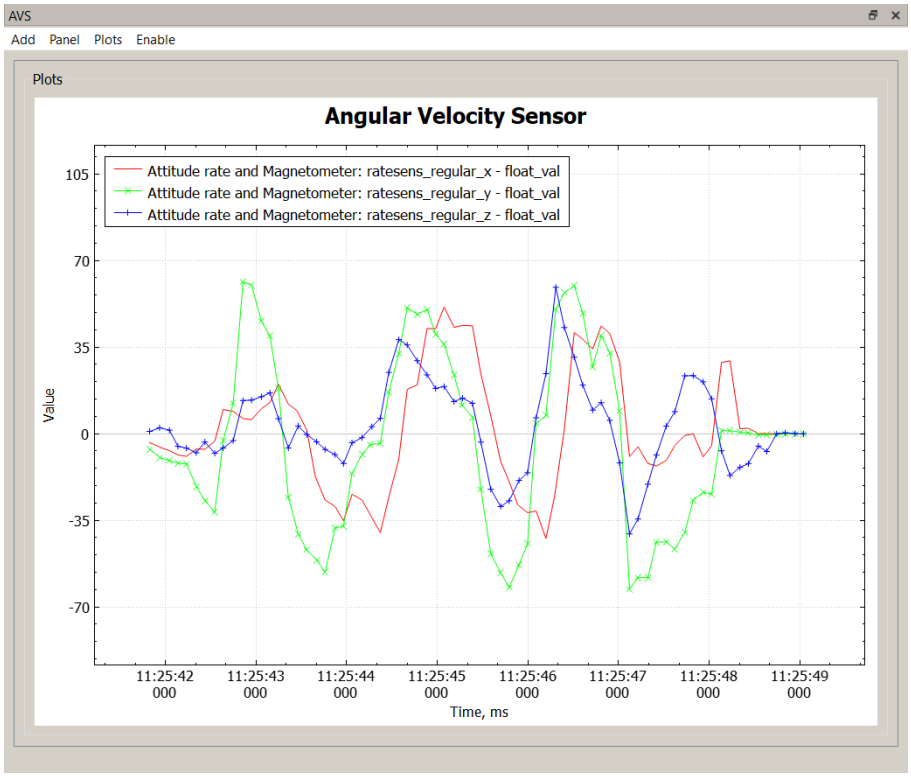


Figure 32 – Dashboard example

Three kinds of tools are supported:

– plots;

– field value tracking (Watch);

– buttons send commands (Actions).

The dashboard menu includes the following items:

– Enable/Disable - activation of receiving data on the panel; with Enable, the plot continues to be built using the received data; with Disable, the plot is stopped;

– Add – adding a new plot to the panel (see p. 3.8.3);

– Panel – panel export to file racks*.hir type;

– Plots – setting Autoscale mode for automatic scaling of plots.

3.8.2 Creating a new panel

To create a new panel, select in the menu «Window - New instrument panel», then a dialog box appears for entering the name of the new panel:

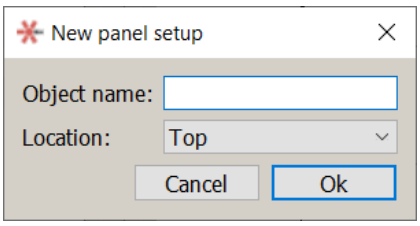


Figure 33 – The window of adding the new panel

In the input window should indicate:

– Object name - panel name;

– Location - initial placement of the panel in the main HA software window (can be changed later).

After entering the data, click Ok. A new dashboard appears inside the HA software main window.



Figure 34 – An example of a new dashboard

3.8.3 The formation of the dashboard

After creating a new dashboard, menus for inserting controls become available.

To create a chart by field, need to configure the chart output area, this is done in the dashboard menu «Add - CustomPlot ...» and fill in the fields of the dialog box (figure 35).

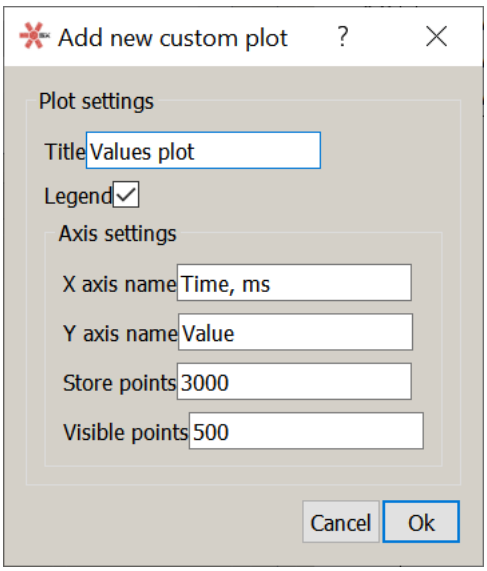


Figure 35 - Plot settings window

Where:

– Title - name of print area;

– Legend - show legend on a plot;

– X axis name - X axis display name;

– Y axis name - Y axis display name;

– Store points - number of plot points (large values can cause performance problems for fast data flow);

– Visible points – number of points displayed.

After entering the data, click Ok.

On the «Fields» command panel, context menu items will be available for displaying parameter values on the dashboard. A command in the «Fields» panel whose fields include the value whose values you want to display should be opened. By right-clicking on the input field of a value of interest, a context menu opens. Selecting «Add to plot» opens a list of formed dashboards and their elements - plots and fields of the last «Watch» value (figure 36). Click on the corresponding plot or field «Watch».

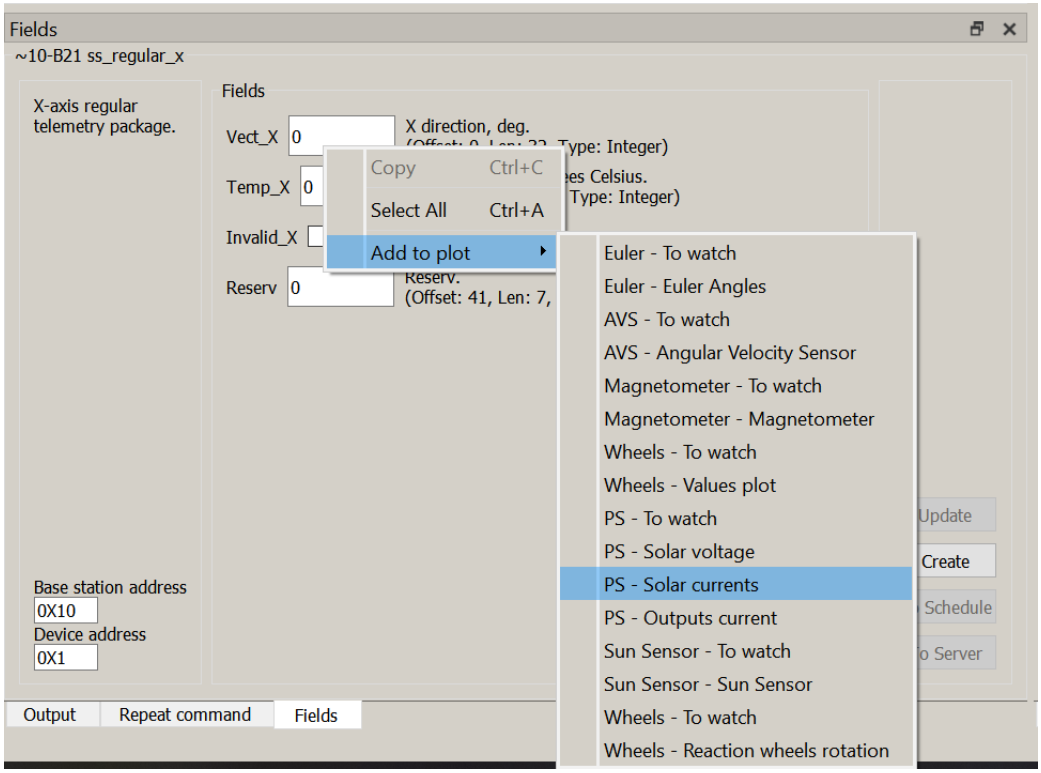


Figure 36 – Context menu for displaying a parameter on the dashboard

To install a command button on the dashboard, right-click the corresponding command in the «Fields» panel (figure 37). In the context menu that opens, select «Add to rack». A list of dashboards opens, where you can select the panel to install the command button. Similarly, you can set the command button from the «Queue» panel.

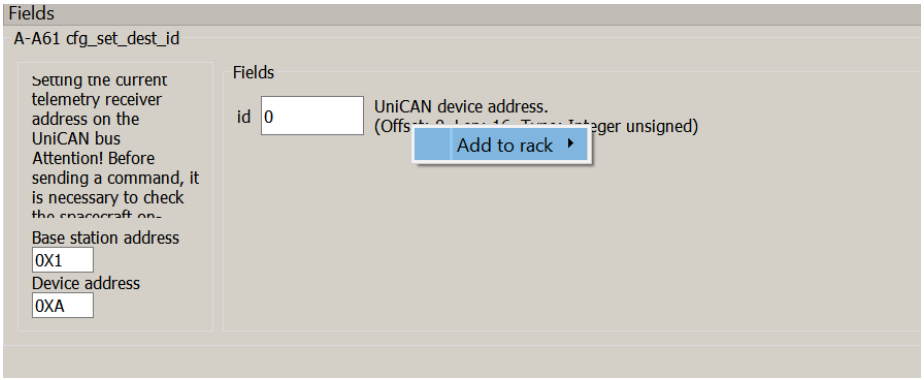


Figure 37 – Insert command buttons

For the new button, the name should be specified in the opened window (figure 38).

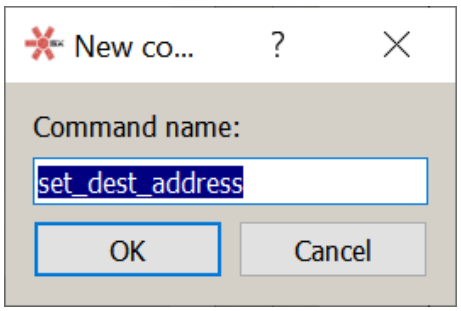


Figure 38 - Button name entry window

New buttons are installed on the dashboard, the first 10 buttons are added «hot keys» from the keys "0" to "9" (numbers on the main panel of the keyboard) (figure 39).

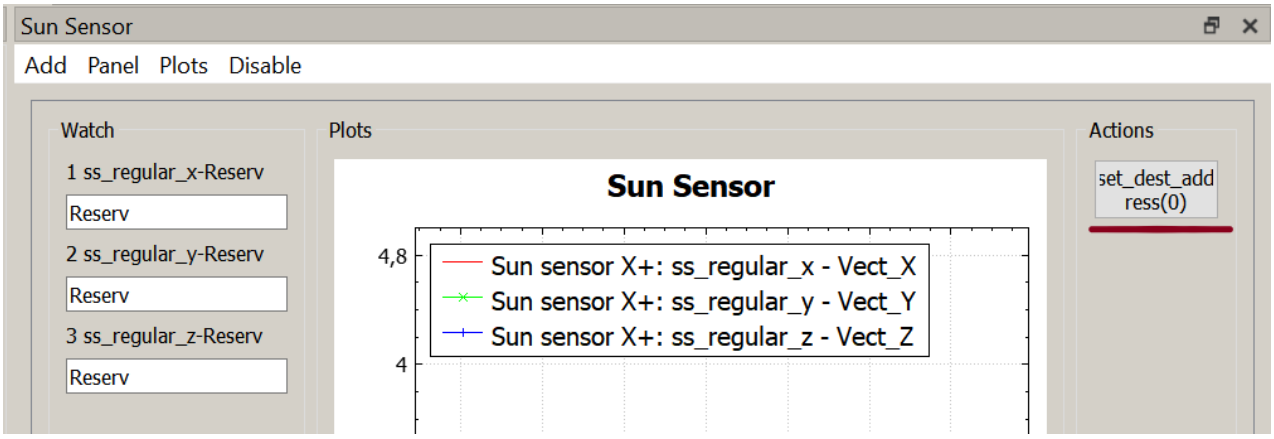


Figure 39 – An example of a formed dashboard

3.8.4 Export panel

The formed dashboard can be saved to a file. To do this, select «Panel - Export ...» in the dashboard menu and select a file name. The file has the extension «.hir» and is an xml-structure that can be edited using XmlPad or any text editor.

3.8.5 Panel file connection

When the program loads, panels are automatically loaded, the*.hir files of which are in the \Resources\Racks folder.

If panel loading errors occur, error descriptions will be displayed in the message window, and problem items will not be placed on the dashboard. Errors usually occur when a downloadable panel was created with a different set of satellite map files and device protocols.

3.8.6 Using the panel

Activation of receiving data on the panel is carried out by pressing the Enable/Disable menu. When starting HA software, all panels are active.

With a large flow of information and the use of several active panels with plots, performance problems may occur. To reduce the load on HA software, it is recommended not to display many panels at the same time, but to make tabs of them. Unused panels can be disabled, or disable Autoscale mode for plots.

Any items added to the panel can be removed from the context menu.

The panels themselves can be unloaded from the program through the «Window - Destroy dock widget» menu.

3.8.7 Plots

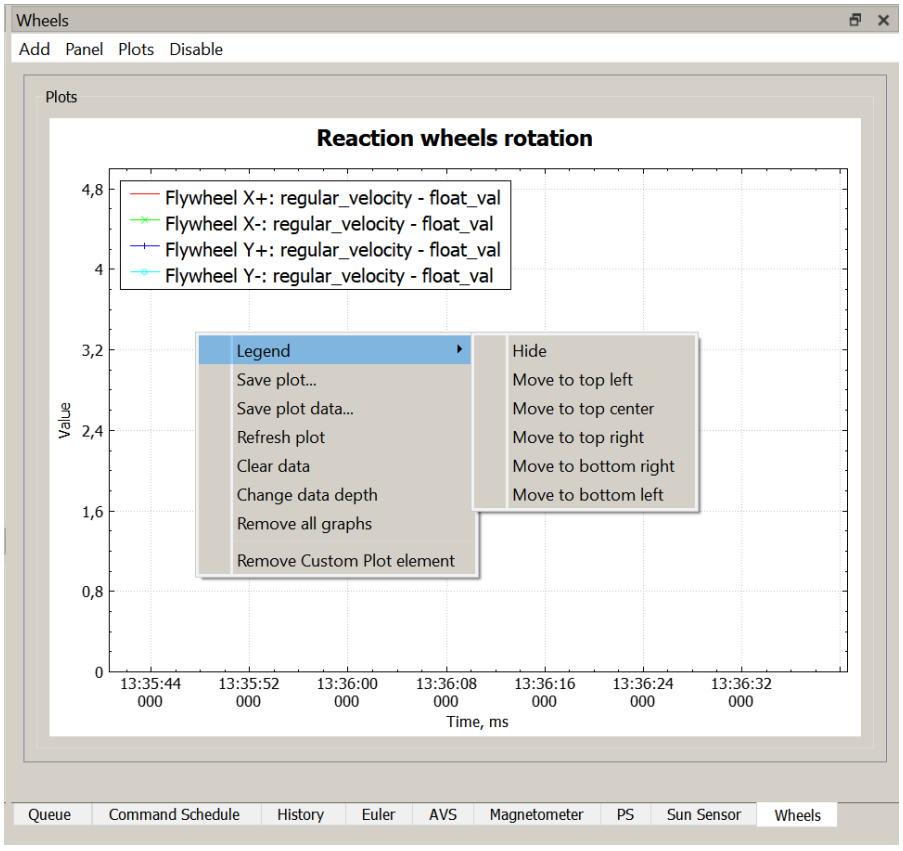


Figure 40 - Example of plotting a graph

The build area supports the following functions (figure 40):

– scaling of plots (along both axes or along one axis);

– double-click to edit the area name and axis labels;

– auto zoom (Plots - Autoscale);

– Legend - show/hide/move description of plots symbols;

– Save plot - saving the current image to a graphic file (png, jpeg, pdf, bmp);

– Save plot data - saving the data of the selected plot to a .csv file (attention, uploading a large amount of data can take a lot of time);

– Refresh – plot redrawing;

– Clear data - clear previous plot data;

– Change data depth – number of points displayed on the plot;

– Remove all graphs – delete plotted graphs;

– Remove Custom plot element – removing the plotting field.

To get the exact value at the selected point in the graph, select the graph and double-click to create a «marker» at the point of interest. The status panel displays the values of this point in the plot (figure 41).

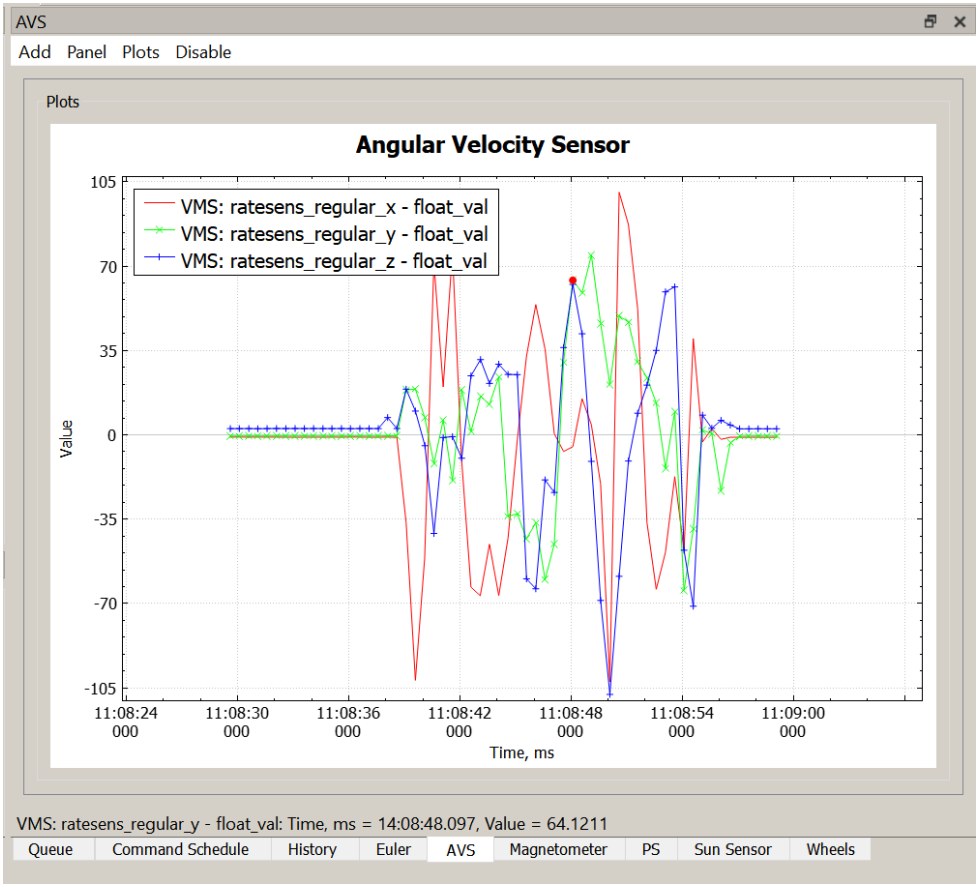


Figure 41 – An example of determining a value at a point in a graph

3.8.8 Send buttons

Buttons for sending commands can be configured to send one or more commands. In the latter case, a pause of 1 ms is inserted between sending commands. The composition of the commands corresponding to the button can be seen in the «tooltip» when you mouse over the button area (figure 42).

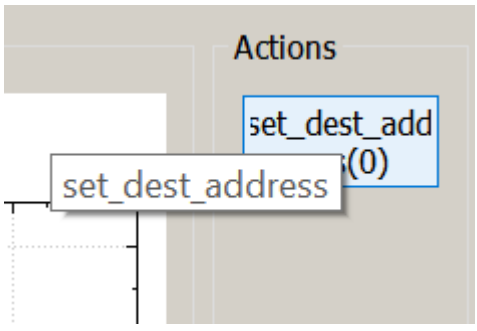


Figure 42 – Button popup list of commands

When adding a button to the panel, the first 10 are assigned «hot keys», which are indicated in brackets after the name of the button. When a hot key is pressed, the

same sequence is sent as a mouse click on a button. The action is confirmed by displaying the message in the history panel. For the hot keys to work correctly, it is necessary that the focus (cursor) be on the button area at the moment of pressing.

ATTENTION! The buttons work without using the command queue, sending data to the satellite without confirmation. Care must be taken when using them.

3.8.9 Tracking values

Allows quickly track the last value of the selected field on the dashboard. It is recommended to use for fields that rarely change their value.

4 HOUSTON SERVER SOFTWARE

4.1 General description

The Houston Server software provides two-way interaction between HA software client applications and satellite cable network.

HS software connects to the satellite cable network using one of the supported adapters (CANverter, DTA-CAN), connects to one or more HA software client applications through a TCP/IP network protocol.

HS software is designed to handle a significantly larger amount of data than HA software, and operates regardless of the availability of network connections and the availability of HA software clients. HS software continues to receive data from the satellite cable bus and save it in its own message log file in case of HA software client malfunction (telnet unican messages are also recorded in the log). After reconnecting to HS software, the HA software client can continue to work with satellite.

The HS software handle the satellite message headers and transmits the callsign of the spacecraft with which the connection is established via HA

4.2 Application scenarios

The performance of HS software can be affected by the large number of connected HA software, therefore it is recommended to limit the maximum number of connections: for networks with high latency (WiFi, Internet) - two HA software clients, for Ethernet 100/1000 Mbit networks - no more than four HA software. It is recommended to avoid sending commands to the satellite from several HA software, as this can lead to unpredictable results due to possible inconsistency in the actions of HA software users.

Two connection schemes are used for HA software.

In the first connection scheme for HA software:

– first workstation of HA software - a dispatcher user with the right to generate and send commands;

– the second workstation of HA software is a user-observer

without the right to form and send commands. Is a «hot reserve» dispatcher.

Both HA software can run simultaneously and receive data, but only the dispatcher user sends commands. In the event of a failure of the HA software of the dispatcher user, the user of the «hot reserve» takes control until the failure is eliminated.

In the second scheme of connections for HA software:

– first workstation of HA software - a dispatcher user with the right to form and send commands;

– there may be several simultaneously working observer users, one of which is the dispatcher's «hot reserve».

4.3 Main menu Houston Server software

The main menu of HS software is shown in the figure 43.

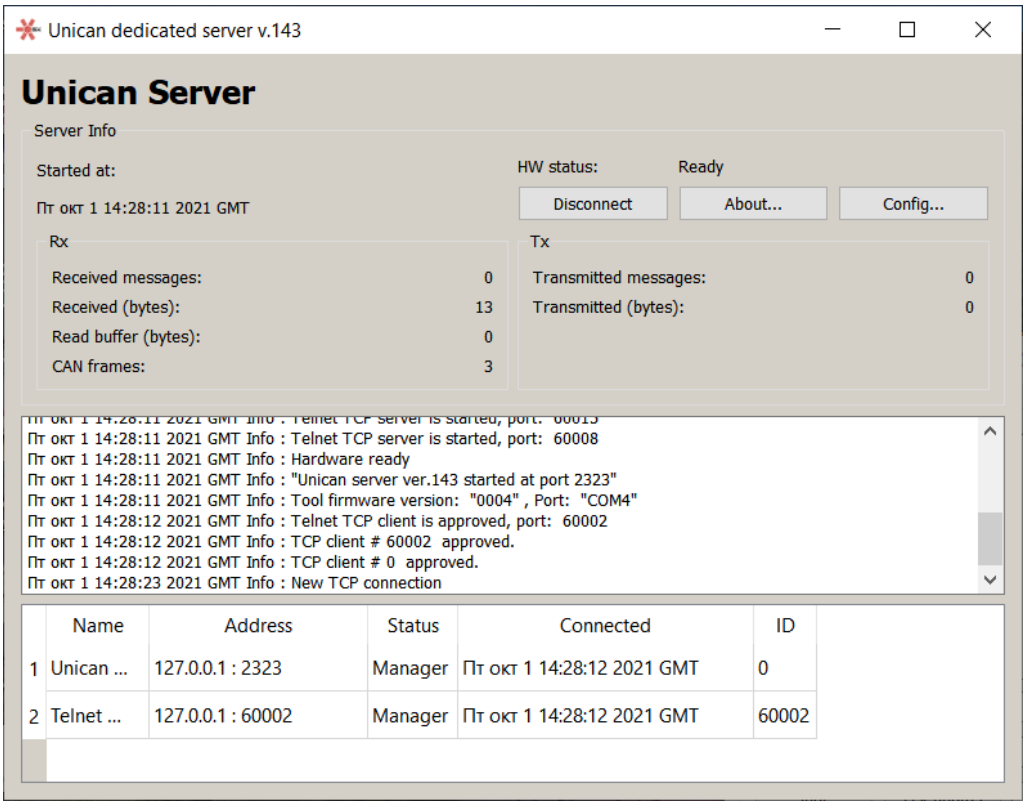


Figure 43 – Main menu HS software

The top line displays the HS software version number.

4.3.1 Server info panel content

The Server info panel displays following information:

– date and time of HS software launch (Started at);

– COM-port status; communication channel with satellite equipment (HW status);

– number of messages received from satellite;

– number of received bytes of information (received (bytes));

– number of messages sent to the satellite (Transmitted messages to satellite);

– number of bytes of information transmitted (Transmitted (bytes));

– size of the read buffer (Read buffer (bytes));

– number of messages that were sent to the server over the CAN bus (CAN Rx).

There are «Connect», «About» and «Config» buttons on the «Server info» panel.

4.3.2 Connect button actions

For a USB connection, the Interface parameter in the configuration file must be set to usbtin.

If the device is connected, the server establishes the connection automatically, if several devices are connected, a message will appear with the choice of the device to connect to.

4.3.3 About button actions

The About button opens the information window about Houston CC SP (figure 44).

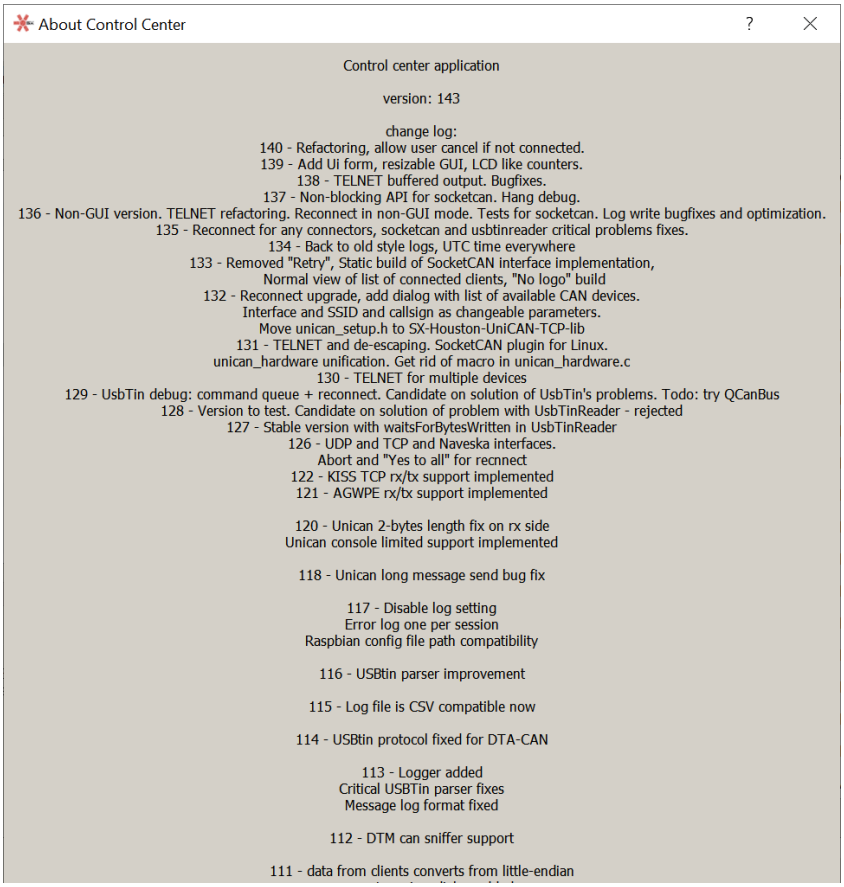


Figure 44 - Houston CC SP information window

The Ok button closes the information window. About Qt button opens the Qt development environment information window (figure 45).

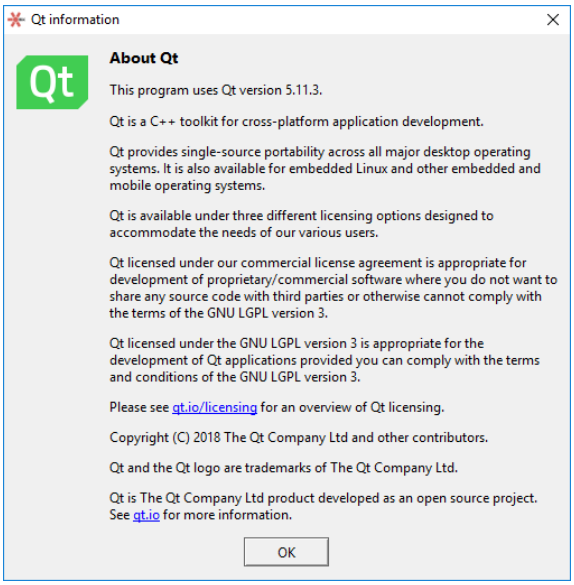


Figure 45 - Qt development environment information window

The Ok button closes the information window.

4.3.4 Config button actions

The «Config» button opens the settings window «Parameters» (figure 46).

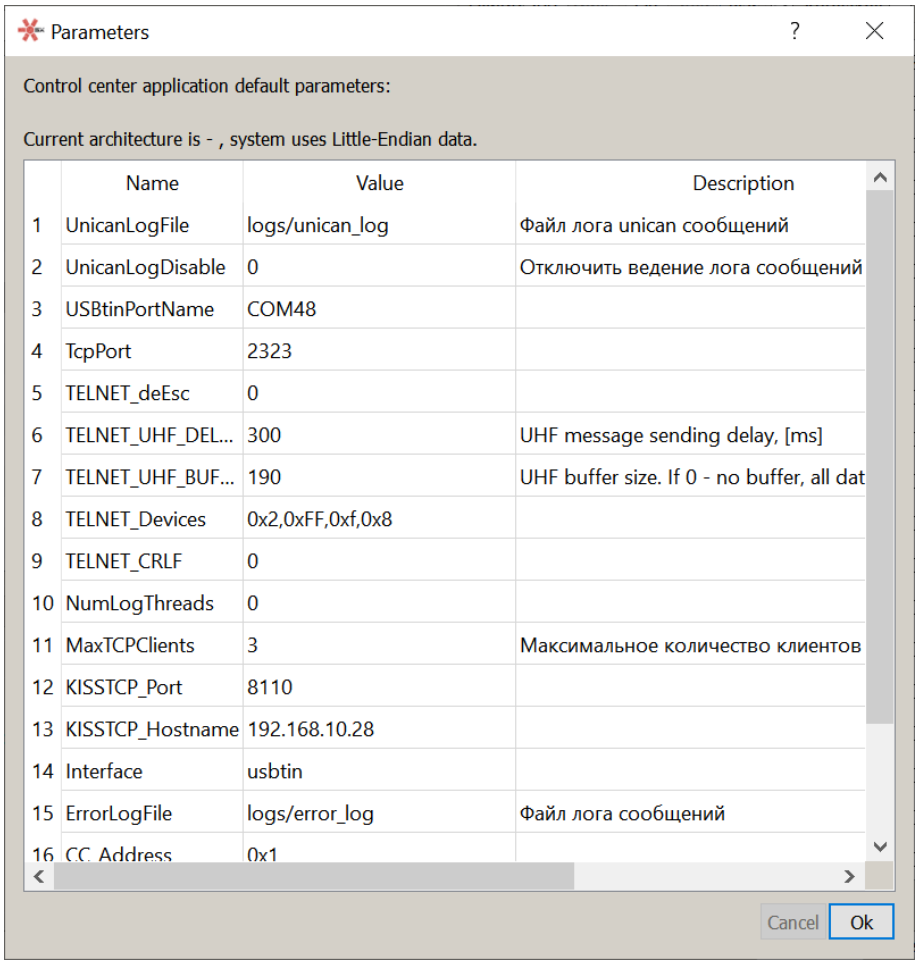


Figure 46 –Houston Server software parameters window

The Name column displays parameter names that cannot be edited.

The Value column displays parameter values that can be changed by the user. To change, select the appropriate cell in the table with the mouse and enter a new value from the keyboard.

The Description column displays parameter descriptions that cannot be edited.

By pressing the «Ok» button, the entered parameter values are saved and the «Parameters» window is closed.

The «Cancel» button closes the «Parameters» window without saving parameter values.

4.3.5 System message panel

The panel displays the following information about system messages:

- date and time of the message;
- message type – Info, Critical, Warning, Debug;
- message content.

Info messages are informational and do not require any action from the user. Critical messages require analysis and elimination of the causes of an emergency. Debug messages are generated only during the debug phase of HS software.

4.3.6 Panel of connected clients HA software

The panel displays the following information about the status of HA software clients with whom information is exchanged (including telnet connections):

- HA software client name (Name);
- HA software client IP-address client (Address);
- HA software client status (Status);
- HA software date of connection with the client (Connected);
- HA software ID of the connected client (ID).

4.4 Houston Server TCP message protocol

Houston Server allows multiple client connection via specified TCP port. The TCP port number is set up by a server parameter «TCP port». A single TCP packet may contain multiple messages.

The TCP message datagram format is described below.

Offset	Size	Name	Description
0x00	2	tagST	Packet start tag. #define UCD_MSG_START_TAG 0xBA5E
0x02	2	msg	Message type 1) To satellite, from application to server #define UCD_MSGTYPE_TO_SAT 0x1000 2) Application state, from application to server #define UCD_MSGTYPE_APP_INFO 0x1001 3) From satellite, from server to application #define UCD_MSGTYPE_FROM_SAT 0x2000 4) Server info, from server to application #define UCD_MSGTYPE_SRV_INFO 0x2001 5) Server state, from server to application #define UCD_MSGTYPE_SRV_STAT 0x2002
0x04	2	zero	Zero word. Value is 0x0000.
0x06	4	len	Packet size in bytes = 2 + 2 + 2 + 4 + Payload data size + 2
0x0A	len	data	Payload (depends on Message type, msg)
len	2	tagEnd	Packet end tag #define UCD_MSG_END_TAG 0xBA11

1) Message type : UCD_MSGTYPE_TO_SAT.

This message type is sent by Client application connected to Server port, to transfer UNICAN message to satellite.

Payload for message type: UCD_MSGTYPE_TO_SAT			
Offset	**Size**	**Name**	**Description**
0x00	4	message_tag	Message tag
0x04	2	unican_msg_id	Unican message id
0x06	2	unican_address_from	Sender address in satellite network
0x08	2	unican_address_to	Receiver address in satellite network
0x0A	2	unican_length	Unican message length
0x0C	unican_length	data	Unican message data

```
// Payload for message type: UCD_MSGTYPE_TO_SAT

typedef struct ucs_unican_to_sat_t
{
    quint32    message_tag;           //!<ofs=0x00 unican message tag
    quint16    unican_msg_id;         //!<ofs=0x04 unican message id
    quint16    unican_address_from;   //!<ofs=0x06 sender address in sat
network
    quint16    unican_address_to;     //!<ofs=0x08 receiver address in sat
network
    quint16    unican_length;         //!<ofs=0x0A data size
```

```
} ucs_unican_to_sat_t;
```

2) Message type : UCD_MSGTYPE_APP_INFO.

This message type is sent by Client application connected to Server port after establishing a connection.

Payload for message type: UCD_MSGTYPE_APP_INFO			
Offset	**Size**	**Name**	**Description**
0x00	4	version	Version number
0x04	32	desc	Application description string = L"Unican control center"
0x24	8	reserv	Reserved

```
// Payload for message type: UCD_MSGTYPE_APP_INFO
typedef struct ucs_app_info_t
{
    quint32     version;       //!<ofs=0x00
UNICAN_DEDICATED_SERVER_LIB_VER=0x64
    char        desc[32];      //!<ofs=0x04 desc=L"Unican control center"
    char        reserv[8];     //!<ofs=0x24 reserved,[0] - for client type
} ucs_app_info_t;
```

3) Message type : UCD_MSGTYPE_FROM_SAT.

This message type is sent by Server to all connected Client application as a response to all processed UNICAN messages.

Payload for message type: UCD_MSGTYPE_FROM_SAT			
Offset	**Size**	**Name**	**Description**
0x00	4	direction	Message direction 0x00 – from satellite 0x01 – to satellite
0x04	4	tx_status	Transmit status 0x00 – transmit error 0x01 – transmit ok
0x08	8	serverTime	Server time in UTC (UTC since 1970, [ms])
0x10	8	stampId	Autoincrement message stamp
0x18	4	message_tag	Message tag
0x1C	2	unican_msg_id	Unican message id
0x1E	2	unican_address_from	Sender address in satellite network
0x20	2	unican_address_to	Receiver address in satellite network
0x22	2	unican_length	Unican message length
0x24	4		Alignment interval
0x28	unican_length	data	Unican message data

```
// Payload for message type: UCD_MSGTYPE_FROM_SAT
#define UCD_UNICAN_DIR_FROM_SAT     0
#define UCD_UNICAN_DIR_TO_SAT       1

#define UCD_UNICAN_TX_ERR           0
#define UCD_UNICAN_TX_OK            1
```

```
typedef struct ucs_unican_to_app_t
{
    quint32    direction;
    quint32    tx_status;
    quint64    serverTime;
    quint64    stampId;
    quint32    message_tag;
    quint16    unican_msg_id;
    quint16    unican_address_from;
    quint16    unican_address_to;
    quint16    unican_length;
} ucs_unican_to_app_t;
```

4) Message type : UCD_MSGTYPE_SRV_INFO.

This message type is sent by Server to Client application as a response to UCD_MSGTYPE_APP_INFO message type.

Payload for message type: UCD_MSGTYPE_SRV_INFO			
Offset	**Size**	**Name**	**Description**
0x00	4	version	Server unican lib version UNICAN_DEDICATED_SERVER_LIB_VER = 0x64
0x04	4	client_state	Client state. Set to 0x01
0x08	4	server_state	Server state. Set to 0x00
0x0C	4		Alignment interval
0x10	8	serverTime	Server time in UTC (UTC since 1970, [ms])
0x18	32	desc	Server description string = L"Unican dedicated server"
0x38	8	reserv	Reserved

```
// Payload for message type: UCD_MSGTYPE_SRV_INFO
typedef struct ucs_server_info_t
{
    quint32     version;
    quint32     client_state;
    quint32     server_state;
    quint64     serverTime;
    char        desc[32];
    char        reserv[8];
} ucs_server_info_t;
```

5) Message type : UCD_MSGTYPE_SRV_STAT.

This message type is sent by Server to Client application as a response to UCD_MSGTYPE_APP_INFO message type.

Payload for UCD_MSGTYPE_SRV_STAT			
Offset	**Size**	**Name**	**Description**
0x00	4	state	Server state code. Set to 0x00.
0x04	4	hw_state	Hardware state. (see enum HWState) 0x00 – Hardware error 0x01 – Hardware not inited 0x02 – Hardware ready
0x08	4	errcode	Server error code. Set to 0x00.
0x0C	4	hw_errcode	Hardware error code. (see enum SerialPortError)

			0x00 – No error 0x01 – Device not found 0x02 – Permission error 0x03 – Open error 0x04 – Parity error 0x05 – Framing error 0x06 – Break condition error 0x07 – Write error 0x08 – Read Error 0x09 – Resource error 0x0A – Unsupported operation error 0x0B – Unknown error 0x0C – Timeout error 0x0D – Not open error
0x10	8	data	Payload data
len	2	reserv	Reserved

```
// Payload for message type: UCD_MSGTYPE_SRV_STAT

#define UCD_HWSTATUS_ERROR          0
#define UCD_HWSTATUS_NOTINIT        1
#define UCD_HWSTATUS_READY          2

enum HWState
{
        HW_NOTINIT = UCD_HWSTATUS_NOTINIT,
        HW_READY = UCD_HWSTATUS_READY,
        HW_ERROR = UCD_HWSTATUS_ERROR
};

enum SerialPortError
{
        NoError,
        DeviceNotFoundError,
        PermissionError,
        OpenError,
        ParityError,
        FramingError,
        BreakConditionError,
        WriteError,
        ReadError,
        ResourceError,
        UnsupportedOperationError,
        UnknownError,
        TimeoutError,
        NotOpenError
};

typedef struct ucs_server_state_t
{
    quint32     state;
    quint32     hw_state;
    quint32     errcode;
    quint32     hw_errcode;
    char        reserv[8];
} ucs_server_state_t;
```

5 WMHELP XMLPAD SOFTWARE

WmHelp XmlPad - application designed to work with xml files. WmHelp XmlPad provides visual design tools xml и DTDs. The program fully supports xml-scheme and CVS format. It is possible to highlight syntax, navigate through elements, preview and print xml-schemes in the form of graphic diagrams, code validation, component refactoring and the use of regular expressions.

(Description taken from http://mysoftdom.ru/, detailed description on the softopedia.com).

6 HARDWARE

6.1 General description

Various hardware is used to ensure Houston Control Center operation; the following devices are supported:

- DTA-CAN interface converter;
- CANverter interface converter.

HS software is installed on a PC with a CAN adapter connected to it via USB. HA software clients can run on the same PC as the HS software, or on other PCs. This method is convenient for debugging individual devices, because it allows to create several working station.

6.2 Initializing CAN under Windows

The USB_driver_DTA_DTM.exe file installation required. Then from the installed directory (C:\Program Files (x86)\STMicroelectronics\Software\Virtual driver comport\Win7(8) for example) run dpinst_amd64 (x86).exe. A reboot may be required.

6.3 Initializing CAN under Linux

The socketcan_starter.sh script can be used to initialize socket CAN which need to copy to the directory with the can-utils project, then enter the superuser password:

$. /socketcan_starter.sh/dev/ttyACMX

Deinitialization:

$. /socketcan_starter.sh

Viewing messages:

$ ./$ ./candump slcan0 Detailed instructions can be found in Justin and Linux-CAN

7 TELNET SUPPORT

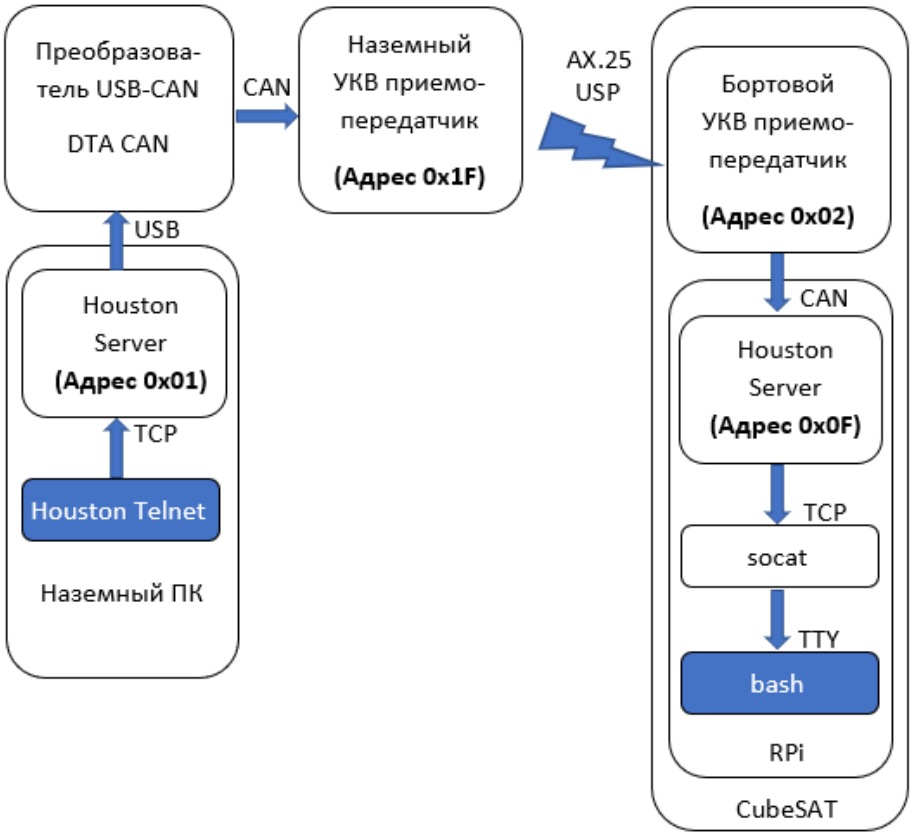


Figure 47 – Device operation diagram by telnet

To enable Telnet communication, the server configuration must specify the addresses of devices that support the TELNET protocol:

TELNET_Devices = 0x02,0x1f,0x0f

7.1 Using ExtraPuTTY or TeraTerm software.

Special character processing mode should be enabled in Houston Server conffiguration:

TELNET_CRLF = 1

To access the OBCU (on-board computer unit) command line:

Launch the TELNET client (telnet, PuTTY). First, make sure that the server is running, the DTA-CAN adapter is connected.

1a) on Linux, run the command:

$ telnet 127.0.0.1 (60000 + deviceAddress)

To display the console help type «? + enter key».

1b) on Windows, run PuTTY or ExtraPuTTY. It is possible to use any of these terminals to work with the OBCU command line. To use the file transfer mechanism from the OBCU, nessesary to use ExtraPuTTY.

2) Configure the connection in the PuTTY (ExtraPuTTY)

Category – Session:

Host Name = 127.0.0.1

Port = 60015 (60000+deviceAddress)

Connection Type = Telnet

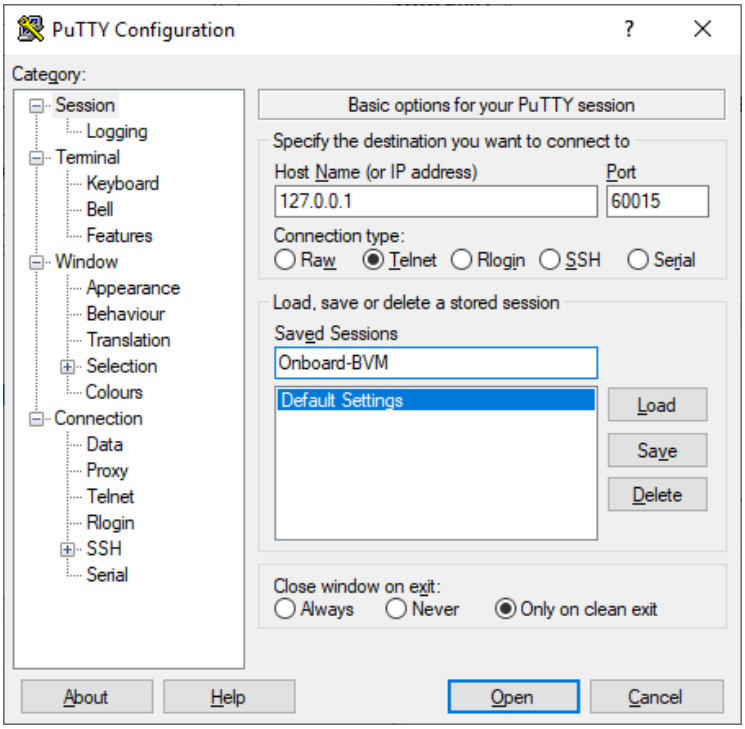


Figure 48 – Configuring the TELNET client in PuTTY. Category Session

Category – Terminal (figure 49):

Implicit CR in every LF = TRUE

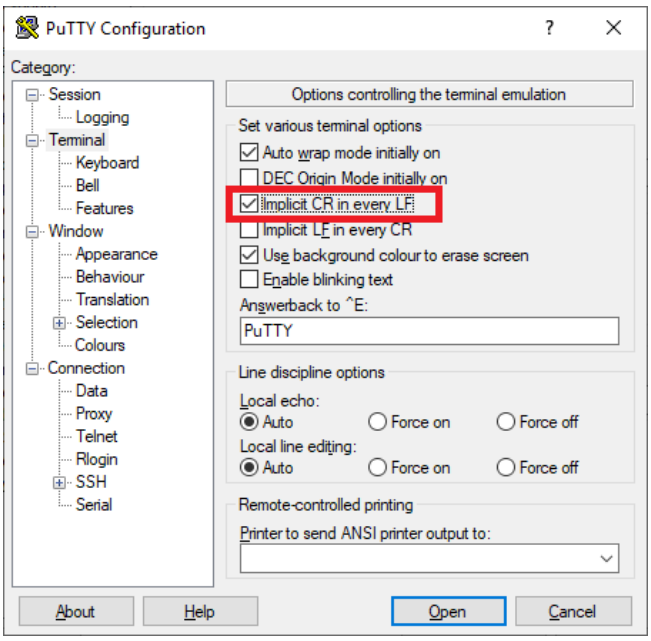


Figure 49 – Configuring the TELNET client in PuTTY. Category Terminal

Category – Connection/Telnet (figure 50):

Return key sends Telnet New Line instead of ^M = FALSE.

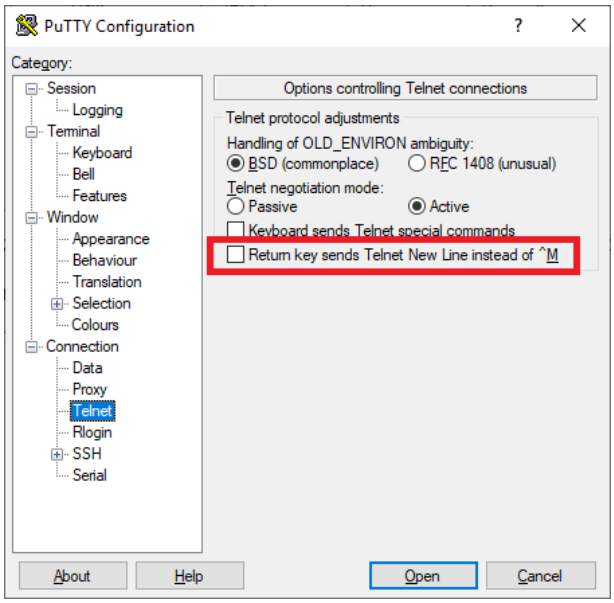


Figure 50 – Configuring the TELNET client in PuTTY. Category Connection/Telnet

After completing the settings, it is recommended to save the connection parameters by writing the connection name (for example: «Onboard-BVM») (figure 48) in the Saved Sessions field and clicking the «Save» button.

3) Open the connection by clicking the «Open» button.

After opening the terminal window, press the Enter key on the keyboard and make sure that a prompt appears in the terminal to enter the OBCU command line

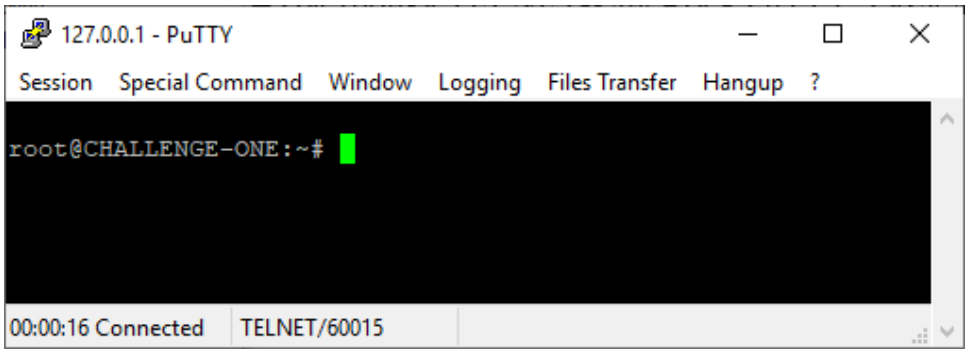


Figure 51 – TELNET client. OBCU input prompt

Note: if after pressing Enter the prompt for input did not appear, you should close the connection and reopen it.

4) The Xmodem or Ymodem protocol is used to transfer files from the OBCU. It is recommended to use Ymodem. To transfer a file from the OBCU:

4a) In the terminal, enter the command (figure 52):

sb -Y -b <filename>

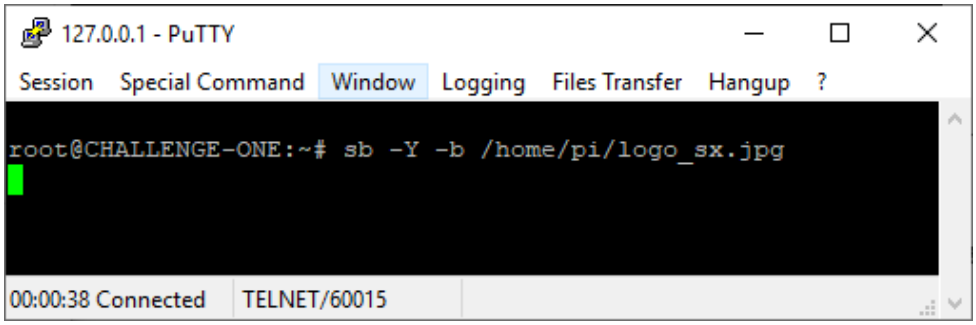


Figure 52 – TELNET client. An example of entering a command to get a file by Ymodem

4b) In the terminal window, select the menu item:

Transfer→Ymodem→Receive (figure 53).

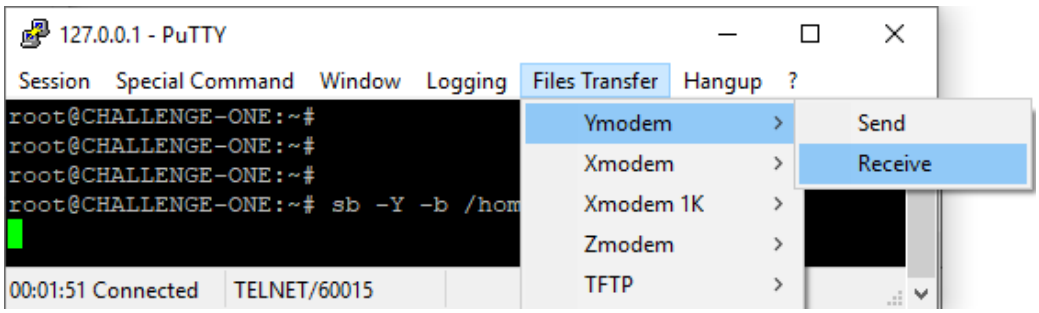


Figure 53 – TELNET client. Enabling Ymodem file receive mode

4c) Wait until the operation is completed and the file transfer progress display window is closed (figure 54).

Note: by default, received files are saved in the folder

C: \ Users \ <User> \ AppData \ Local \ VirtualStore \ Program Files \ ExtraPuTTY \ Bin.

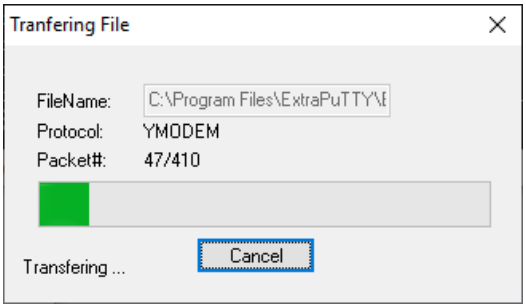


Figure 54 – TELNET client. A window indicating the progress of file transfer from the OBCU

5) When working through the Tera Term terminal, make the following settings.

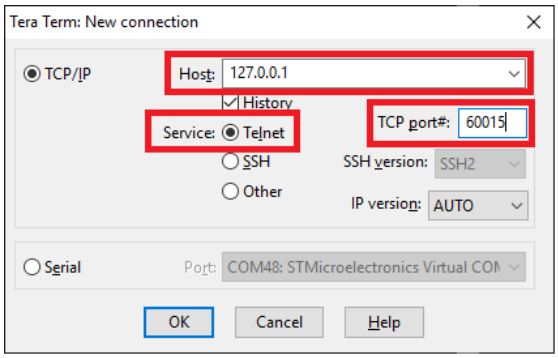


Figure 55 – TELNET client Tera Term. Connection setup window

Open the terminal settings window from the Setup / Terminal ... menu and make the following settings:

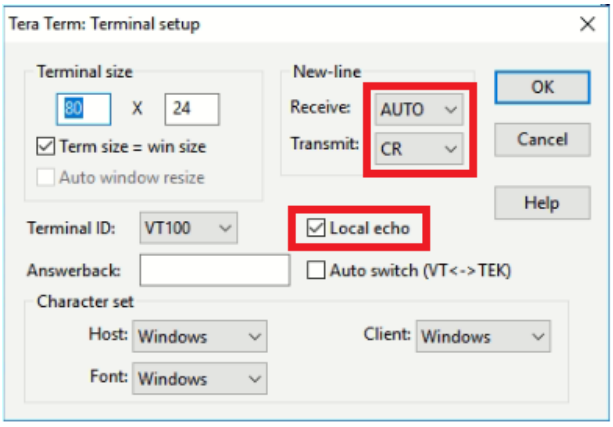


Figure 56 – TELNET client Tera Term. Terminal Settings Window

After opening the terminal window, press the Enter key on the keyboard and make sure that a prompt appears in the terminal to enter the OBCU command line.

6) The Xmodem or Ymodem Protocol is used to transfer files from the OBCU via the Tera Term terminal. It is recommended to use Ymodem. To transfer a file from the OBCU:

6a) Enter the following command in the terminal: sb -Y -b filename.

6b) Select the File/Transfer/YMODEM/Receive menu item (figure 55).

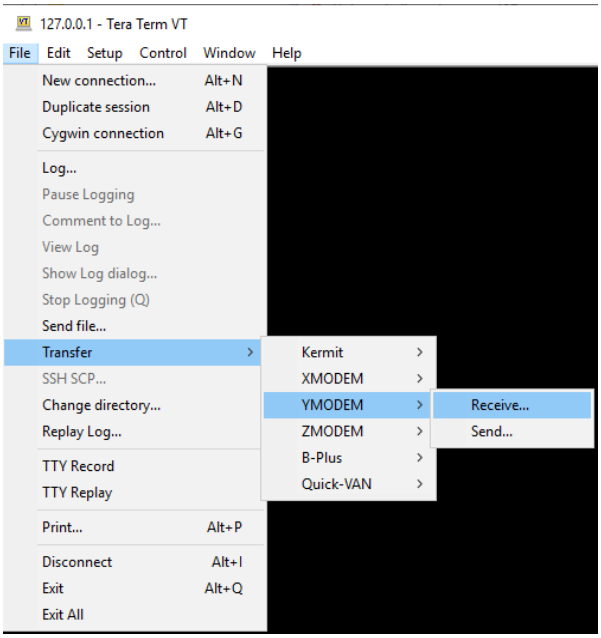


Figure 57 – TELNET client Tera Term. Enabling Ymodem file reception mode

6c) After the «Tera Term: YMODEM Receive» window appears, wait for the transfer to complete and close the window.

Note: by default, received files are saved in the folder: C:\Users\<User>\AppData\Local\VirtualStore\Program Files (x86)\teraterm

7.2 Using Houston Zmodem Terminal.

The utility simplifies the process of transferring files to or from the spacecraft to the ground station using Ymodem and Zmodem protocols. Zmodem protocol allows to resume file transfer in case of interruption due to disconnection of the communication channel.

The main window is shown on Figure 56. The top multiline text field represents the terminal. The edit fields and buttons in the middle are used for managing file transfers and in particular for managing photo file transfers. The multiline text filed in the bottom represents logs of file transfers.

Special character processing mode should be disabled in Houston Server configuration:

TELNET_CRLF = 0

Houston Telnet uses Houston Server to communicate to UHF transmitter. The TCP/IP connection status is indicated in status bar.

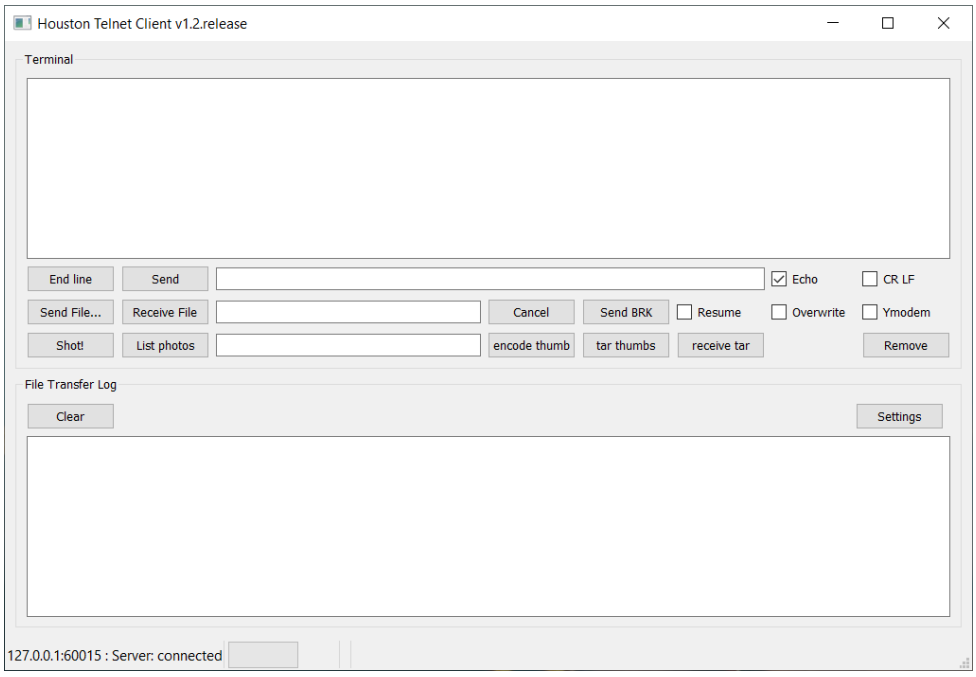


Figure 58 – Houston Telnet main window

The buttons description is showed below.

- **Send** – send a bash command string specified in the text field on the right of the button. The CR LF check box sets the end-of-line character (0x0A if not checked and 0x0D 0x0A if checked).
- **Receive File** – starts file transfer from the on-board folder to the ground folder. The text field on the right specifies the file name from the current directory. The Zmodem protocol is used as a default. The **Ymodem** checkbox switches to Ymodem protocol. The **Overwrite** checkbox instructs the receiver to overwrite the local file with identical name. The **Resume** checkbox allows to start the resume mode if previous file transfer interrupted.
- **Send File** – starts file transfer from the ground folder to on-board folder.
- **Receive File -** starts the file transfer from the onboard folder to the ground folder.
- **Cancel** – sends the termination character to sender and cancels the local receive routine.
- **Send BRK** – sends the termination character to sender (used when the sender is not responsible after file transfer).
- **End line** – resets shell input buffer and gets the shell prompt.
- **List Photos** – shows the list (ls -l) of photo files if **photos** directory.
- **encode thumb** – generate a string for sending a command to convert the thumb with the specified parameters.
- **tar thumbs** – generates a string to send a command to archive the specified thumb.
- **Receive tar -** download the specified thumbs archive.
- **Remove** – removes the photo and it’s thumbnail by specified number from the on-board photo/thumb directory.
- **Clear** – clears the log text area.

- **Shot**! – make a photo shot (creates photo and thumbnail files)
- **Settings** – opens the Settings window.

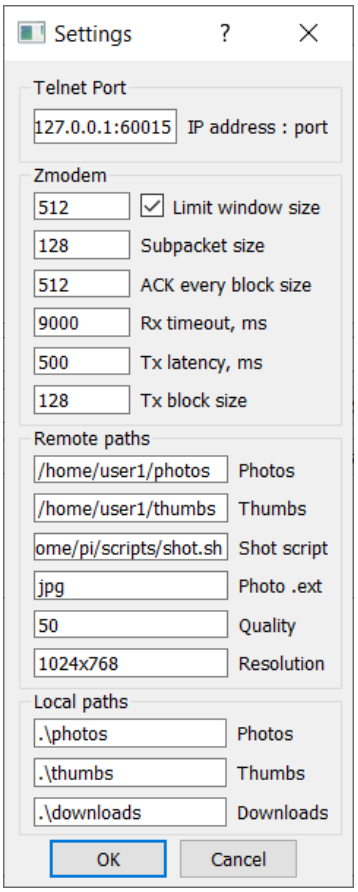


Figure 59 – Houston Telnet Settings window

The settings window allows to setup parameters:

- **Telnet port** – Houston Server connection port, IP:port.
- **Zmodem:**
  - window size:
  - subpacket size;
  - block size for ACK;
  - timeout on receive;
  - message delay;
  - transmit block size.
- **Remote paths –** remote (spacecraft) photo directories, photo file extensions, script for making a photo shot. Also quality and resolution settings that used in «Encode thumb». The default script shot.sh requires 2 parameters: camera number

and output file format. For example, to capture the photo from on-board Raspberry Pi camera use the following Shot script parameter value:

/home/pi/scripts/shot.sh 0 jpg

to capture the photo from USB FA-CAM202 camera use the following Shot script parameter value:

/home/pi/scripts/shot.sh 1 jpg

to capture the photo from USB Basler camera use the following Shot script parameter value:

/home/pi/scripts/shot.sh 2 jpg

- **Local paths –** local (ground) photo directories and directories for other file downloads.

Recommended telnet settings for different UHF bitrate:

1. Bitrate = 2400

Limit window size = 512
Subpacket size = 128
ACK every block size = 512
Rx timeout = 9000
Tx latency = 500

2. Bitrate = 4800/9600

Limit window size = 1024
Subpacket size = 128
ACK every block size = 1024
Rx timeout = 6000
Tx latency = 200

3. Bitrate = 19200

Limit window size = 2048
Subpacket size = 128
ACK every block size = 2048
Rx timeout = 3000
Tx latency = 500

In general, the sequence of actions for downloading photos looks like below.

1. Make sure the «Server:connected» status is shown in the status bar of the main window. If not check the Telnet port parameter in settings window and Houston Sever running.

2. Push «End line» button. The shell prompt must appear in terminal text field.

3. Push «List Photos» button. The photo file list must appear in terminal text field. Assume the file names correspond to the following template: #.jpg.

4. Type the number of the photo to the text field on the right of the Receive File button to download full photo and push the button «Receive File».

To download thumbnail of the specified quality:

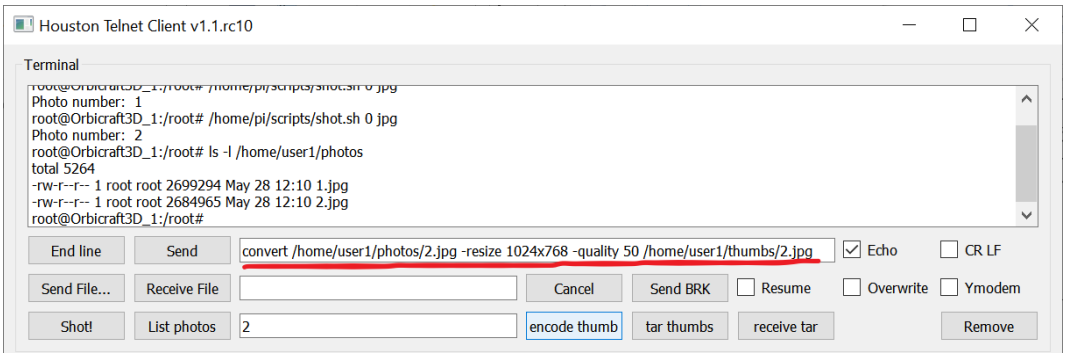


Figure 60 – Houston Telnet: thumb converting

– type the number of the photo to the text field on the right of the List photos button, push the «encode thumb» button;

– if necessary change the photo convertation settings and push «Send» button;

– push «tar thumbs» button and then push «Send» button;

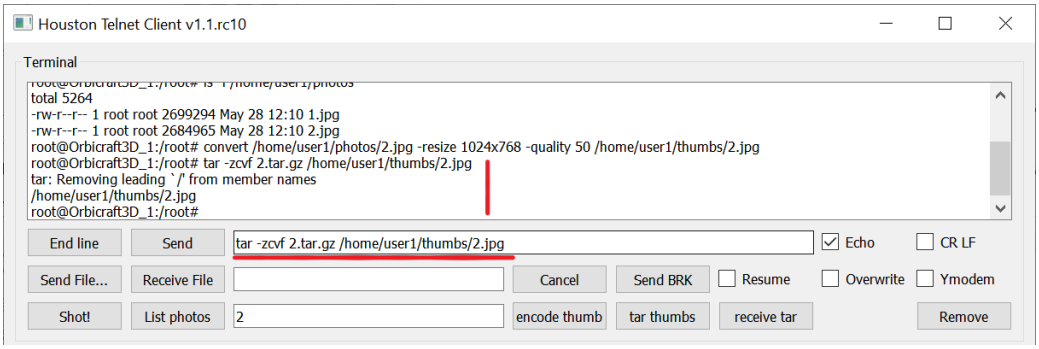


Figure 61 – Houston Telnet: thumb archiving

– push «Receive thumb» button and after string with the file archive will appear push «Receive File» button.

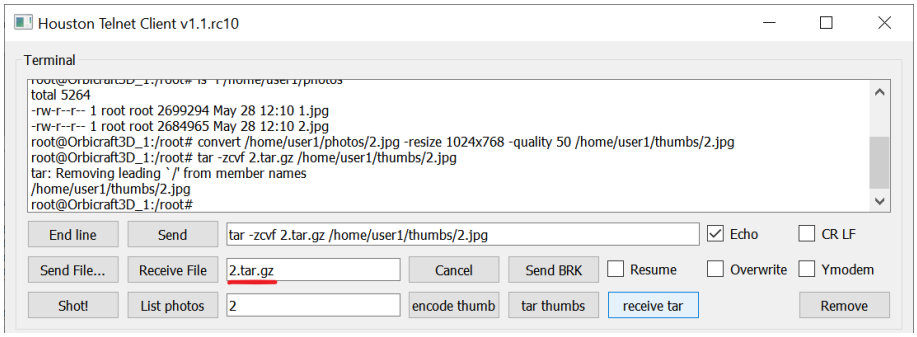


Figure 62 – Houston Telnet: preparing the archive file for the download

5. The terminal window looks like below:

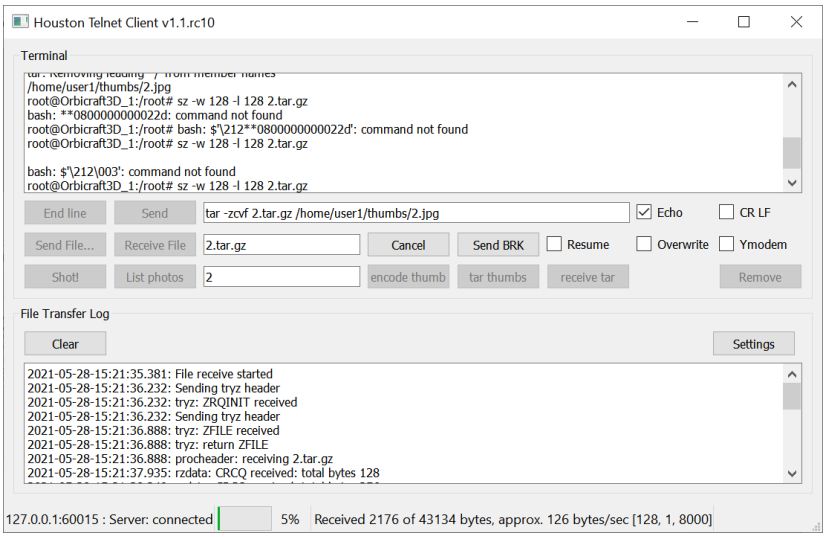


Figure 63 – Houston Telnet: starting photo download

6. Wait until file transfer finished. The approx. download speed and progress bar are shown in the status bar. When the transfer finishes the terminal window looks like below («File receive ends» appears in the log).

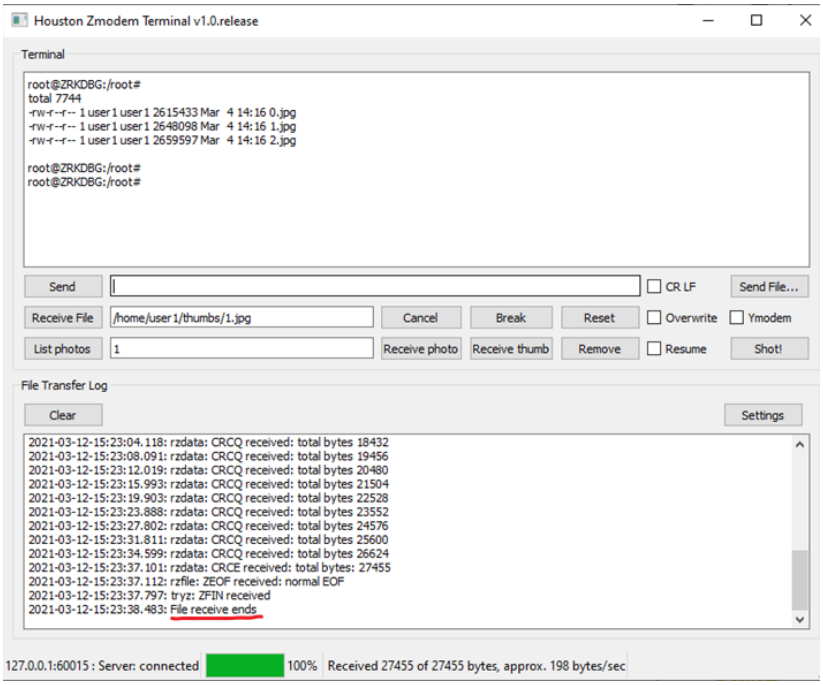


Figure 64 – Houston Telnet: photo download finished

7. The downloaded photo will be in the «downloads» folder of the houston telnet application.

8. Push «End line» button. The shell prompt must appear in terminal text field.

APPENDIX A. DEVICE PROTOCOL FILE DESCRIPTION

The device protocol file contains a description of all incoming and outgoing data packets supported by the device. Work with packages not described in the device protocol file is limited to display in the Hex View panel. HA software works with several log files corresponding to each type of satellite device. Device protocol files are usually located in a resources\devices folder. The paths to all device protocol files must be listed in the configuration file (resources\unican_config.xml) with «DeviceDesc» tag.

The filling of the device protocol files is regulated by the unican_device_schema.xsd xml scheme (resources\devices) and must fully comply with it.

The following elementary types are used in the description:

– text - letters and numbers, Russian or Latin, except for special characters <,>, ', “, etc. (see XML 1.0 standard), when entered in an editor such as XmlPad, they are automatically replaced;

– number - a natural number, integer or fractional, it is possible to specify in hexadecimal format with the prefix 0x;

– list - an enumerated type based on text or number; possible values are listed in the scheme.

Object: **Device**

Describes a single device. Parameters describe the filling scheme (unican_device_schema.xsd).

Field	Type	Description	Note
DevModel	Text	Device name	
Packet<..>	Object	Description of packet data/command	At least one packet

Object: **Packet**

Describes a single data packet for exchange.

Field	Type	Description	Note
PacType	List	Command type: datain – telemetry packet; command – command	Only packets with command type are available for sending to the device
PacId	Number	Unican two-byte message code (MsgId). Must be unique within a single device	
PacName	Text	Command name	
PacDesc	Text	Command description	
DataLen	Number	Command data length (besides MsgId)	0 if the package contains no fields other than MsgId
Field<..>	Object	Data/command field description	May be absent

Object: **Field**

Describes a single device. Parameters describe the filling scheme (unican_device_schema.xsd).

Field	Type	Description	Note
FldType	List	Field type: int – unsigned integer (up to 32 bits); uint – signed integer (up to 32 bits); float – floating-point number (32 bits only); string – custom text; data – random data (hex); bit – single bit field	The type of the field affects its presentation to the user and data casting during the formation of unican packets
FldName	Text	Field name	
FldDesc	Text	Field description	
FldValue	Text	Field value	Depends on type (number or text)
FldOffset	Number	Field offset relative to the beginning of the packet data in bits	
FldLen	Number	Field length in bits	
FldByteOrder	List	Type of representation of multibyte data in a packet: BE – big-endian; LE – little-endian	

Field	Type	Description	Note
FldEdit	List	Ability to edit the field before sending: YES; NO	
Limit <..>	Object	Description of data / command restrictions	May be absent

Object: **Limit**

Describes the constraints that a field value in a command must satisfy. If try to set a value for the field that does not meet the restriction, the user will be presented with a message with the specified text. Also allows to create a list of possible values for enumerated fields.

Field	Type	Description	Note
LimType	List	Condition type: = - equally; != - not equal; > -more LimValue; >= - more or equal LimValue < - less LimValue <= - less or equal LimValue; enum – value for list; pattern – format string (see documentation QLineEdit Class)	
LimAction	List	The type of reaction system: none; info; warning; deny	A message will be displayed to the user with this text if the condition is not met. The deny type also prohibits the input of a value that does not satisfy this condition.
LimDesc	Text	Restriction description	It will be shown to the user as a message
LimValue	Text	The value to compare the value entered by the user. The type match the field type of the parent object	

APPENDIX B. DESCRIPTION OF THE SPACECRAFT ADDRESS MAP FILE

The map file contains a structured representation of the composition of one spacecraft in terms of systems, modules and devices; it is used to form a visual representation of all the spacecraft devices and assign each device a specific address in the address space of the Unican bus. The map file also contains the Unican address of the control center..

The map file is in the resources\maps folder. The path is specified in the configuration file (resources\unican_config.xml) with «SputnikMap» tag Work with devices not described in the file is limited in HA software.

Protocol file filling is regulated unican_map_schema.xsd xml-scheme unican_map_schema.xsd (folder resources\) and must fully comply with it.

The following elementary types are used in the description:

– text - letters and numbers, Russian or Latin, except for special characters <,>, ', “, etc. (see XML 1.0 standard), when entered in an editor such as XmlPad, they are automatically replaced;

– number - a natural number, integer or fractional, it is possible to specify in hexadecimal format with the prefix 0x.

Object: **Sputnik**

The key element of the file, exists in a single copy. Describes one spacecraft. Parameters describe the filling scheme (unican_map_schema.xsd).

Field	Type	Description	Note
SputnikName	Text	Spacecraft name	
SputnikDesc	Text	Spacecraft description	
CenterAddr	Number	Control center address	Used to send commands as sender address
System <..>	Object	Description of the composition of the spacecraft system	At least one

Object: **System**

Describes one spacecraft system.

Field	Type	Description	Note
SysName	Text	System name	
SysDesc	Text	System description	
Module<..>	Object	Description of the composition of the module of the spacecraft system	At least one

Object: **Module**

Describes the composition of one module.

Field	Type	Description	Note
ModName	Text	Module name	
ModDesc	Text	Module description	
Device<..>	Object	Device description	At least one

Object: **Device**

Describes one device: its type and address.

Field	Type	Description	Note
DevModel	Text	Device model	The description of commands for the model is contained in the protocol description files (resources \ devices \ *. Xml). Match tag «Device»
DevName	Text	The name of the device for this spacecraft	
DevDesc	Text	Description of the device for this spacecraft	
DevAddress	Number	Unican device address	Used to send commands and decrypt telemetry