# CyPro User Manual

version 53

applies to CyPro v3.2.4 and later

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# Index

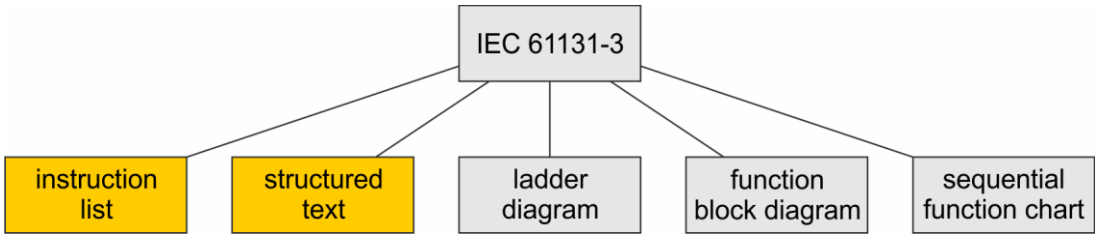
# Introduction

## Installation

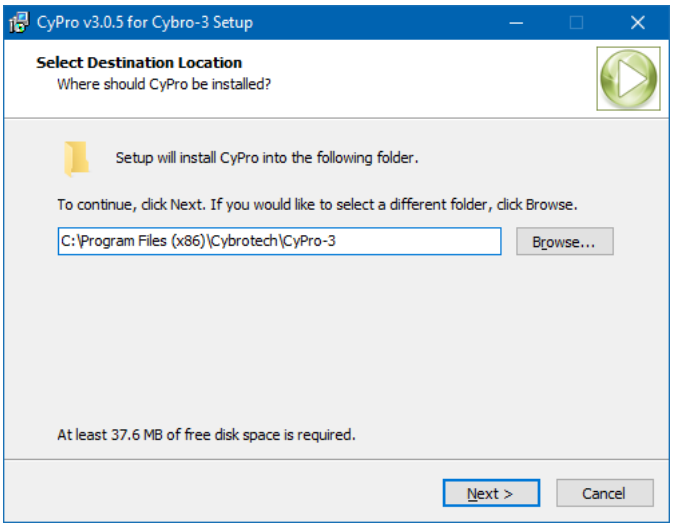
CyPro is integrated development environment for Cybro controllers, with text editor, compiler and on-line monitor. It's running on Windows 7/8/10/11 or Linux/Wine.

Each controller has unique 5-digit serial number, also used as communication address (NAD).

Compiler implements structured text (ST) and instruction list (IL) from IEC 61131-3 standard for programming logical controllers. Other languages are not supported.




Hardware requirements are modest, any PC capable of running MS Windows should be sufficient. Installation uses cca. 40Mb, default directory is C:\Program Files (x86)\Cybrotech\CyPro-3.




Installation does the following:

- copy files into the specified directory
- create start menu icons
- create desktop icon (optional)
- set association to .cyp file type (optional)

No file is copied to windows directory, no system files are replaced or changed. Default directory is:

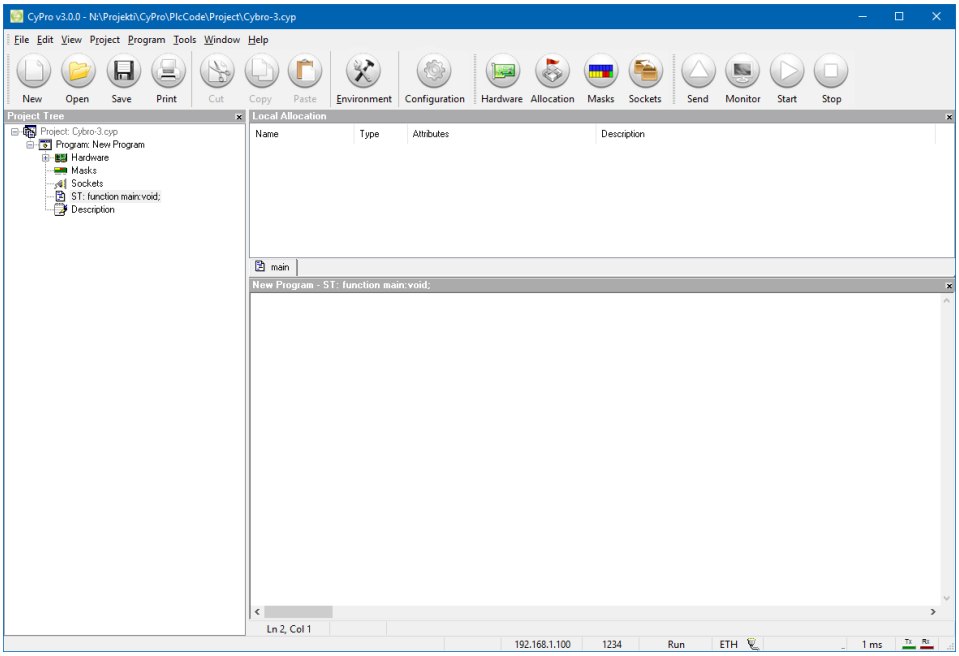
- C:\Program Files (x86)\Cybrotech\CyPro-3 (program and binaries)
- C:\Program Files (x86)\Cybrotech\CyPro-3\Examples (plc programs and function library)
- C:\Program Files (x86)\Cybrotech\CyPro-3\Projects (user projects)

To upgrade CyPro, install a new release into the same directory. User settings will be preserved. With new CyPro, it is required to also upgrade firmware (kernel). To do this, open Tools/Kernel Maintenance and send the new kernel.

# User interface

## Main window

CyPro consists of editor, toolbars and status bar. Default window is shown below:




Each component can be docked or floating. To undock, drag the component by the left vertical line over the edit area. To dock it again, drag window to main window border.

## Standard toolbar

- New — Create a new empty project
- Open — Open an existing project (Ctrl-O)
- Save — Save current project (Ctrl-S)
- Print — Print current project (Ctrl-P)
- Cut — Remove the selection and place it on the clipboard (Ctrl-X)
- Copy — Copy the selection onto the clipboard (Ctrl-C)
- Paste — Insert the content of the clipboard at the cursor, replacing any selection (Ctrl-V)

## Program toolbar

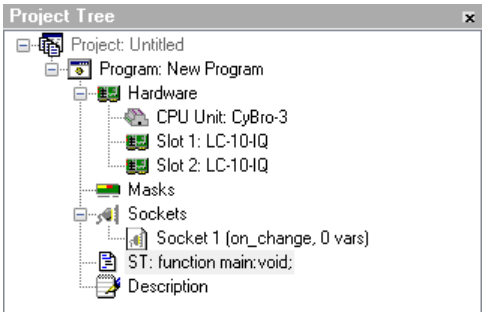
- Hardware — Open the Hardware Setup dialog box (F5)
- Allocation — Open the Allocation Editor dialog box (F6)
- Masks — Open the Mask List editor (F7)
- Sockets — Open the Socket List editor (F8)

## Communication toolbar

- Send — Send current project to Cybro (F9)
- Monitor — Open the on-line Variable Monitor (F10)
- Start — Start program (F11)
- Stop — Stop program and turn off all outputs (F12)

Project tree

Displays project hierarchically.




Right clicking any component opens it's context sensitive pop-up menu. Depending on type, it is possible to Add, Edit, Delete or change Properties of the selected component.

Status bar

Status bar shows various information about communication and connected Cybro.


System message (left side) show result of the preceding operation.

Project status indicate that current project is not saved. It reflects changes in any part of the project, such as source, allocation, mask, socket, data manager or monitor list.

IP address shows IP address of connected controller.

A-bus address shows Cybro A-bus address (NAD). Right click to select another or enter a new one.

PLC status shows:

| | |
|---|---|
| Off-line | Cybro is not responding. |
| Run | Cybro is on-line and running. |
| Stop | Cybro is on-line, stopped. Outputs are inactive and program is not executing. |
| Pause | Cybro is on-line, paused. Outputs remain active, but program is not executing. |
| Error | Cybro is on-line, some error occurred. Error codes are listed in the appendix. To clear the error press Stop. |
| Loader | Cybro is on-line, but system software (kernel) seems to be damaged. Start Kernel Maintenance and send a new kernel. |

Com port status indicates whether communication cable is properly connected:


OK


cable not connected


communication port used by another application

Delay shows roundtrip time, from message sent to message received, in milliseconds.

Communication indicators show activity, green is transmit (Tx), red is receive (Rx).

Pull-down menu

File

| | |
|---|---|
| New | Create a new project |
| Open | Open an existing project |
| Load From PLC | Load project from controller |
| Save | Save current project |
| Save As | Save current project under new name |
| Save alc File | Save allocation file in text format |
| Save csv File | Save allocation file in csv format |
| Printer Setup | Set printer options |
| Print | Print current project |
| Close | Close current project |
| Recent Projects | Open recently opened project |
| Exit | Exit program |

Edit

| | |
|---|---|
| Undo | Cancel the last action |
| Redo | Cancel the last Undo operation |
| Cut | Delete the selection and put it on the clipboard |
| Copy | Copy the selection onto the clipboard |
| Paste | Insert text from the clipboard to the insertion point |
| Delete | Delete the selection |
| Select All | Select the whole document |
| Find | Find specified text |
| Find Next | Find next occurrence of the specified text |
| Find Previous | Find previous occurrence of the specified text |
| Replace | Find specified text and replace it |
| Go to Line Number | Move insertion point to specified line number |
| Indent Block | Move selected lines right by inserting leading spaces |
| Unindent Block | Move selected lines left by deleting leading spaces |
| Comment/Uncomment | Insert or delete comment ("//") before selected lines |
| Insert Identifier | Display list of functions and global variables |
| Properties | Show properties of the selected project module |

View

| | |
|---|---|
| Project Tree | Show Project Tree |
| Local Allocation Editor | Show Local Allocation Editor |
| Editor Tabs | Show Editor Tabs |
| Compiler Messages | Show Compiler Messages |
| Standard Toolbar | Show Standard Toolbar |
| Program Toolbar | Show Program Toolbar |
| Communication Toolbar | Show Communication Toolbar |

Project

| | |
|---|---|
| New Program | Create a new program in the current project |
| New Program From PLC | Load program from controller into the current project |
| Remove Program | Remove program from the current project |
| Properties | Show properties of the current project |

Program

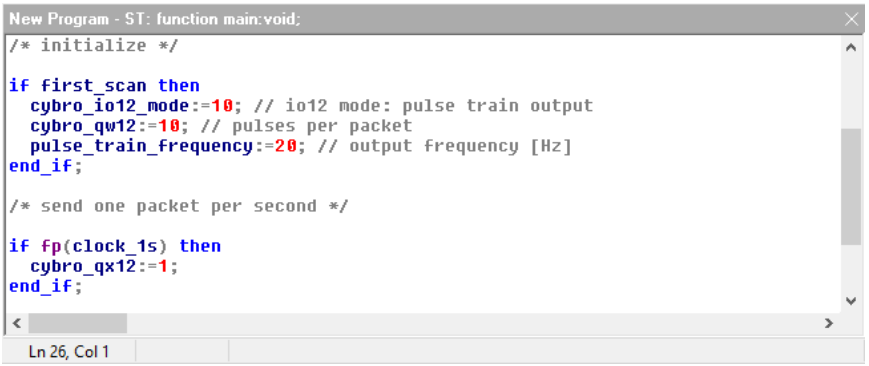
| | |
|---|---|
| Hardware Setup | Open Hardware Setup dialog box |
| Allocation Editor | Open Allocation Editor dialog box |
| Mask Editor | Open Mask List editor |
| Socket Editor | Open Socket List editor |
| Syntax Check | Check the current file for errors |
| Send | Send current program to controller |
| Send Without Init | Send program without initializing variables, when possible |
| Start PLC | Start Cybro program |
| Stop PLC | Stop Cybro program and turn off all outputs |
| Pause PLC | Pause Cybro program, keep outputs active |
| Add NAD | Add new network address to the current program |
| Remove Current NAD | Remove current NAD from the current program |
| Select NAD | Select current network address for the active program |
| Connect/Disconnect | Connect/Disconnect communication port |
| Configuration | Settings related to plc program |

Tools

| | |
|---|---|
| PLC Info | Display various controller-related information |
| Kernel Maintenance | Update system software |
| Online Monitor | Online access to plc variables |
| Identify Modules | Identify IEX modules and individual inputs/outputs |
| Init all variables | Initialize all variables, including retentive |
| Multisend | Send program to multiple controllers |
| Erase Protected Program | Erase password protected program |
| Communication Monitor | Low-level A-bus communication monitor |
| Environment Options | Settings related to CyPro environment |

Edit window

Edit window is used to type and edit PLC program. Each function has its own window.

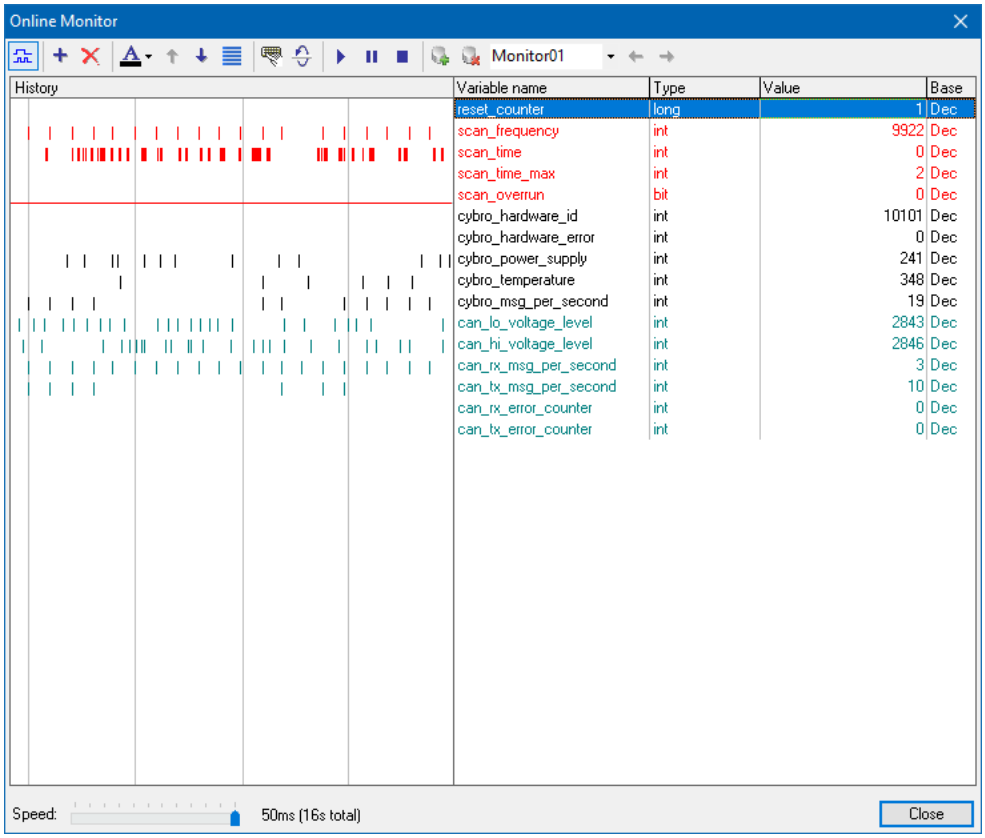



Editor uses syntax highlight - variables, constants, functions and other language elements are displayed in different colors. To customize colors, open Tools/Environment Options/Colors.

Insert identifier (Ctrl-Space) is used to display a list of allocated variables and available functions.

# Online monitor

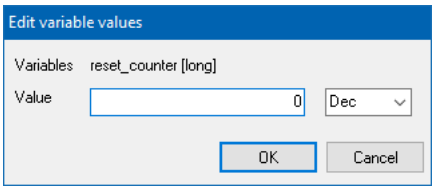
Online monitor is designed to display and change controller variables.




To insert new variables use Add button (Insert), select desired variables and press OK. To rearrange variables, click Move Up / Move Down, or use Ctrl-Up / Ctrl-Down (arrow) keys.

Monitor update rate is 20ms (50 times per second). Scroll rate is 50ms, it can be changed with Speed slider. First number is time to move a single pixel, second is total time from left to right.

To enter a new value, click Edit selected variables (Alt+Enter), right-click and select Properties, or double-click the variable.



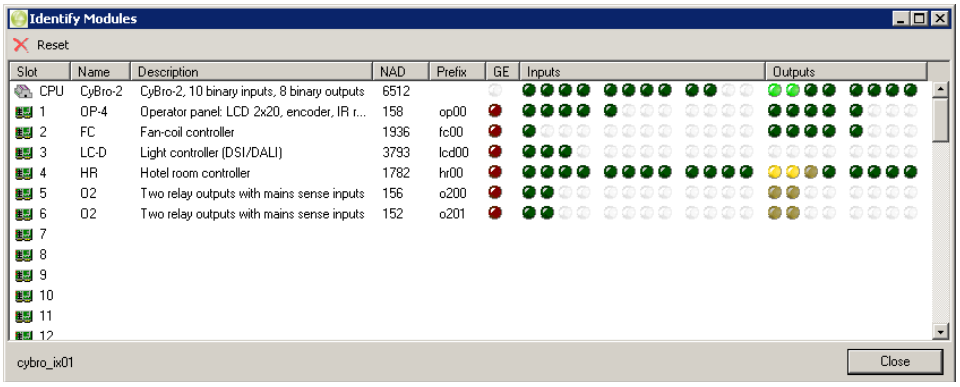

Enter value and press OK. Value is sent and immediately read back, monitor always display the actual value. Multiple variables can be set at once.

To toggle a bit variable, press Space key.

Monitor supports multiple sets. To create a new set click Add new varset, then insert variables. For a quick access press Alt-1 to Alt-5, or Ctrl-Left / Ctrl-Right (arrow) keys.

# Identify modules

Identify is a tool used to identify individual inputs/outputs.




Each LED represents single digital input or output. When mouse is positioned over LED, signal name is shown in the bottom left corner.

Input and output LEDs are defined according to the following table:

| LED | current level | changed |
|---|---|---|
| | 0 | no |
| | 1 | no |
| | 0 | yes |
| | 1 | yes |

General error (GE) is defined as:

| LED | description |
|---|---|
| | module is operating properly |
| | error, module is not operative |

To identify unknown input:

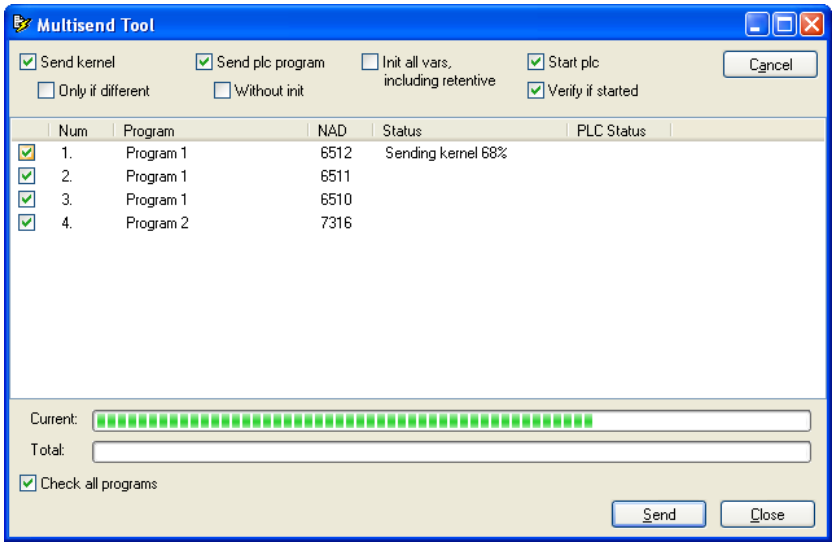
1. Reset all
2. Press and hold unknown input for a second
3. Look for the yellow LED

To identify unknown output:

1. Click LED to toggle the output

# Multisend

Multisend is tool to update multiple controllers at once.




All programs and all NAD's are listed.

It is optional to send program either without initialization (only if allocation is not changed), with a standard initialization (retentive variables are preserved), or with forced initialization (all variables are initialized, including retentives).

Option Check all programs will verify all programs by reading back and comparing to original.

# Programming

## Hardware

### Expansion modules

Cybro is expanded with IEX-2 modules. For the complete list, check hardware manual.

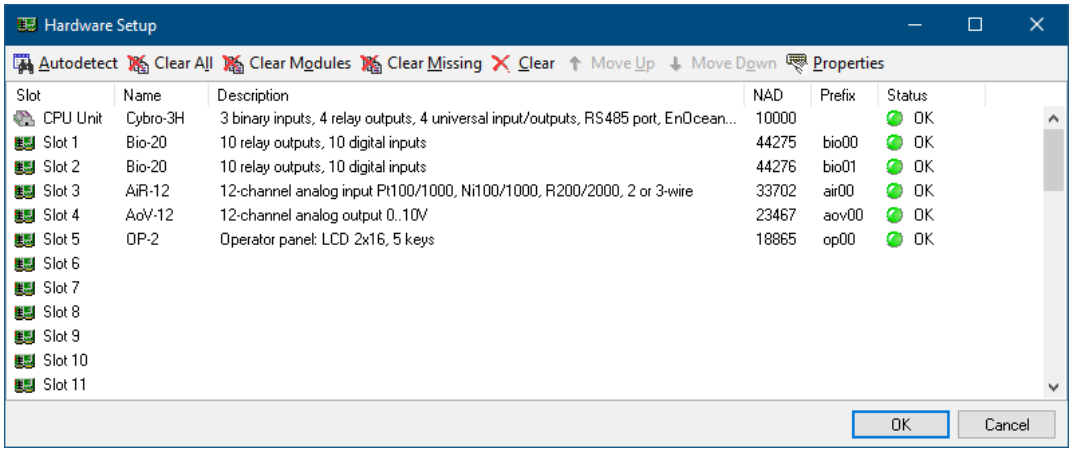
Each module occupies a single slot. Slot is logical entity, used to address the module.


Each IEX-2 module has unique address, equal to serial number. Autodetect will detect module type, address, and assign slot number. Slot 0 is reserved for Cybro internal inputs and outputs.

Some modules implement autoaddress feature, used to fit devices into a predefined hardware list.

### Hardware setup

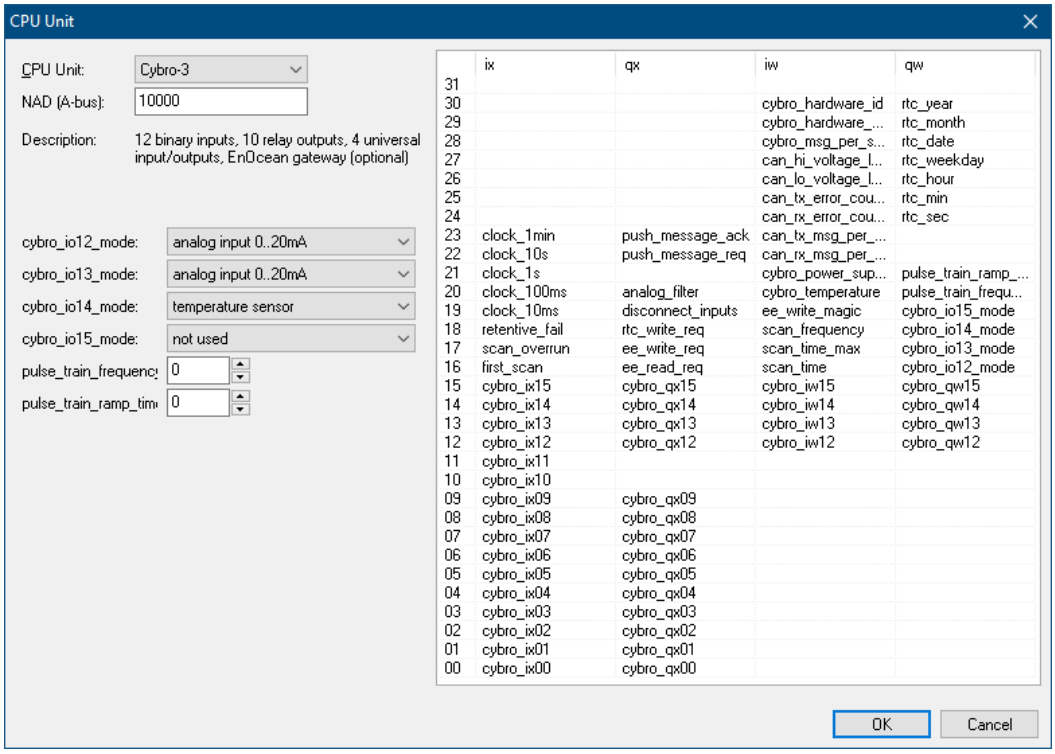
To perform automatic detection of connected modules press Autodetect button.



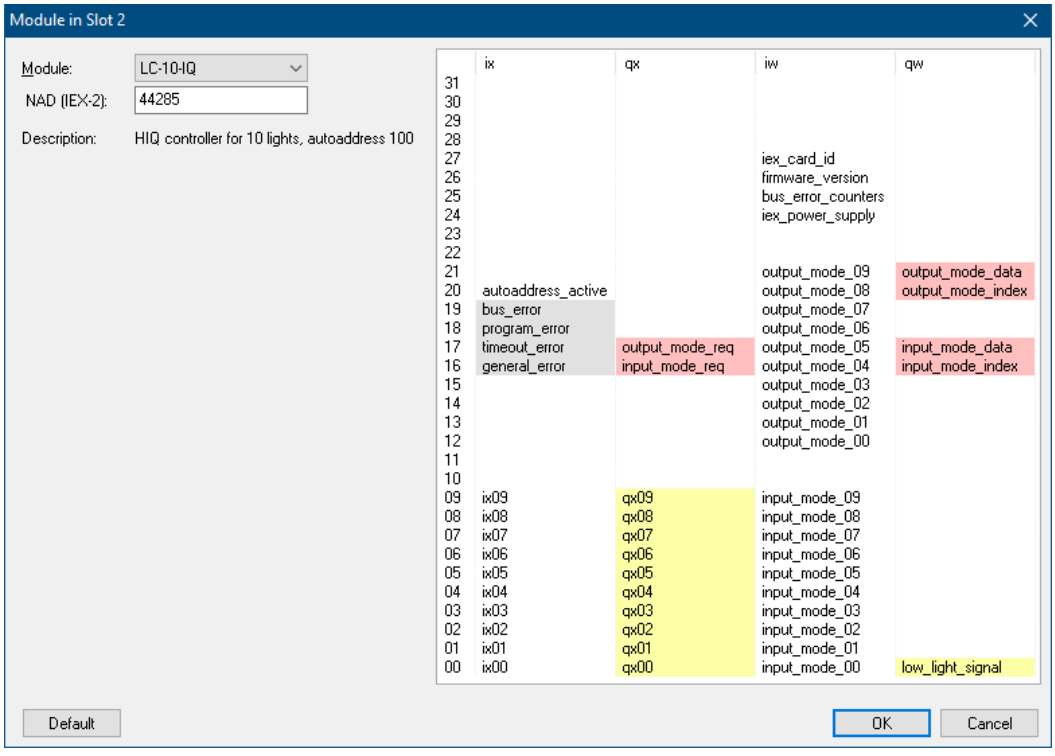

Dialog shows slot number, module type, short description, communication address, variable prefix and status.

### Device properties

To open device properties, double click the module, or click right and select Properties.




Dialog shows automatically assigned i/o variables for the module. Everything device does is accessable through this variables.




Variables are sorted in four columns: I-inputs, Q-outputs; X-digital, W-analog (word).

Each module has a four status variables (general_error, timeout_error, program_error, bus_error), shaded gray. When general_error is zero, everything is ok, module is fully functional.

Yellow shaded variables are sent on change. When changed, it is sent automatically.

Red shaded variables are sent on request. Each group of four has it's own request. To send the group, set request to 1.

To get description of each variable, hover mouse over. The description comes from the cym file.

# Variables

### Naming

Variable name may contain letters, digits and underline symbol. First character must not be a digit. Maximum length is 32 characters. Name is not case sensitive. Special and national characters (ß, ä, ü, ë, č, ć, š, ž...) should not be used.

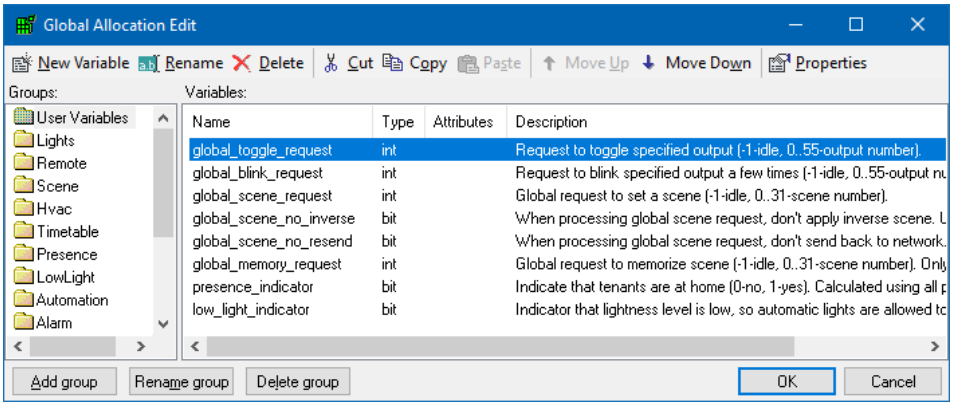
Examples of a valid name:

```
i
caret_position
maximum_water_level
```

Name must not match IEC-1131-3 keyword.

### Allocation

Variables are allocated using Global Allocation Edit. To insert a new variable, choose group and click New Variable.




### Basic data types

| type | size | range |
|---|---|---|
| bit | 1 bit | 0..1 |
| int | 16 bits | -32768..32767 |
| long | 32 bits | -2147483648..2147483647 |
| real | 32 bits | $-10^{38}..10^{38}$ |

Bit is a single boolean variable with only two possible states, zero or one. It is used for flags, logical equations, logical states and other. The result of comparison instruction is also bit type.

Int is a 16-bit signed number. It is used for counting, encoding states, fixed point arithmetic and similar.

Long is a 32-bit signed value. It is used when numbers outside of 16-bit range may occur. Processing speed is the same as for the 16-bit integers, but they use more memory.

Real is a floating point number. Float consist of 8-bit exponent and 24-bit mantissa, so the result has 5 to 6 significant digits.

### Other data types

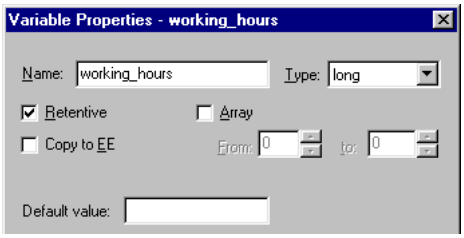
In bit, out bit, in word and out word variables represent physically connected binary (bit) and analog (integer) signals. In bit and out bit are bit type. In word and out word are integer type.

Timer is a structured data type, consisting of a several dedicated fields.

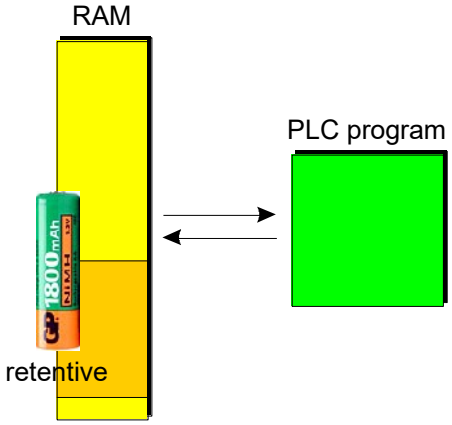
Constant is used to represent a value that will never be changed. For example, Pi=3.141592 can be defined for trigonometrical calculations. Constants are replaced in preprocessing, data type does not apply.

### Retentive variables

Retentive variables retain their value when power supply goes down, and also when PLC is stopped. To make variable retentive, set the retentive flag in the global allocation dialog.




Both retentive and non-retentive variables reside in the same RAM, but retentives are automatically copied to battery backup RAM.




Number of retentive variables is not limited. If needed, the whole PLC memory can be retentive.

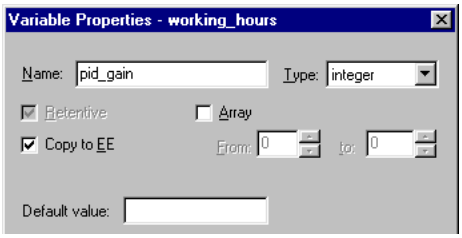
Data retention time is specified in Cybro hardware manual. When power is lost for a period longer than specified, content of retentive memory may be lost.

System bit retentive_fail indicates that retentive memory is damaged or lost. It is set automatically after power-on, and cleared next time PLC is started.

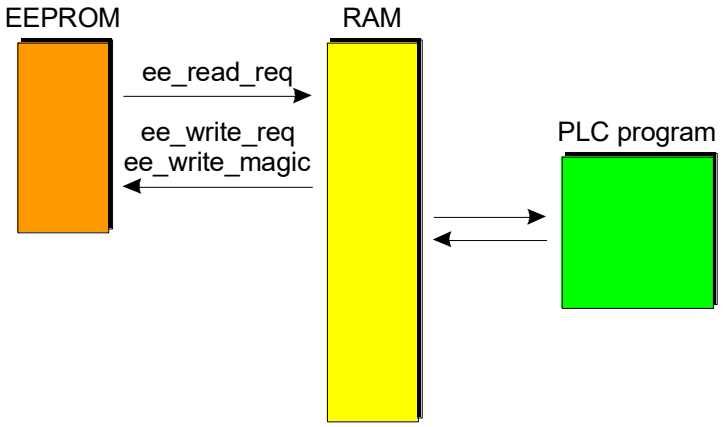
When allocation is changed, sending program to PLC will clear all variables. If allocation is not changed, retentives are preserved. To send program without initialization, use Send Without Init.

### EE variables

Variables that must be preserved for a long period without electricity are stored in EEPROM. To configure this, set "Copy to EE" checkbox.




EE variables resides in RAM memory as all other retentive and non-retentive variables, but they also have a copy in EEPROM. Because of this, they are used by PLC program the same way as all other variables, but in addition, reading and writing to EE is available.




To read all variables from EE to RAM, set bit ee_read_req. Bit will be automatically cleared when copy is finished. Depending on number of EE variables, copy process may last a few seconds.

To write all variables from RAM to EE, set ee_write_magic to 31415 and set ee_write_req. When copy is finished, both variables will be cleared. Depending on number of EE variables, write process may last a few seconds. The purpose of magic is to protect from accidental writing.

Only the whole EE can be read or written, there is no method to read or write a single variable.

EE variables should not be accessed by program during read or write. The operation is finished when command variable (ee_read_req or ee_write_req) is returned to zero.

EE variables are automatically retrieved on power-up.

Total number of EE variables is limited by physical size of EE memory, specified by hardware manual. To check memory usage, open PLC Info dialog box, tab PLC Program, Total EE size.

### I/O variables

I/O variables are used to access physical inputs and outputs. Cybro uses four I/O address spaces, two binary and two analog. Binary inputs and outputs are allocated respectively, starting from the ix0 as the first input and qx0 as the first output.

binary inputs

| | |
|---|---|
| IX2047<br>IX2016 | slot 31 |
| . . . | |
| IX63<br>IX32 | slot 1 |
| IX31<br>IX0 | on-board |

binary outputs

| | |
|---|---|
| QX2047<br>QX2016 | slot 31 |
| . . . | |
| QX63<br>QX32 | slot 1 |
| QX31<br>QX0 | on-board |

Analog i/o space has 32 analog inputs and 32 analog outputs for each slot. Slot 0 is reserved for Cybro local inputs and outputs. In word and out word variables are both integer type (16 bit signed).

analog inputs

| | |
|---|---|
| IW2047<br>IW2016 | slot 31 |
| . . . | |
| IW63<br>IW32 | slot 1 |
| IW31<br>IW0 | reserved |

analog outputs

| | |
|---|---|
| QW2047<br>QW2016 | slot 31 |
| . . . | |
| QW63<br>QW32 | slot 1 |
| QW31<br>QW0 | reserved |

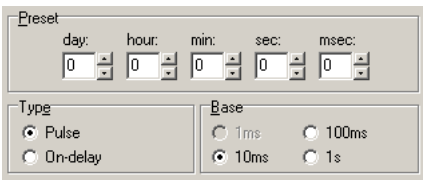
Input and output variables are auto-allocated, their name is in the form:

nnnxx_varname

where nnn is prefix (e.g. bio for Bio-24), xx is card number (starting from zero) and varname is the function it performs. For example, operator panel key F is allocated as op00_key_f.

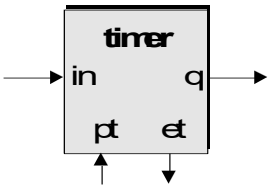
### Timer

Special structured type, used to determine time interval. To define a new timer variable, open Insert New Variable dialog box, choose timer type, enter name, adjust preset, type and timer base, then press OK.




Timer base is a period in which the timer is incremented, time resolution of the timer.

Timer may be represented as the function block with two inputs and two outputs:




Correspondingly, the timer variable consists of four fields. Each field is an elementary data type.

| name | direction | type | description |
|---|---|---|---|
| in | input | bit | input |
| q | output | bit | output |
| pt | input | long | preset time |
| et | output | long | elapsed time |

To use timer, the following syntax applies:

```
<timer name>.<field>
```

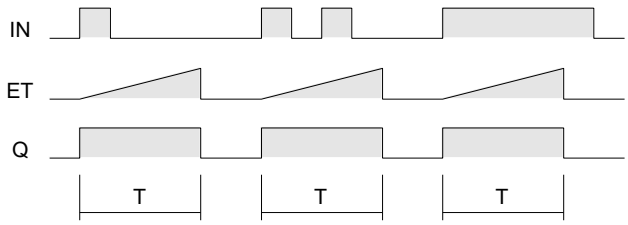
For example, to set the preset of the wash_timer to 15 seconds (assuming the base is 100ms):

```
wash_timer.pt:=150;
```

Elapsed time of the wash_timer will start at 0 and increment every 100ms until it reaches 150.

**Pulse timer**

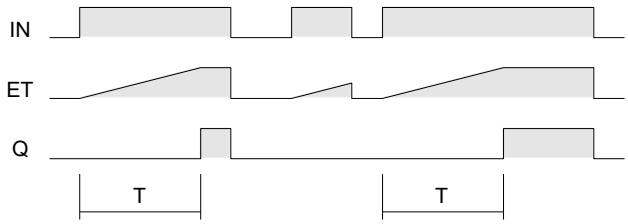
Timer output is activated immediately after the rising edge of input signal. After the specified time, the output will go off. Changes of input signal during active pulse do not affect output.




Typical application is a staircase timer.

**On-delay timer**

When input is activated, timer starts counting. After specified time output activates and stays high, until input goes low. Available fields are the same as pulse timer.




Typical application is a star-delta switch for three-phase motors.

### Visibility

Each variable can be marked as:

| | |
|---|---|
| User | visible across all tools |
| System | visible in tools used by administrators (CybroOpcServer, CybroDataTool) |
| Hidden | not visible outside of CyPro environment |

Automatically allocated I/O variables are marked as "System".

## Refresh processing

Cybro implements soft refresh processing. In a regular cycle, inputs are sampled immediately before and outputs are refreshed immediately after the execution of PLC program.

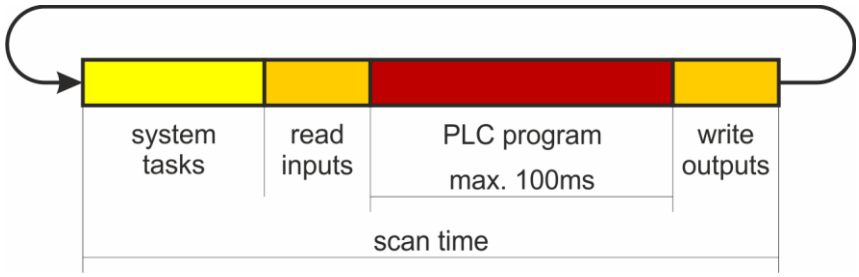
When scan time is very short, inputs and outputs may not refresh in each scan.

When scan time is very long, inputs may update during the scan, to reduce lag.

IEX modules are updated strictly before and after the scan.

### Scan overrun

Scan time is defined as a time needed to complete a full program cycle. It consists of system tasks and PLC program.




When scan time exceeds 100ms, controller goes into scan overrun error and stops program execution (current scan will be finished). Error code is displayed on the status bar. To disable this feature, uncheck Scan overrun stops program in Configuration options dialog box.

When scan time exceeds 250ms, program will be interrupted by hardware watchdog, regardless of overrun settings. When this happens 10 times in a row, program will be stopped with repetitive reset error.

# Structured text

Structured text is a high level language similar to Pascal, specifically developed for industrial applications.

### Assignment

Assignment is used to store value in a variable. An assignment statement has the following format:

```
variable := expression;
```

The assigned value should be lower or equal data type than the variable.

### Expressions

Expressions are used to calculate a value, derived from other variables and constants. Expression may use one or more constants, variables, operators or functions. Using expressions, Cybro can perform complex arithmetic operations, including nested parentheses and mixed data types.

Examples:

```
y_position:=5;
down_timer.pt:=15000;
case_counter:=case_counter+1;
start:=(oil_press and steam and pump) and not emergency_stop;
valid_value:=(value = 0) or ((value > 10) and (value <= 60));
```

### Operators

Cybro supports a number of arithmetic and logical operators, listed in the following table:

| operator | alias | unary | binary | function | bit | int | long | real | result |
|---|---|---|---|---|---|---|---|---|---|
| + | | | • | | | • | • | • | same |
| - | | • | • | | | • | • | • | same |
| * | | | • | | | • | • | • | same |
| / | | | • | | | • | • | • | same |
| mod | % | | • | | | • | • | | same |
| not | ! | • | | • | • | • | • | | same |
| and | & | | • | | • | • | • | | same |
| or | \| | | • | | • | • | • | | same |
| xor | | | • | | • | • | • | | same |
| shl, shr | | | • | | | • | • | | same |
| rol, ror | | | • | | | • | • | | same |
| = | == | | • | | • | • | • | • | bit |
| <> | != | | • | | • | • | • | • | bit |
| <, <= | | | • | | | • | • | • | bit |
| >, >= | | | • | | | • | • | • | bit |
| := | | | • | | • | • | • | • | same |

### Expression evaluation

Expressions are evaluated in a particular order depending on precedence of the operators and other sub-expressions. Parenthesized expressions have the highest precedence. Top precedence operators are evaluated first, followed by lower precedence. Operators of the same precedence are evaluated left to right.

Consider the following example:

```
Speed1 := 30.0;
Speed2 := 40.0;
Press  := 50.0;
Rate   := Speed1/10 + Speed2/10 - (Press+4)/9;
```

In this example, evaluation order is:

```
Rate   := 30.0/10 + 40.0/10 - (50.0+4)/9
Rate   := 3.0     + 4.0     - 54.0/9
Rate   := 3.0     + 4.0     - 6.0
Rate   := 1.0
```

Evaluation order can be changed using parentheses:

```
Speed1 := 30.0;
Speed2 := 40.0;
Press  := 50.0;
Rate   := Speed1/10 + Speed2/(10 - (Press+4)/9);
```

In this example, evaluation order is:

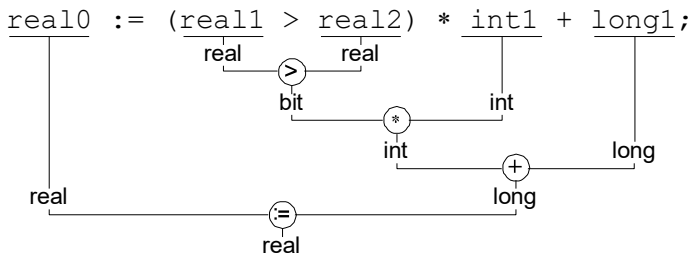
```
Rate   := 30.0/10 + 40.0/(10 - (50.0+4)/9)
Rate   := 30.0/10 + 40.0/(10 - 54.0/9)
Rate   := 3.0     + 40.0/(10 - 6.0)
Rate   := 3.0     + 40.0/4.0
Rate   := 3.0     + 10.0
Rate   := 13.0
```

**Type conversion**

Lower-to-higher data type conversion is performed automatically:

bit → int → long → real

In the following example, multiple of implicit conversions are performed:




If both arguments are integer, result is also integer, regardless of the operation.

```
i := 25;
r := i/10; // result is r=2
```

To get the expected result, constant should be written as 10.0:

```
i := 25;
r := i/10.0; // result is r=2.5
```

Same result can be obtained by using the cast operator:

```
i := 25;
r := real(i)/10; // result is r=2.5
```

### Multiline expressions

In a multiline expression, each line must end with an operator:

```
heater_on := (heater_temperature < 600) and
             (((mode = MANUAL) and start_pressed) or
              ((mode = AUTO) and heater_request));
```

### Flow control

This commands define order in which program statements are executed.

#### if..then..else

Conditionally execute one or another block of statements:

```
if <expression> then
  <statements>;
elsif <expression> then
  <statements>;
else
  <statements>;
end_if;
```

Example:

```
if a>(2*b) then
  d:=3;
elsif a>b then
  d:=2;
elsif a=b then
  d:=1;
else
  d:=0;
end_if;
```

#### case..of

Conditionally execute one of multiple statements. It consists of an selector and a list of statements, each preceded by a constant. Selector type must be ordinal (boolean, integer or long).

```
case <expression> of
  <value>: <statements>;
  <value>: <statements>;
  <value>: <statements>;
else
  <statements>;
end_case;
```

Example:

```
case material_type of
  1: speed:=5;
  2: speed:=20;
     fan:=ON;
  3: speed:=40;
     fan:=ON;
     cooling:=ON;
else
  speed:=0;
end_case;
```

### for..do

The for...do construction allows a set of statements to be repeated specified number of times. Counting variable is incremented by 1 at the end of the loop.

```
for <var>:=<expression> to <expression> do
  <statements>;
end_for;
```

The statements within the loop must not contain fp or fn instructions.

Example:

```
for i:=0 to 19 do
  channel[i]:=TRUE;
end_for;
```

### while..do

The while...do construction allows one or more statements to be repeatedly executed while particular boolean expression is true. The expression is tested prior to executing the statements. When if becomes false, statements are skipped and the execution continues after the loop.

```
while <expression> do
  <statements>;
end_while;
```

The statements within the loop must not contain fp or fn instructions.

Example:

```
while value<(max_value-10) do
  value:=value+position;
end_while;
```

**Return value**

Structured text function may return a single value of one of the basic types (bit, int, long, real). Return value is defined by the following expression:

```
result := expression;
```

Variable result is automatically declared when function is configured to return a value (function properties). Data type is the same as the type returned by function. Within a function, result may be used more then once:

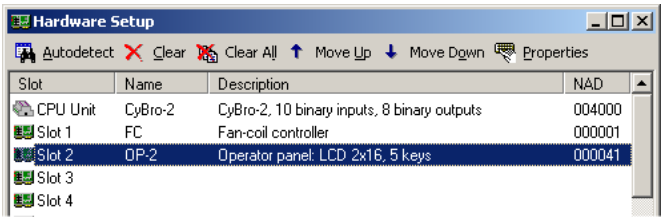
```
if a<=b then
  result:=a;
else
  result:=b;
end_if;
```

# Operator panel

## General

Operator panel is the optional external device connected to the Cybro via the IEX-2 bus. OP provides LCD display and a few keys readable from the PLC program.

OP has to be defined in the Hardware Setup dialog box. Configuration is saved within project.



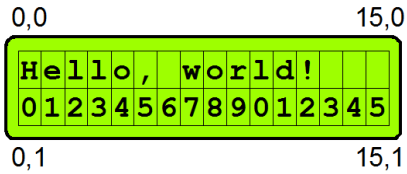

To program operator panel, the following tools are available:

| | |
|---|---|
| Print functions | Structured text functions typed in the PLC program. Used to display strings and values. |
| Panel buttons | Bit variables readable from PLC program, represent current button state. |
| Panel masks | Visual tool for programming operator panel, used to enter parameters. Capable of entering integer values, decimal values and values represented by strings. Parameters may be hierarchically organized. |

## Print functions

Print functions are structured text functions used to display text messages and values.

First parameter is slot number where display appears in the hardware setup. Two following parameters of all functions are x and y coordinates. They are used to set display position. Print origin is in the upper left corner.




Printing outside visible range may produce unexpected results.

Print functions are:

```
dclr(slot:int);
```

Clear the whole display (fill with spaces).

```
dprnc(slot:int, x:int, y:int, c:char);
```

Print single ASCII character on specified coordinates. Character may be entered directly ('A'), as ASCII constant (65), or as integer variable. Values from 0 to 255 are allowed.

```
dprns(slot:int, x:int, y:int, str:string);
```

Print a string of characters, enclosed in single quotes.

```
dprnb(slot:int, x:int, y:int, c0:char, c1:char, value:bit);
```

Print first or second ASCII character, depending on bit value. If value is false, the first character is printed, otherwise the second.

```
dprni(slot:int, x:int, y:int, w:int, zb:bit, value:int);
```

Print integer value to specified coordinates. Parameter w defines width. For example, if w is 4, print range is -999 to 9999. Parameter zb is zero blanking. If zb is 1, leading zeroes are replaced with spaces.

```
dprnl(slot:int, x:int, y:int, w:int, zb:bit, value:long);
```

Print long value to specified coordinates. Parameter w defines width. For example, if w is 6, print range is -99999 to 999999. Parameter zb is zero blanking. If zb is 1, leading zeroes are replaced with spaces.

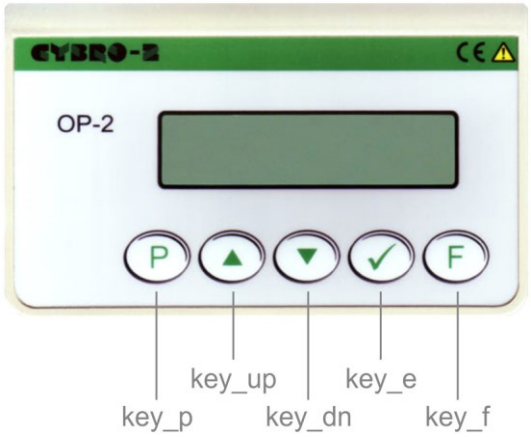
```
dprnr(slot:int, x:int, y:int, w:int, dec:int, value:real);
```

Print real value to specified coordinates. Parameter w defines width, parameter dec defines number of decimals. For example, if w is 6 and dec is 2, print range is -99.99 to 999.99. Zero blanking is always on.

Each parameter (except string in dprns) may be constant, variable or expression.

## Panel buttons

Operation panel buttons are accessible from PLC program as binary input variables:




Key P is used to invoke and exit mask, so it's not available for PLC program (reading is zero). However, if no entry point is defined, it behaves the same as other keys. In such case, mask may be invoked by writing mask number to op00_next_mask.

When mask is active, up, dn and e are not available (readout is zero). Key F is always available.

Key variable is true as long as the key is pressed. When key is released, it becomes false.

Any two (or more) keys may be pressed simultaneously. This may be used to initiate a special function. In the following example, pressing up and down simultaneously resets product_count.

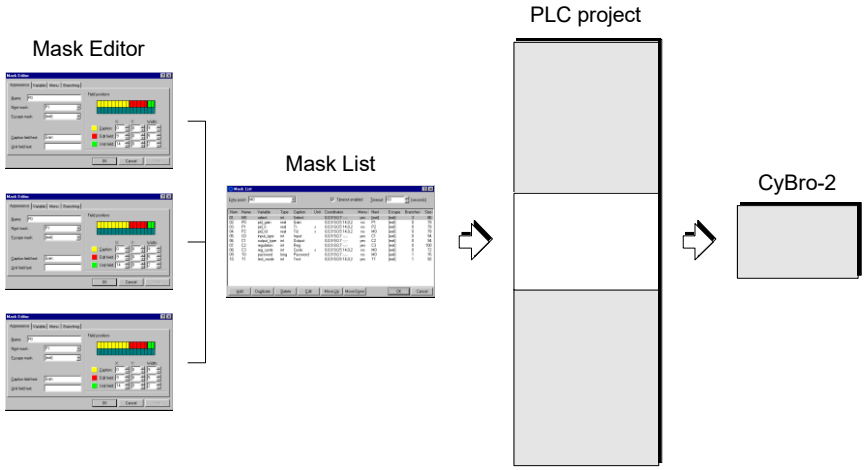
```
if fp(op00_key_up and op00_key_dn) then
  product_count:=0;
end_if;
```

Variables are allocated automatically when OP is defined in Hardware Setup.

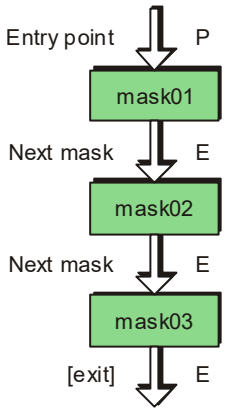
# Panel masks

Mask is visual tool for creating user inputs on operator terminal. Masks are transferred to the Cybro together with PLC code.

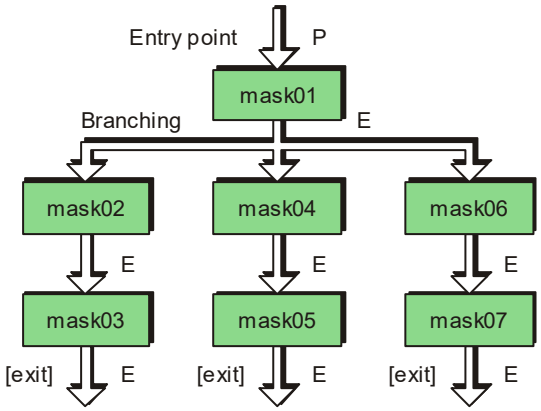
User creates a new mask or edits the existing one by using Mask Editor. Created masks are listed in the Mask List. Masks are integral part of the PLC project, they are saved on the disc and transferred to the controller.



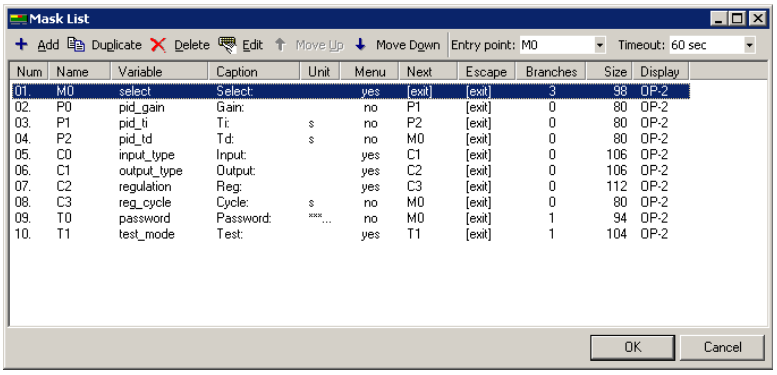

When user presses P, Cybro sends first mask to the OP. Pressing E advances to the next mask.



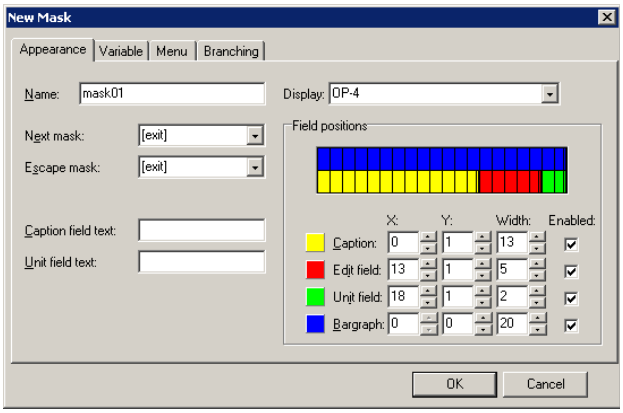

Masks can be organized hierarchically:



To start working with masks, press Masks button or F7. Mask List dialog box will appear.




To create a new mask click Add or press Insert key. Mask Editor dialog box will appear.




Name is a unique string identifier that identifies a particular mask.

Next mask defines a mask that becomes active after E key is pressed.

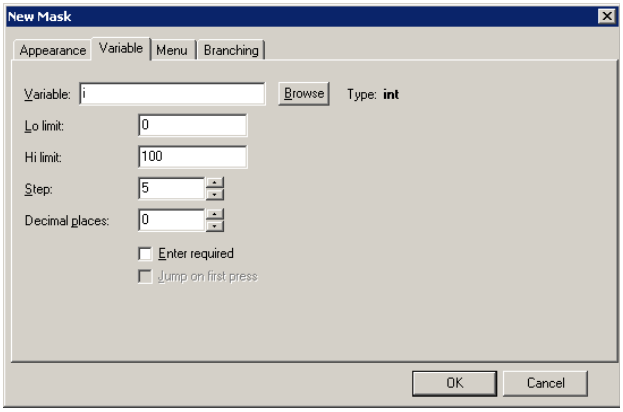
Escape mask defines a mask that becomes active after P key is pressed. Usually, this key is used to exit from mask.

Caption field is a short string that will appear on the display to identify the currently edited variable. Caption position is represented by the yellow rectangle. To move the caption, drag the rectangle into the desired position. To resize caption, drag the right edge of the rectangle.

Edit field is a display area in which the value of edited variable is displayed. It is represented by the red rectangle. Edit field should have enough space for editing variable in the desired range. To move and resize field, drag it like the caption.

Unit field is a short string, similar to caption. Unit field is represented with green rectangle, and it is commonly used for displaying engineering units.

Bargraph is a semi-graphic horizontal progress bar. Few different styles are available. To use bargraph, both low and high limits should be defined.



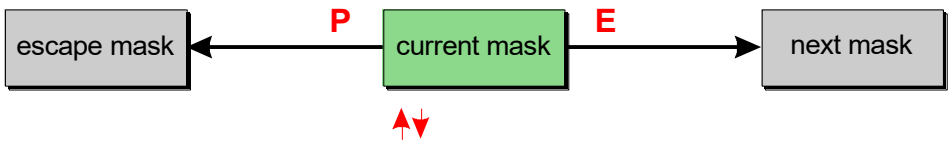

Lo limit and Hi limit define allowed range.

Step defines a value for which the variable will be changed for a single key press.

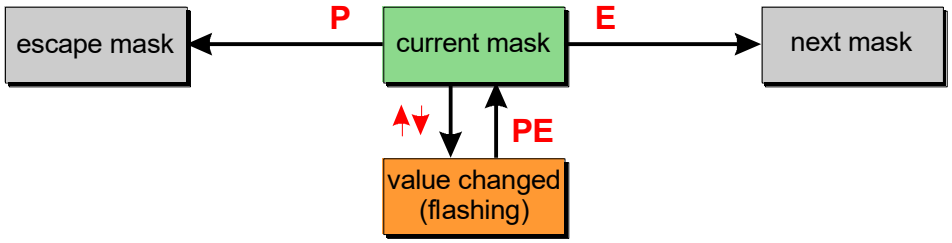
Decimal places may be used for real as well as for integer and long variables. In the former case, only the display is fractional (e.g. for decimal places=1, value 254 is shown as 25.4).

Enter required and Jump on first press define method to operate with navigation keys (P, E). Three combinations are available:

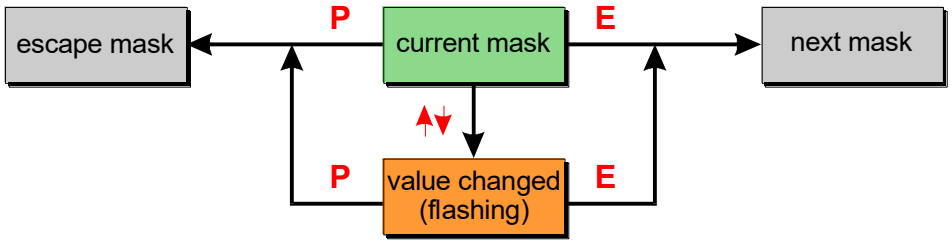
Enter required: no




Enter required: yes
Jump on first press: no

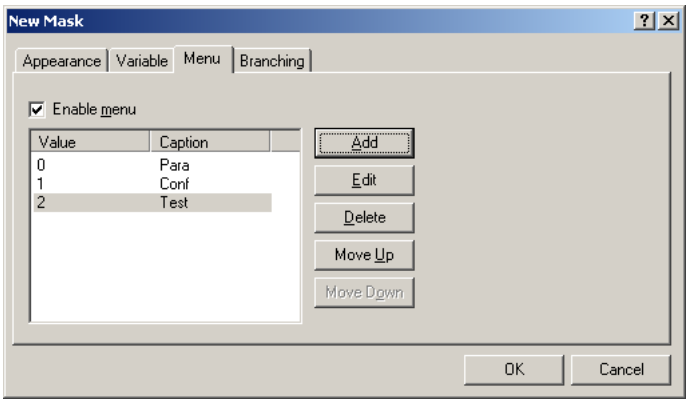



Enter required: yes
Jump on first press: yes



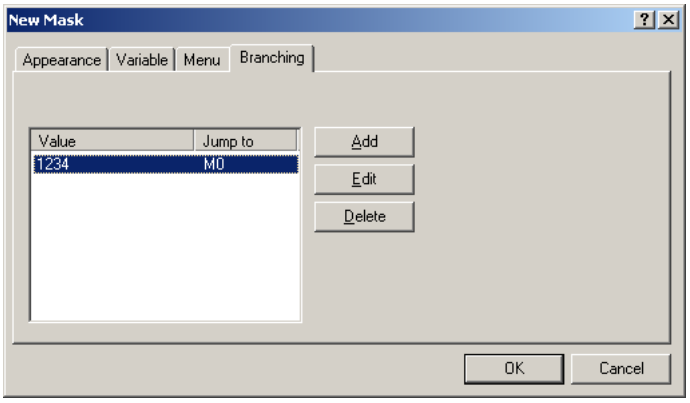

If enter required is false, changed value will be sent to Cybro immediately after up or dn key is pressed. If enter required is true, changed value will be sent to Cybro only when E key is pressed. To indicate that change is not confirmed, changed value will flash.

Variable may be entered as menu rather than as numerical value. To define menu entries, run Mask Editor, click Menu tab and Add as many items as needed.




When executing Cybro program, the display will show items by name, and variable product_type will take value 0, 1 or 2.

Branching tab provides branching onto different masks according to the entered value. This can be used to organize parameters into various parameter sets, but also for a password protected parameters.




Active mask takes control of all panel keys except the F key, so it is not possible to use them from Cybro program at the same time. Mask fields are displayed “over” the user display. After exiting mask, display content is restored.

If mask is too large to fit into operator panel it will not be activated, and it will operate like an empty mask. Mask size is displayed in Mask List dialog box. Available operator panel mask memory is displayed in the Hardware Setup dialog box. To decrease mask size reduce number of menu entries or reduce edit field width. Reducing caption and unit field width may also save few bytes.

Only one mask can be active at the time.

## Program interface

Cybro program can get currently active mask number by reading variable current_mask. When current_mask is zero, no mask is active.

Program may force execution of a certain mask by writing to variable next_mask. After the mask is sent, next_mask is set to -1, and current_mask changes accordingly.

The following example shows mask handling process:

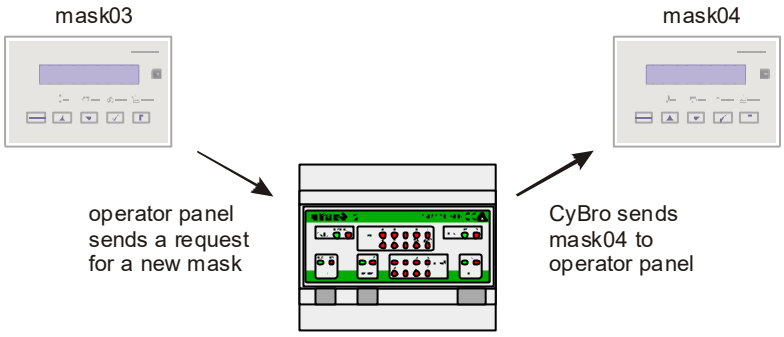
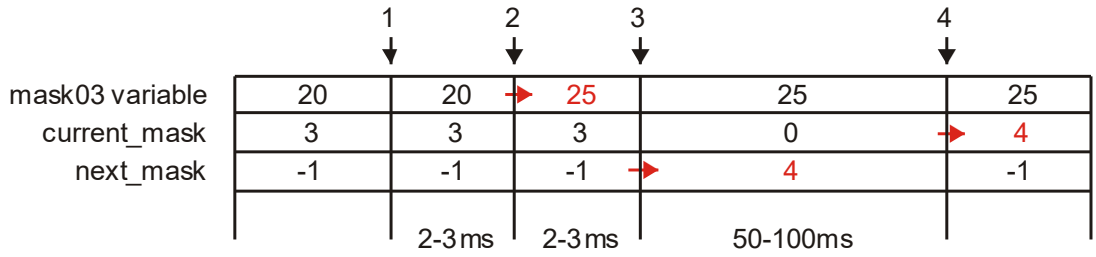



Table shows approximate timings and values for the transition:




Events are marked by black arrows:

1. Enter is pressed
2. Value is sent to Cybro
3. Request for new mask is sent to Cybro
4. New mask sent to operator panel and activated

Red arrows mark value change.

The same transition may be initiated with the following plc program:

```
if <condition> then
  op00_next_mask:=4;
end_if;
```

Short gap in current_mask value comes from the network response time. To check if there is an active mask, program should also check the value of next_mask, like the following example:

```
if op00_current_mask=0 and op00_next_mask=-1 then
  op00_next_mask:=10;
end_if;
```

Both mask control variables may also be accessed remotely, using the A-bus.

# Serial interface

## Features

Cybro controller features multiple communication ports. All of them can be used simultaneously. Port parameters are set at the compile time, it's not possible to change them within the program.

| No | Port | description | A-bus slave | A-bus socket | Modbus master | Modbus slave | free pgm |
|---|---|---|---|---|---|---|---|
| 1 | COM1 | RS232 serial port | yes | - | PLC program | yes | yes |
| 2 | COM2 | RS232 serial port | yes | - | PLC program | yes | yes |
| 3 | COM3 ENO | RS485 serial port EnOcean interface | - | - | PLC program | - | yes |
| 4 | RFM | free-programmable radio interface | - | - | PLC program | - | yes |
| 5 | ETH | Ethernet interface, TCP/IP protocol | yes | yes | PLC program | yes | yes |
| 6 | CAN | SMS interface on GSM-2 module | - | - | - | - | yes |

A-bus is native protocol used to send program (A-bus slave), read/write variables (A-bus slave) and exchange data between controllers (A-bus socket). For more details, check Networking section.

Modbus protocol is developed for industrial applications. It is relatively easy to deploy and maintain compared to other standards, and places few restrictions on the format of the data. Modbus has become de facto standard and is now commonly available in various electronic devices.

Free-programmable means PLC program can send and receive messages, which opens up potential to implement different new protocols.

COM3 port is serial port available on Cybro-3H and Cybro-3W as RS485 interface. On some models it is used for EnOcean transciever. For more details, check hardware manual.

RFM wireless interface uses 868MHz ISM band to send and receive messages. It is used to control WD-1 (DALI bridge), WM-1 (Modbus bridge), WR-1 (Modbus relay) and WR-5 (Modbus relay). It can also be used for Cybro-to-Cybro communication. For more details, check device data sheet.


ETH interface enables plc program to send and receive TCP and UDP messages. Both server and client operation is supported.

CAN is virtual serial port on IEX bus. It can be used to send and receive SMS messages using GSM-2 module.

# Free-programmable mode

With this feature, a wide range of devices can be controlled: various sensors, scales, printers, radio modems, camera and other. Protocol is implemented using the PLC program.

COM1, COM2 and ETH communication ports are full duplex, COM3, ENO and RFM are half duplex. Both master and slave operation is possible.

Serial ports have separate transmit and receive buffer. Each buffer is 1042 bytes in size. That allows for 1024 bytes payload and a few bytes for eventual descriptor and redundancy check.

Rx buffer


Tx buffer


### Select port

```
com_select(port: int);
```

Select must be executed first, before other communication commands. Available ports are:

1 - COM1, RS232 serial port
2 - COM2, RS232 serial port
3 - COM3, RS485 serial port or EnOcean interface
4 - RFM, free-programmable radio
5 - ETH, free-programmable TCP/IP
6 - CAN, free-programmable virtual port

The best place for com_select() is at the beginning of function which implements the protocol. It may be executed in each scan, that has no effect on current receive and transmit operation.

### Create message

Binary messages are created by writing byte by byte to the transmit buffer.

```
tx_bufwr(pos:int, data:int);
```

Write data byte to transmit buffer. Position is 0 to 1041, value is 0 to 255.

```
tx_bufrd(pos:int):int;
```

Read data byte from transmit buffer. Position is 0 to 1041, value is 0 to 255.

ASCII messages may be created with display print commands. Slot number is zero, x coordinate is buffer position, y coordinate is ignored. Output goes to the selected transmit buffer.

```
dclr(0);
```

Fill both receive and transmit buffer with zeros.

```
dprnc(0, x:int, 0, c:char);
```

Write a single character on position x (same as tx_bufwr()).

```
dprns(0, x:int, 0, str:string);
```

Write a string enclosed in single quotes ('abcd'). Special characters are entered as two or three-character combinations:

| combination | ASCII code | hex code |
|---|---|---|
| \n | CR LF | 0D 0A |
| \r | CR | 0D |
| \t | TAB | 09 |
| \\ | \ | 5C |
| \xx | any | xx |

The last option is used to enter any hexadecimal code 00 to FF, e.g. '\41' is the letter 'A'.

```
dprnb(0, x:int, 0, c0:char, c1:char, value:bit);
```

Write a single character, c0 or c1, depending on the bit value.

```
dprni(0, x:int, 0, w:int, zb:bit, value:int);
```

Write 16-bit signed integer as ASCII decimal number. Parameter w is width, zb is zero blanking.

```
dprnl(0, x:int, 0, w:int, zb:bit, value:long);
```

Write 32-bit signed integer as ASCII decimal number. Parameter w is width, zb is zero blanking.

```
dprnr(0, x:int, 0, w:int, dec:int, value:real);
```

Write floating point value as ASCII number with decimals. Parameter w is total width, including decimal point and decimals. Parameter dec is number of decimals. Zero blanking is always on.

**Send message**

```
tx_start(size:int);
```

Send the prepared message. Parameter size is the number of characters to transmit.

```
tx_active():bit;
```

Check whether the transmitter is active: 0-no, 1-yes.

```
tx_count():int;
```

Number of characters left to send. When tx_count() is zero and tx_active() is true, the last character is transmitting.

```
tx_stop();
```

Stop transmitter. Current character will be finished, then tx_active() goes to zero.

### Start receiver

```
rx_start(beg_ch:char, end_ch:char, len:int, beg_tout:int, end_tout:int);
```

Start receiving and define condition to stop.

beg_ch - first character of received message. When receiving is started, all characters are ignored, until the specified character is received. The character is written in the zero position of the receive buffer. To receive message with no specific start character, set to zero.

end_ch - last character of received message. When specified character is received, receiver is stopped (status 2). Character is written as the last byte of the received message. To receive message with no specific end character, set to zero.

len - expected length of received message. After the specified number of bytes is received, receiver is stopped (status 3). To receive a message of variable size, set to zero.

beg_tout - maximum waiting time for the first character, in milliseconds. When timeout is reached, receiver is stopped (status 4). To receive with no time limit, set to zero.

end_tout - maximum time between consecutive characters, in milliseconds. When timeout is reached, receiver is stopped (status 4). To receive with no time limit, set to zero.

For example, with 1200 bps, 8 bits and no parity; transmission of a single character takes about 8ms (start bit + 8 data bits + stop bit = 10bits, 10bits/1200bps = 8.3ms). In such case, end time is typically set to about 25ms.

Examples:

```
rx_start(0,0,0,0,0); // receive continuously
rx_start(0,0,0,0,50); // receive continuously, stop 50ms after the last character
rx_start(':','\r',0,0,0); // receive message starting with ':' and ending with CR
```

Maximum message length is 1042 bytes. When one character more is received, receiver is restarted and the number of received characters starts from 1 again. The buffer is not cleared.

Receiver and transmitter are fully independent.

```
rx_stop();
```

Stop receiving immediately (status 1).

```
rx_count():int;
```

Returns number of received characters. Function rx_start() reset number of characters to zero.

```
rx_active():bit;
```

Check whether the receiver is active: 0-no, 1-yes.

```
rx_status():int;
```

Returns receiver status:

0 - receiver active
1 - stopped by stop command
2 - end character detected
3 - requested size received
4 - timeout expired

**Parse received message**

```
rx_bufrd(pos:int):int;
```

Read data byte from receive buffer. Position is 0 to 1041, value is 0 to 255.

```
rx_bufwr(pos:int, data:int);
```

Write data byte to receive buffer. Position is 0 to 1041, value is 0 to 255.

```
rx_strcmp(pos:int, str:string):bit;
```

Compare receive buffer with a specified string. True when string matches, false otherwise.

```
rx_strpos(pos:int, str:string):int;
```

Search for the specified string. Search starts from the given position. If string is found, function returns position of the first matching character, otherwise it returns -1.

```
rx_strtoi(pos:int):int;
```

Read ASCII decimal number at the given position. If character at the specified position is space, it is skipped until a digit is found. Conversion continues until the first non-digit character.

```
rx_strtol(pos:int):long;
```

Read ASCII decimal number at the given position. If character at the specified position is space, it is skipped until a digit is found. Conversion continues until the first non-digit character.

```
rx_strtor(pos:int):real;
```

Read ASCII decimal number at the given position. If character at the specified position is space, it is skipped until a digit is found. Conversion goes until the first non-numeric character.

Example:

Received message may contain keywords OPEN, CLOSE, AUTO and SET=<value>. Keywords are sent in no particular order and separated by one or more spaces.

```
SET=225 OPEN AUTO
```

Program that parses message according to given specifications:

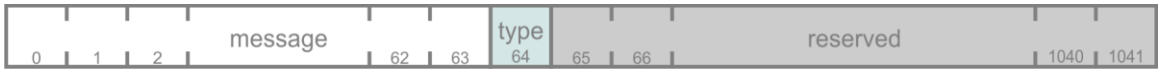
```
if rx_strpos(0,'OPEN')<>-1 then
  main_valve=1;
end_if;

if rx_strpos(0,'CLOSE')<>-1 then
  main_valve=0;
end_if;

if rx_strpos(0,'AUTO')<>-1 then
  automatic_mode=1;
end_if;

position=rx_strpos(0,'SET=');
if position<>-1 then
  setpoint=rx_strtoi(position+4);
end_if;
```

# Free-programmable radio

### Initialize socket

The first command must be com_select(4), it directs all consecutive commands to the radio driver.

Rx/Tx buffer




The folowing command is rx_start(), providing parameters to initialize the radio interface:

```
rx_start(dummy:char, dummy:char, group_hi:int, group_lo:int, timeout:int);
```

group ..... 32-bit group address, zero means factory default
timeout..... the time after which the reception stops [ms], zero to disable

Wireless devices use factory default address 10 seconds from power on, then switch to configured address, if one exists. That allows sending new group address to all devices at the same time. When 10s period runs out, address is locked to protect device against intrusion. On Cybro, this process is under the control of PLC program, which allows receiving new address at any time.

### Send and receive

RFM radio behaves very much like other serial ports. When message is received, receiver is stopped and need to be started again. To stop receiving at any time, use rx_stop(). Function rx_active() returns receiver state (0-off, 1-on), function rx_status() returns more details:

0 - receiver active
1 - stopped by stop command
2 - message received
4 - timeout expired

Command tx_start() begin transmitting prepared message, tx_active() returns transmitter state (0-off, 1-on). It is active immediately after the start command is executed.

### Message type

The type byte (position 64) specifies the content of the message:

0 - DALI (WD-1)
1 - group address (all devices)
2 - Modbus or other serial protocol

Type must be set before the message is sent, and comes with the received message. Type 2 can be used for any serial communication.

### Group address

By default, all devices share the same group address and listen to each other. To separate your devices, create a new secure group. Once group is created, no other device can listen or interfere with your data.

Group can be changed within 10 seconds of power up. After that, the group address is locked.

Note that groups share the same bandwidth. To avoid collisions, keep the traffic low or synchronize requests so that messages don't overlap.

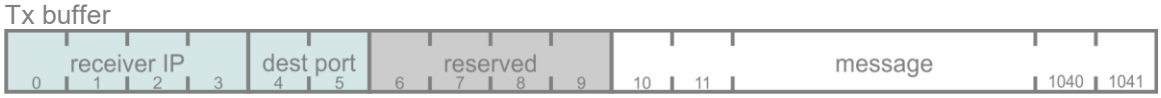
For more details, check RFM demo.cyp.

# Free-programmable TCP/IP

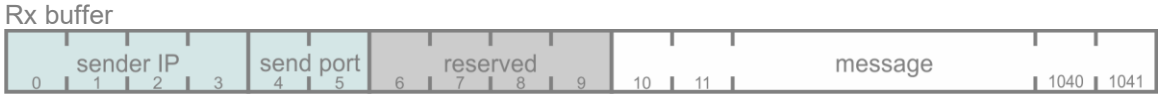
### Initialize socket

The first command must be com_select(5), it directs all consecutive commands to TCP/IP driver. With ETH selected, first 10 bytes of buffer are reserved for IP header:

Tx buffer




Rx buffer




Receiver IP address and port must be written by plc program before the message is sent. Sender IP address and port are written by system when message is received.

The following command is rx_start(), providing parameters to initialize the TCP/IP socket:

```
rx_start(protocol:char, dummy:char, port:int, autostop:int, timeout:int);
```

protocol.... 0-none, 1-UDP, 2-TCP master, 3-TCP slave
port ..... controller port through which messages are sent and received
autostop... when active, receiving reply message will close the connection
timeout..... when time runs out [ms], connection is closed; zero to disable

In UDP mode, the controller is ready to receive and transmit UDP messages right away.

In TCP mode, either master (client) or slave (server) operation is selected. When initialized as a master, Cybro uses receiver address and port to open the connection and send the first message. When initialized as a slave, Cybro enters listen mode, waiting for connection on the selected port.

To prepare the outgoing message, use tx_bufwr() or display print commands. To send the message, use tx_start(). Parameter size is the length of the message, without the header. Other transmit commands are not used.

To check if the message has been received, read the first byte of the buffer using rx_bufrd(). When result is not zero, message has arrived. The rx_count() returns received size, without the header. Parsing is the same as with the serial port. When finished, use rx_bufwr() to invalidate the message and prepare for the next one.

Command rx_status() returns state of the socket:

0 - closed
1 - UDP open
2 - TCP initialised
3 - TCP listen
4 - TCP connected

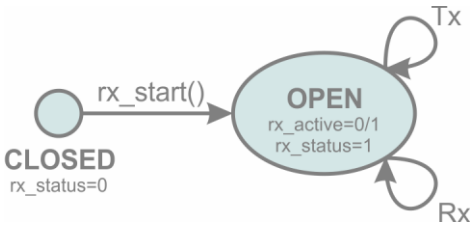
When message is transmitted or received, timeout is reloaded and rx_active() is set. When timeout expires, rx_active() goes to zero.

Command rx_active() returns 1 when connection is extablished (status 4). To close connection at any time, use rx_stop() command. To close the socket, use rx_start() with protocol set to zero.

Reserved local ports are 53 (DNS), 68 (DHCP), 8442 (A-bus LAN), 20000..29999 (A-bus WAN) and 502 (Modbus slave). Other port numbers are free to use.

### UDP mode

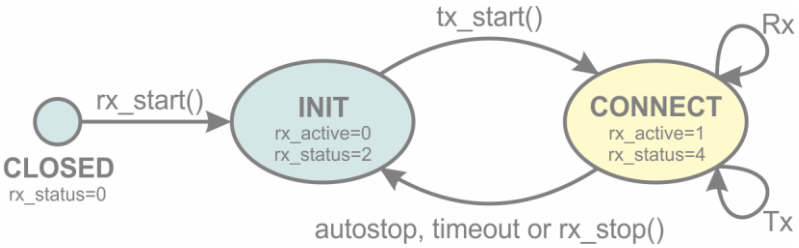
User Datagram Protocol (UDP) is a simple connectionless protocol that allow devices to send and receive messages. Sender destination port must be the same as the receiver local port. Message can be sent to multiple recipients using the subnet broadcast address.




Once socket is open, use tx_start() to send and rx_bufrd() to detect the received messages. Although the state is not changed, autostop and timeout can be used by reading rx_active().

### TCP master

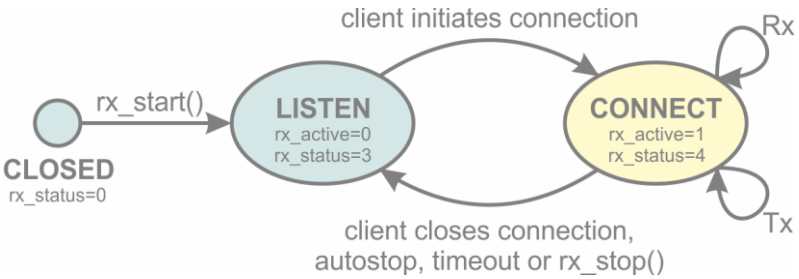
Transmission Control Protocol (TCP) is a connection-oriented protocol and requires handshaking to start communication. Once a connection is established, data can be sent. In master mode, connection is established when controller sends a message to the slave device.




If autostop is set, connection is closed when message is received. If timeout is set, connection closes when time runs out. Timer is reloaded with each received and transmitted message. Only one connection can be opened at a time.

### TCP slave

In slave mode, controller is intialized and waiting for a connection.




The message can only be sent when the connection is established. When sending the message, receiver ip address and port are not used, since connection is already established.

If autostop is set, connection is closed when message is transmitted. If timeout is set, connection closes when time runs out. Slave timeout should be longer than or equal to the master timeout. Timer is reloaded with each received and transmitted message. Only one connection can be opened at a time.

# Free-programmable SMS

### Initialize driver

The first command must be com_select(6), it directs all consecutive commands to the SMS driver. With SMS selected, first 20 bytes are reserved for the phone number:

Tx buffer


Rx buffer


Phone number consist of ASCII digits, the rest must be filled with zeros:


### Send and receive

The command rx_start() is issued to start receciving messages. All parameters are ignored.

```
rx_start(dummy:char, dummy:char, dummy:int, dummy:int, dummy:int);
```

When message is received, receiver is stopped and need to be started again. Function rx_active() returns the receiver state (0-off, 1-on). It is up to PLC program to check the sender number, parse the content of the message and perform the requested tasks.

Command tx_start() sends prepared message to the given phone number. Parameter size is the length of the message (1..160 bytes), without the phone number.

```
tx_start(size:int);
```

Command tx_active() returns transmitter state (0-off, 1-on). When state is zero, transmitter is ready for a new message.

Transmit and receive are fully independent.

### Message format

The format of the message is fully defined by the user. To make the parsing simple, we recommend that messages use one of three syntaxes:

```
start setpoint=24 temperature=?
```

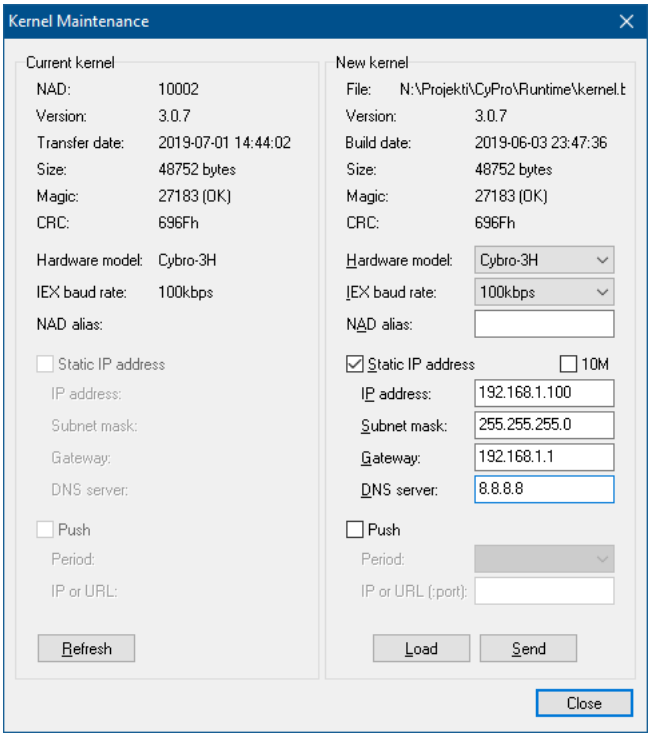
The first is a single command, like start, stop, clean or status. The second and third are used to write and read the value. There are no reserved words, it's up to PLC program to implement the parser.

It is always a good idea for the controller to return a confirmation message.

# Networking

## Ethernet setup

Cybro may have a dynamic IP address given by DHCP server, or static IP address set in Kernel Maintenance. To configure static address, turn on checkbox Static IP address and fill the fields. DNS server is required when push to domain name is used.




Cybro with static IP is accessible right after power-on. Dynamic address may need a few seconds, and up to a minute if controller is connected in a new network. When DHCP server is not available, Cybro will have an invalid IP address (0.0.0.0).

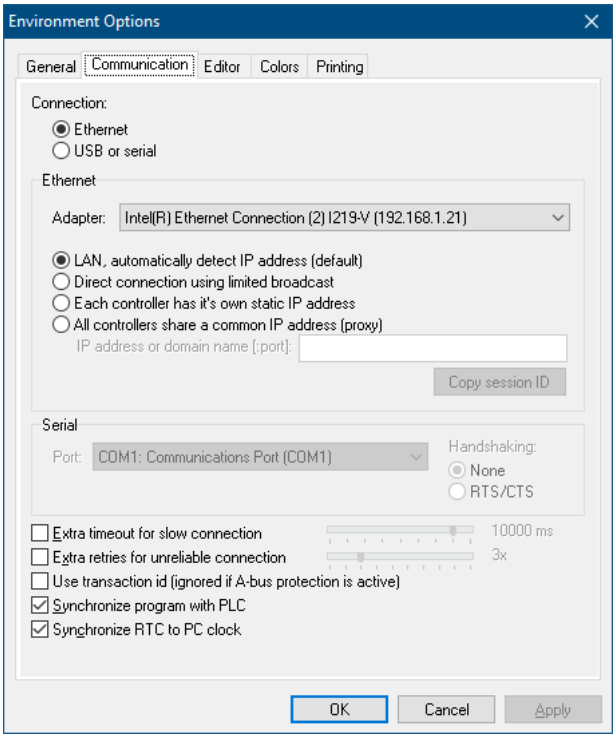
Checkbox 10M is used to disable baud negotiation and force 10Mbps. It may be used when negotiation fails, for whatever reason.

Cybro has 6-byte MAC address in form 00-CB-00-xx-xx-xx, where last three bytes are serial number (NAD). For example, Cybro 20000 (0x4E20) has MAC address 00:CB:00:00:4E:20.

# Connection options

There are several ways to connect programming environment and the controller:

- LAN, IP address is detected automatically
- Direct connection using limited broadcast
- Each controller has it's own static IP address
- All controllers share a common IP address (proxy)




Session id is used when connection is going through server based on CybroWebScada.

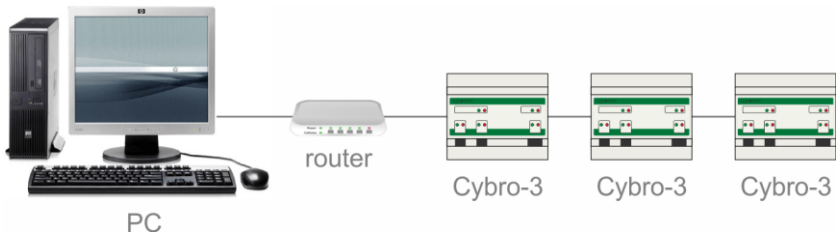
Extra timeout and Extra retries may be used when communication channel is slow. Transaction id adds an unique id to each request/acknowledge pair, avoiding problems with delayed and lost messages. It can't be used if A-bus protection is active.

Recommended settings, depending on network speed:

| | roundtrip | transaction id off | | transaction id on | |
|---|---|---|---|---|---|
| | | extra timeout | extra retries | extra timeout | extra retries |
| local network connection | 0..5ms | - | - | - | - |
| wired internet | 10..100ms | 200ms | 2x | 100ms | 3x |
| 3G/4G/5G connection | 10..200ms | 500ms | 5x | 200ms | 5x |

Synchronize program with PLC means the Start button will also send program. Synchronize RTC to PC clock means the controller real-time clock will be updated when program is sent.

### LAN connection




This is the most common setting, all devices are in the same subnet. IP address may be dynamic (DHCP) or static. CyPro uses subnet broadcast (192.168.0.255) to automatically detect IP address.

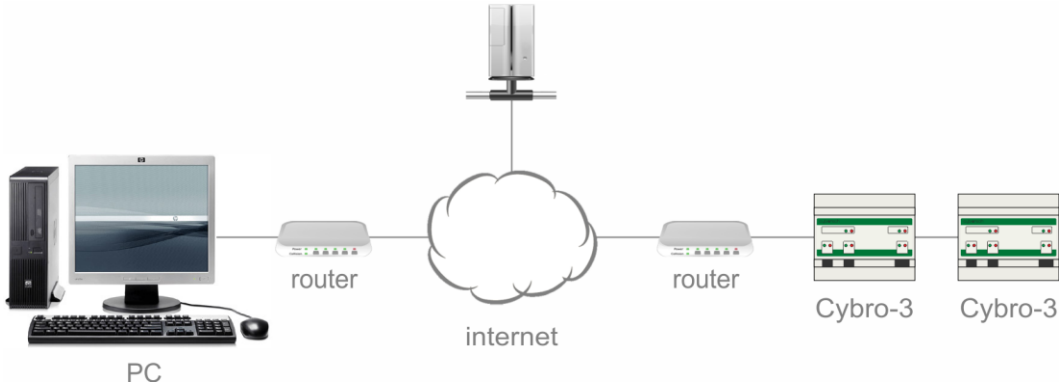
### USB or serial connection


Connect micro USB cable, set environment options to USB or serial, then select port "USB-SERIAL CH340". Connection can be used without power supply. USB provides power supply for CPU, inputs and outputs are inoperative.

### Direct connection (no router)


This connection is used in case of emergency, when no valid IP is available. Messages are transmitted as limited broadcast (255.255.255.255:65535). Don't open CyPro before autoconfiguration address (169.254.x.x) is assigned to PC.

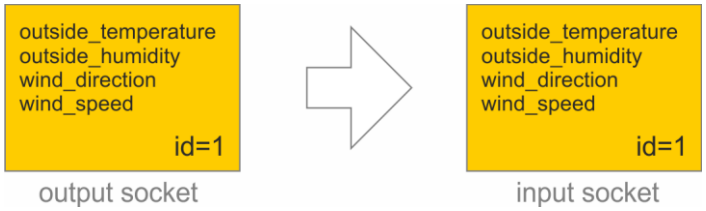
### Internet connection




Internet connection has to solve two problems: how to get ip adddress of the other party, and how to get through the router. For more information, check hardware manual, chapter internet. For more details how to set the connection, check the documentation of the tool used.

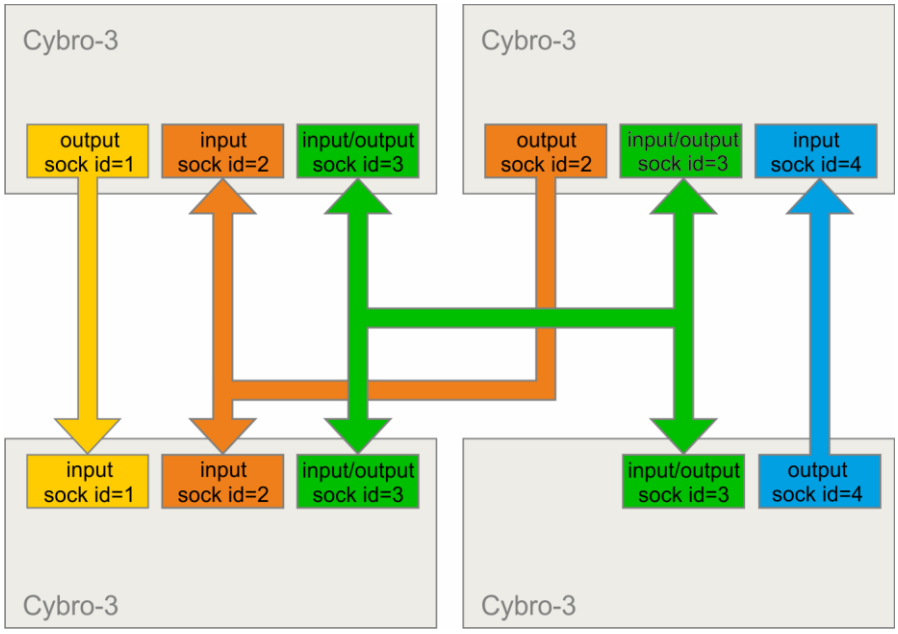
# Socket interface

Socket is a group of variables, used for Cybro-to-Cybro communication. User defines a matching pair of sockets, one for each controller. Sockets must have the same id and must use the same variables (type and order matters, name is not important).




Socket id can be in the range 1 to 255.

Multiple sockets can be used at the same time:




Each controller receive only sockets declared in his program.

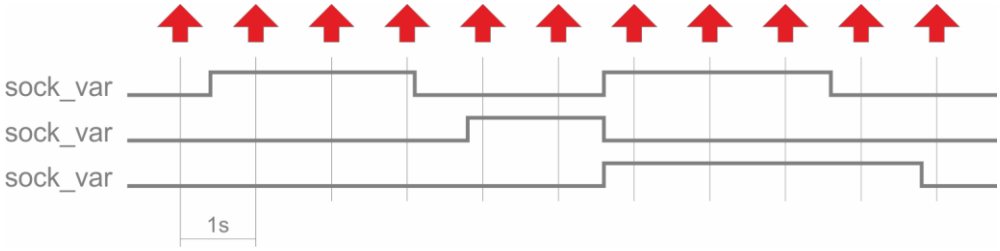
Sender does not know if the receiver actually received the socket. The acknowledge can be sent back through a second socket pair.

Receiver does not know who sent the message, but socket may include sender serial number as a variable within the socket.

Socket size is limited by the maximum size of A-bus message (1024 bytes).

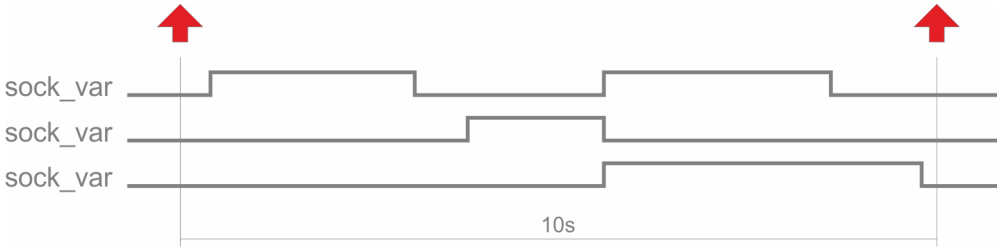
Sending may be triggered in several ways:

**1. Periodic 1s**



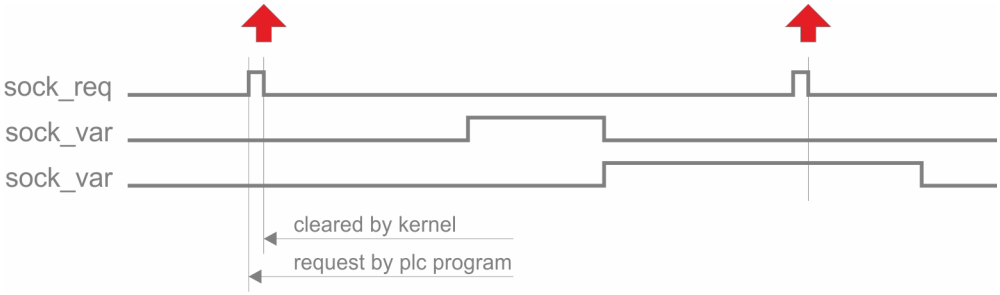

Socket is transmitted once a second.

**2. Periodic 10s**




Socket is transmitted once every ten seconds.

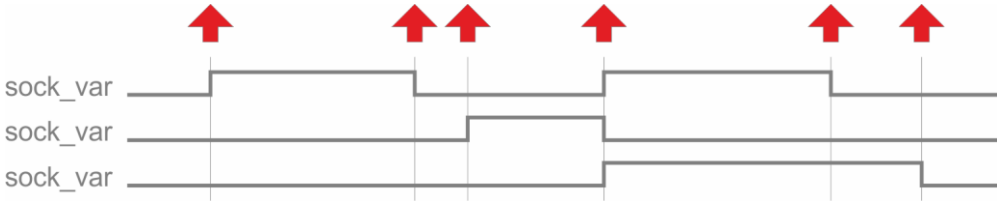
**3. On-request**




Socket is transmitted on request from plc program.

Transmission begins when request bit is set. Kernel responds by clearing the request and sending the socket. Request is the first bit variable in the socket. It is transmitted as 1, so it can be used by receiver to check if the socket has arrived.

**4. On-change**

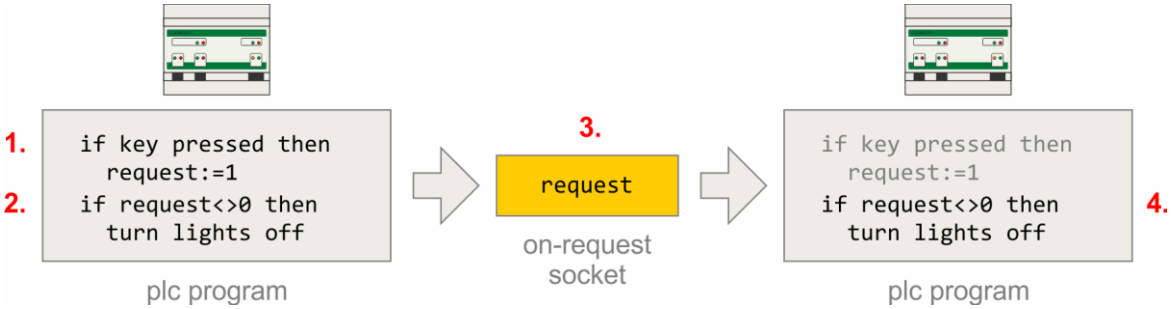



Socket is transmitted each time one of socket variables is changed. Controller must be running.

### On-request example

On-request socket may be used to send event to multiple controllers. One controller sends the socket, all others will receive it. Number of controllers is not limited.

The example shows how to turn off lights controlled by two controllers.



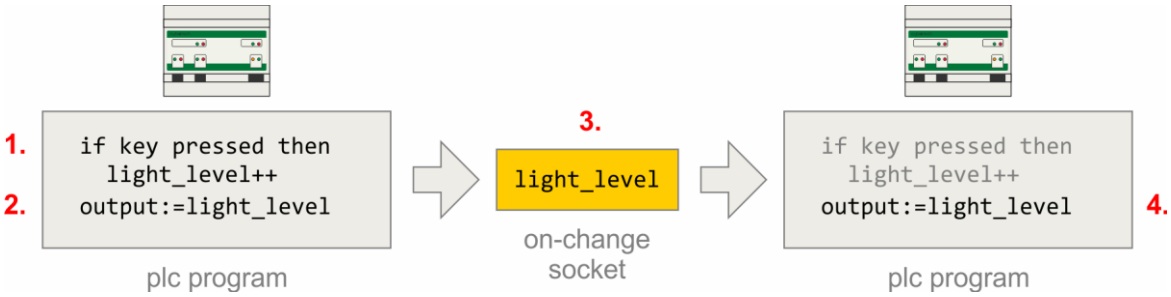

Program in both controllers is the same.

When receiver needs to know request source, 1 is local, 3 is remote (cast to bit when comparing). Request will be active for at least a single scan.

### On-change example

On-change socket is used to synchronize a value between controllers. Each controller may modify the value, all others receive the new value. Number of controllers is not limited.

The example shows a light level setting (0-100%), synchronized between controllers.




Each controller has the same program, local i/o assignment may be different.

# Features

## Real-time clock

Real-time clock (RTC) consist of a hardware clock and calendar. When power is down, it runs from internal battery. For accuracy and data retention time, check hardware manual.

RTC is synchronized to PC when program is sent to the PLC. To enable or disable synchronization, use checkbox Environment/Communication/Synchronize RTC to PC Clock. RTC is also synced with OPC server and HIQ Commander mobile application. It can be set also with PLC program.

To read and write time, use:

```
rtc_hour:int;
rtc_min:int;
rtc_sec:int;
```

| | |
|---|---|
| hour | 0..23 |
| min | 0..59 |
| sec | 0..59 |

To read and write date, use:

```
rtc_year:int;
rtc_month:int;
rtc_date:int;
```

| | |
|---|---|
| year | 2000..2099 |
| month | 1..12 |
| date | 1..31 |

To read and write day of the week, use:

```
rtc_weekday:int;
```

0 - Sunday
1 - Monday
2 - Tuesday
3 - Wednesday
4 - Thursday
5 - Friday
6 - Saturday

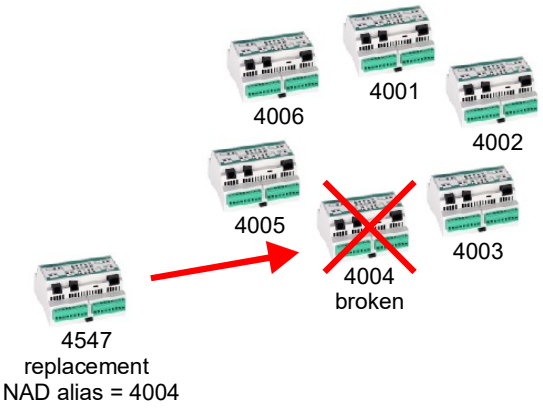
To set real-time clock, write new time/date to variables and set the request flag:

```
rtc_write_req:=1;
```

## NAD alias

Each controller has unique serial number, used as communication address (NAD). Serial number is permanent and can not be changed.

NAD alias is a second, replacement address configurable by user. Alias functions same as the original NAD, controller may be addressed both ways.

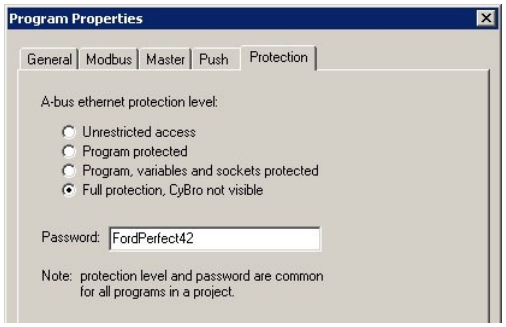



To set new NAD alias, open Kernel Maintenance dialog box, enter alias and send.

Because of security issues, alias is used in local communication only. When controller is connected to the internet, the original serial number is used exclusively.

## Password protection

Cybro controller can restrict access to it's data with password. Depending on selected level, protection may cover only program, program and variables, or everything. For example, when protection level is Program protected, anybody can read and write variables, but needs a password to send a new program.




Password protection affect only Ethernet interface. Serial ports are not restricted (including USB), even when full protection is used.

Password may contain any combination of letters and numbers of a reasonable length. It is case sensitive. Don't use spaces or national characters.

Password is common for all programs in project, it's not possible to define individual password for each controller. Password stored in project file is not secure, so keep your project safe.

When password is used, communication option Transaction id can not be used.

To send a new program to protected controller, use command Erase protected program.

If you forget the password, unlock controller using the USB port.

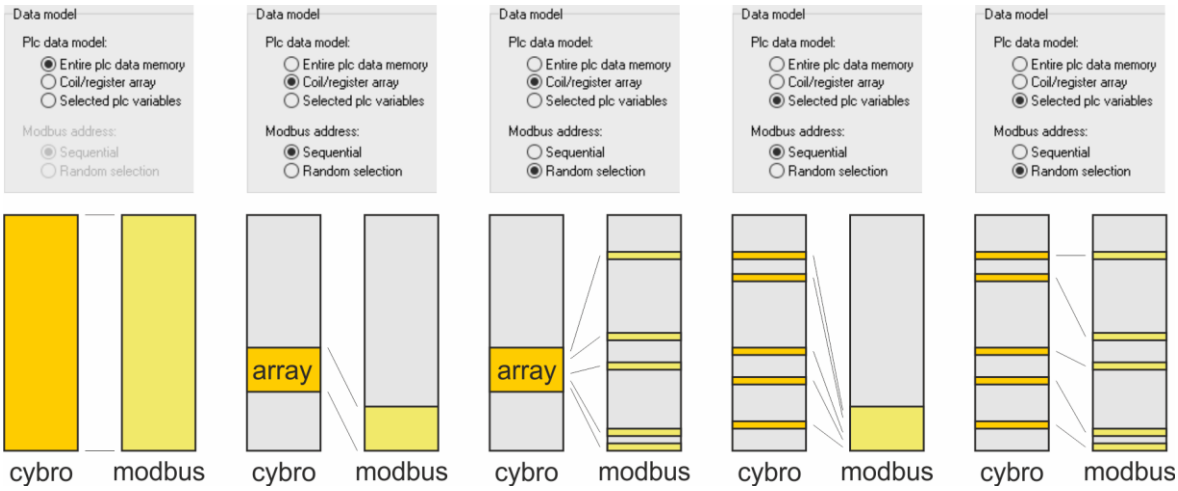
# Modbus slave

Modbus communication protocol is published in 1979, for use with programmable logic controllers. It has since become de facto standard for connecting various devices.

Cybro supports:

- Modbus RTU slave (RS232/RS485)
- Modbus TCP slave (Ethernet)

Modbus data model describes how modbus coils and registers are translated to Cybro memory.




Modbus model include coils and holding registers. Discrete inputs and input registers are not supported.

When "Entire plc data memory" is selected, list of available coils/registers can be exported in csv format. List may be imported by modbus master, refering variables by name instead of a number.

Function codes:

| code | hex | command |
|---|---|---|
| 1 | 01h | READ_COILS |
| 3 | 03h | READ_HOLDING_REGISTERS |
| 5 | 05h | WRITE_SINGLE_COIL |
| 6 | 06h | WRITE_SINGLE_REGISTER |
| 15 | 0Fh | WRITE_MULTIPLE_COILS |
| 16 | 10h | WRITE_MULTIPLE_REGISTERS |

Other codes will be rejected as ILLEGAL_FUNCTION (exception code 01h).

Data types:

- bit (0 or 1) for coils
- int (16-bit integer) for registers

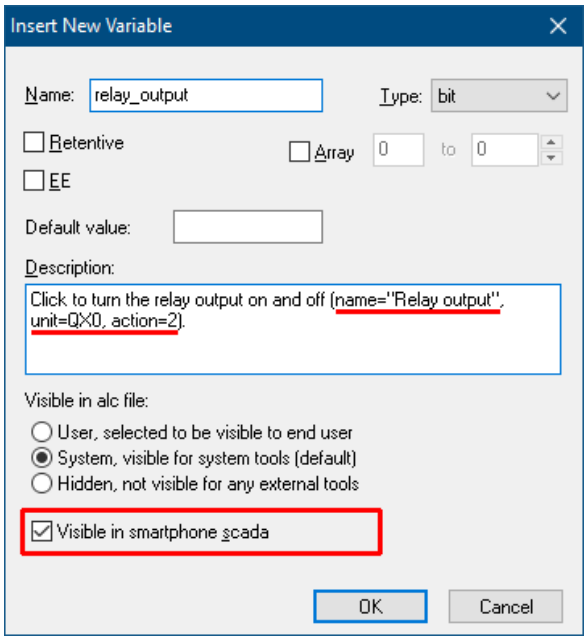
Other data types are not supported.

When Modbus RTU master is needed, use ModbusRtuMaster.cyp from Examples.

# Mobile application

HIQ Commander is mobile app used to monitor, control and configure your plc program.

User should mark the variables, open app and start autodetect. The app displays a list of objects, each representing a single variable. Each object is used to display variable in one of the predefined modes. The mode can be configured with tags, which are entered in the variable description. Object can also be used to change the value, by using the action tag.




To setup variables, open allocation editor, variable properties, and do the following:

• tick checkbox "visible in smartphone scada"
• enter tags into the variable description

Tags may be placed anywhere within description, and separated by space or comma. Each tag has default setting. When default is alright, the tag doesn't need to be specified.

Make sure the variable is not hidden, and the allocation file is sent to the controller.

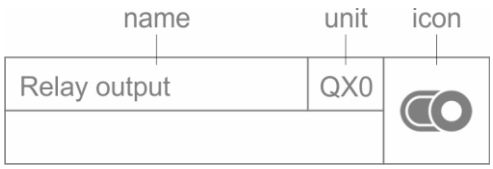
The number of objects is not limited.

When plc is configured, open HIQ Commander and start autodetect. Ensure the mobile is on Wi-Fi, the same network as the controller. If alright, the list of objects will appear.

To use the application remotely, over the internet, ownership of the controller must be confirmed. Ensure the mobile is on Wi-Fi, the same network as the controller, open Settings and press Enable.

For more details, open HIQ Commander demo.cyp from CyPro examples.

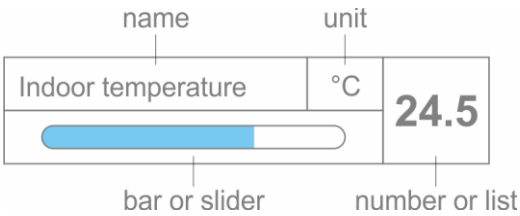
### Binary object




Tags available for the binary object:

type.....object type, bit or int (default is bit for bit variables, int for others)
name .....object name (default is variable name)
unit.....short text displayed on the right (default is none)
icon.....icon number, check appendix (default is 0)
action.....0-none, 1-write, 2-toggle (default is 0)
value.....value that will be written by write action (default is 1)

### Integer object




Tags available for the integer object:

type.....object type, bit or int (default is bit for bit variables, int for others)
name .....object name (default is variable name)
unit.....short text displayed on the right (default is none)
dec.....number of digits after decimal point (default is 0)
list .....list of strings, separated by 'or' symbol (OFF|HEAT|COOL) (default is none)
bar .....0-none, 1-show bargraph (default is 0)
min.....minimum for increment, slider, spin edit (default is 0) and keypad (default is none)
max.....maximum for increment, slider, spin edit (default is 100) and keypad (default is none)
step.....step size for increment, slider and spin edit (default is 1)
action.....0-none, 1-write, 2-toggle, 3-increment, 4-slider, 5-string list, 6-spin edit, 7-keypad (def 0)
value.....value that will be written by write action (default is 1)

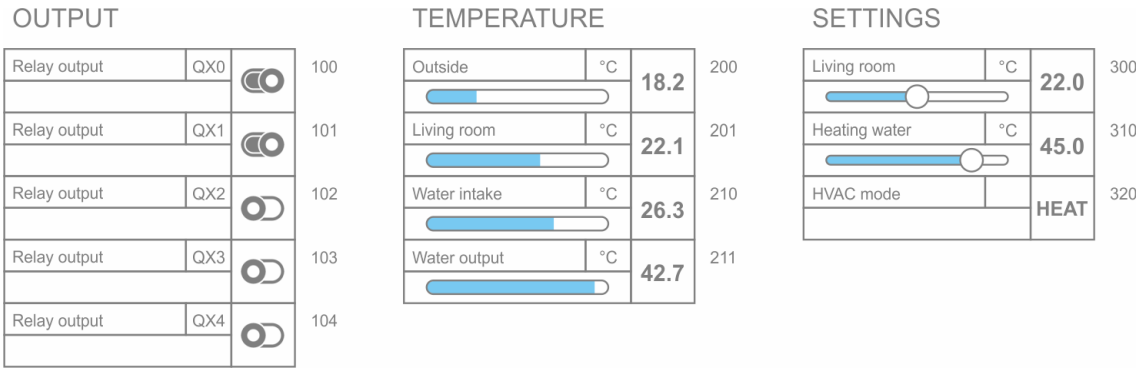
Tags are entered in the description field of the variable. General form is <tag>=<value>. The order and position doesn't matter. String with spaces must be enclosed in quotation marks. There should be no spaces before and after the '=' sign. Object name can be changed within application. Keypad action has no default limits, the limits are applied only when min and max are explicitely stated.

### Tabs and order

The order of objects is determined by variable type and position in the allocation list. Bit variables are at the top, followed by integers, long integers and finally floats. To specify the order of objects manually, use the following tags:

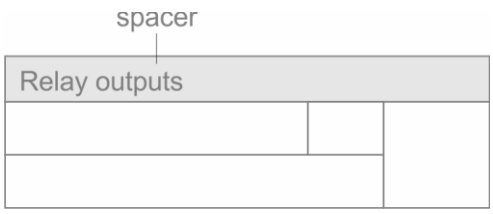
pages.....tab names (default is tabs not visible)
pos.....position and page number (default is as in the allocation list)

Tag pages defines the name for each tab, and consequently the total number of tabs. It should be specified only once, within the first variable. Tag pos defines position of object in the list. Numbers can be skipped, which may be useful when objects are added later. The hundreds digit has a special meaning, it defines the tab on which the object is displayed.




bit output_qx00: pos=100, action=2, pages=OUTPUT|TEMPERATURE|SETTINGS
bit output_qx01: pos=101, action=2
bit output_qx02: pos=102, action=2
...
int hvac mode: pos=320, action=5, list=OFF|HEAT|COOL

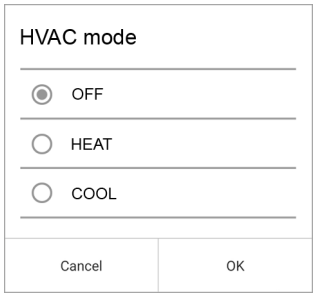
### Spacer



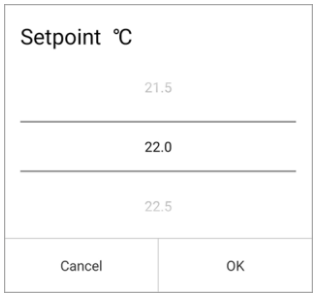

spacer.... visual separator between objects, with optional title (default is none)

### Actions

| | |
|---|---|
| 0: none | object is read only |
| 1: write | write a single value |
| 2: toggle | switch between 0 and 1 |
| 3: increment | increment by step, positive or negative, loop back when min/max is reached |
| 4: slider | drag handle left and right to adjust the value |
| 5: string list | select a single choice from the list (0, 1 or 2) |




6: spin edit enter value by turning the wheel

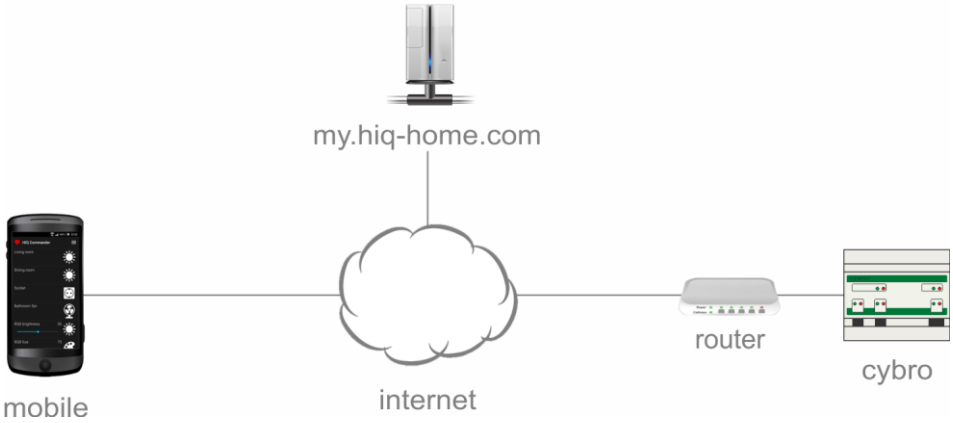



7: keypad enter value digit by digit


When EE variable is modified, EE magic and write request are applied automatically. When RTC variable is modified, RTC write request is applied automatically.

### Internet

In a local network, application talks directly to the controller. When mobile is remote, the traffic is routed through the server.



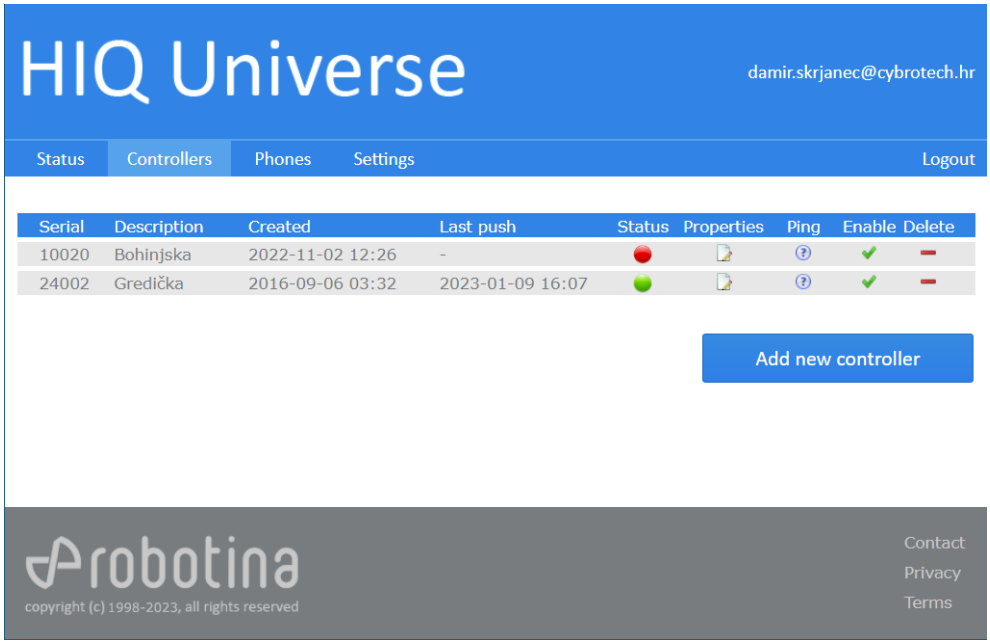

There are two ways to register to the server:

• autodetect, turn on enable internet access switch
• settings, press internet access enable button

Mobile must be in the same network as the controller. Both procedures are fully automatic. Server creates a record for both mobile device and controller.

For a better security and access control, you may create the user account. Sign-in to http://my.hiq-home.com, then add your controller to the list. Account is not requred for internet access.

To do this, you need CyPro online monitor. Set authentification_req, copy authentification_code and type serial number and the 6-digit number into the online form. Description is optional.



The mobile is automatically visible in the phones list.


To add new phone, run the same procedure again.

To secure the system, disable adding new phones. That will ensure maximum security, nobody will be able to gain control, even if they have access to your local network.

### Examples

| Relay output | QX0 | |
|---|---|---|
| | | |

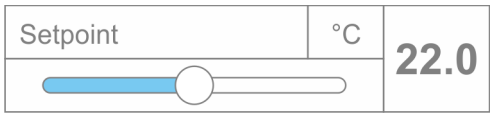
bit relay_output;
description: Click to turn the relay output on and off (name="Relay output", unit=QX0, action=2).

| Output power | kW | 2.1 |
|---|---|---|
| | | |

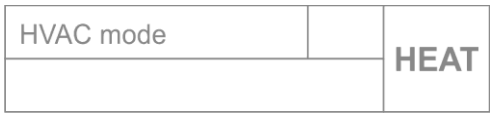
int output_power;
description: Measured output power for all phases (name="Output power", unit=kW, dec=1).

| House temperature | °C | 24.5 |
|---|---|---|
| | | |

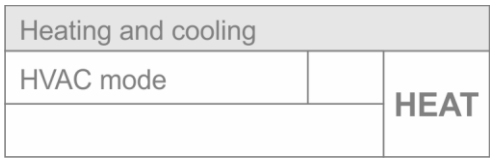
int temperature;
description: Measured temperature (name="House temperature", unit=°C, dec=1, bar=1, min=100, max=300).




int setpoint;
description: Setpoint temperature (name="Setpoint", unit=°C, dec=1, min=100, max=300, step=5, action=4).



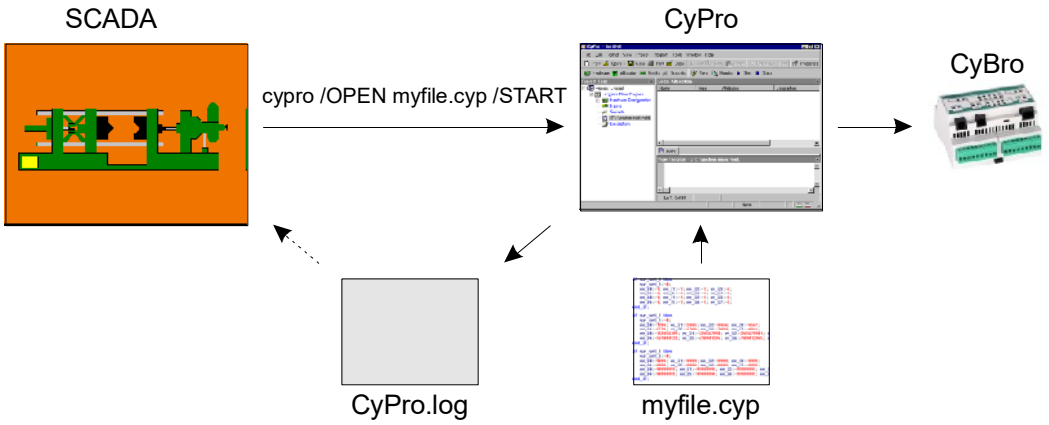

int hvac_mode;
description: HVAC operating mode (name="HVAC mode", list=OFF|HEAT|COOL, action=5).




int hvac_mode;
description: HVAC operating mode (spacer="Heating and cooling", name="HVAC mode", list=OFF|HEAT|COOL, action=5).

# Command line options

Command line options are specified upon starting CyPro. They are used to automatically perform some tasks, such as sending a program. Using command line options, CyPro may be used as external compiler for another application.




Command line options are:

| | |
|---|---|
| /NEW [filename.cyp] | Create a new project. Filename is optional. |
| /OPEN filename.cyp | Open existing project with specified filename. |
| /SAVE | Save project. |
| /SAVEAS filename.cyp | Save project under specified name. |
| /EXIT | Exit CyPro. |
| /NAD number | Select program. If specified NAD exists, that program will be selected, otherwise NAD is appended to current program. |
| /AUTODETECT | Hardware autodetect. |
| /START | Compile, send (only if different) and run. |
| /STARTALL | Start all programs in project. |
| /STOP | Stop current program. |
| /SEND | Send current program. |
| /HIDDEN | Silent operation, do not show any window or dialog box. |

Filename may be given as name or full path. When file name contain spaces, use double-quote ("my file.cyp"). If an operation requires user input to continue execution, default option is used automatically. For example, when autodetect asks for a network address, default address (zero) will be used automatically.

When started with command line options, CyPro creates log file with all commands and results. Log file is saved in CyPro directory (c:\Program Files (x86)\Cybrotech\CyPro-3\CyPro.log).

When /HIDDEN mode is used, CyPro will automatically exit after last command is executed.

When using command line options, it is advisable to turn on checkbox Allow multiple instances in Environment Options. If only single instance is allowed and CyPro is already running, command line requests will be proceeded to the active copy.

Examples:

```
cypro.exe myfile.cyp
```

Start CyPro and open project myfile.cyp.

```
cypro.exe "c:\My Documents\myfile.cyp"
```

Start CyPro and open project myfile.cyp in specified directory. As path may contain spaces, quotas are required.

```
cypro.exe /HIDDEN /OPEN "myfile.cyp" /START /EXIT
```

Start CyPro, open an existing project (myfile.cyp), start PLC (compile, send & run) and exit. Operation is hidden, no window or dialog box will appear. Possible errors are saved in CyPro.log.

```
cypro.exe /HIDDEN /NEW /AUTODETECT /SAVEAS "myfile.cyp" /EXIT
```

Start CyPro, open a new project, start Autodetect, save as myfile.cyp and exit. Operation is hidden, no window or dialog box will appear. Possible errors are saved in CyPro.log.

```
cypro.exe /HIDDEN /NEW /NAD 4000 /AUTODETECT /SAVEAS "myfile.cyp" /EXIT
```

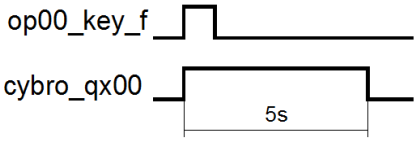
Start CyPro, open a new project, add new NAD, start Autodetect to detect connected IEX-2 modules, save as myfile.cyp and exit. Operation is invisible, no window or dialog box appears. Possible errors are saved in CyPro.log.

```
cypro.exe /HIDDEN /OPEN "myfile.cyp" /AUTODETECT /START /EXIT
```

Start CyPro, open an existing project (myfile.cyp), start Autodetect (assuming the project has no hardware setup and network address), start PLC (compile, send & run) and exit. Original file remain unchanged. Operation is silent, no window or dialog box will appear. Errors are saved in log file.

# Getting started

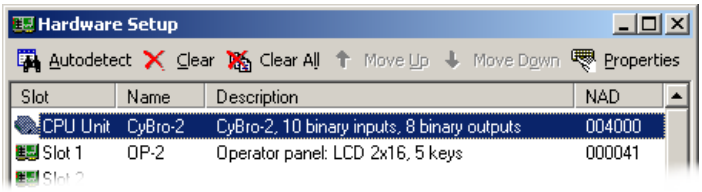
This example, a simple timer activated with a key, will show steps to get program running.




### Step 1: hardware

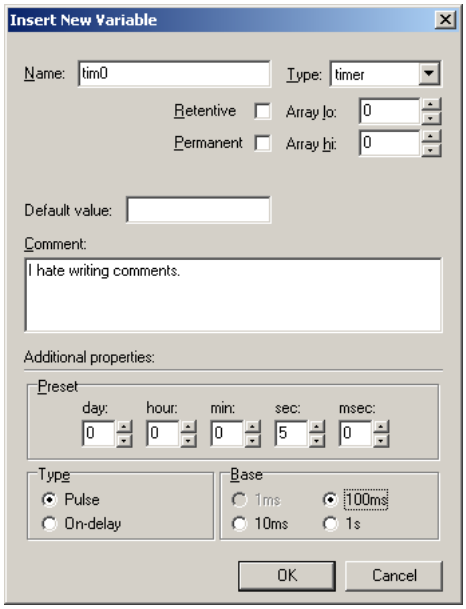
The example will use Cybro controller and OP-2 panel. Connect power supply, ethernet and panel according to hardware manual.

Open CyPro and select File/New Project. Open Hardware Setup and run Autodetect.




### Step 2: variables

Project will use variable of timer type. Start Allocation Editor, and press Insert:




Enter name, select type, preset and time base.

### Step 3: write code

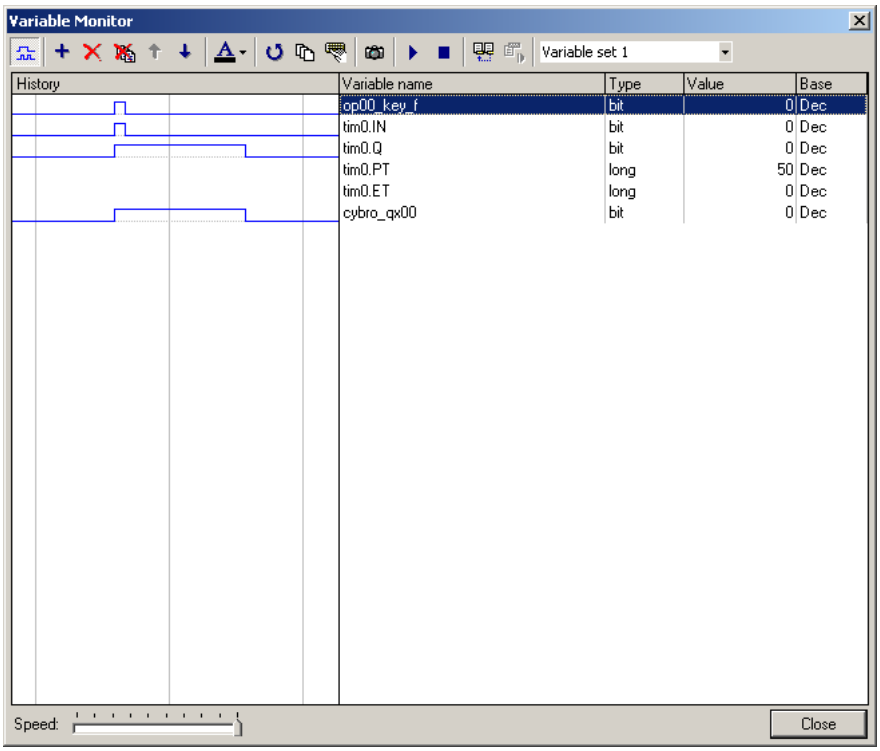
PLC code connects the OP key to the timer input, and the timer output to the output relay:

```
tim0.in:=op00_key_f;
cybro_qx00:=tim.q;
```

### Step 4: run

To compile and send program, just press Start button. Status line shows the program is running.

To check operation, open Variable Monitor, add variables, and press F key.




Graph in the left pane shows the program is running as expected.

# Appendix

## Data type summary

### Elementary

| type | width | range |
|---|---|---|
| bit | 1-bit | 0..1 (*) |
| integer | 16-bit signed | -32768..32767 |
| long | 32-bit signed | -2147483648..2147483647 |
| real | 32-bit single precision | $-3.4x10^{38}..3.4x10^{38}$ |

(*) each bit variable is stored as a byte, casting to bit allows 0..255 range

### Input/Output

| type | width | type | description |
|---|---|---|---|
| ix | 1-bit | bit | digital input |
| qx | 1-bit | bit | digital output |
| iw | 16-bit | integer | analog input |
| qw | 16-bit | integer | analog output |

### Timer

| field | type | access | description |
|---|---|---|---|
| in | bit | read write | control input |
| q | bit | read write | timer output |
| pt | long | read write | preset time |
| et | long | read write | elapsed time |

### Constants

decimal

```
address := 12345; // 16 or 32-bit signed integer
```

binary

```
address := 2#10111; // 16-bit signed integer
```

hexadecimal

```
address := 16#FFFF; // 16-bit signed integer
```

# Structured text summary

### Operators

| operator | alias | unary | binary | function | bit | int | long | real | result |
|---|---|---|---|---|---|---|---|---|---|
| + | | | • | | | • | • | • | same |
| - | | • | • | | | • | • | • | same |
| * | | | • | | | • | • | • | same |
| / | | | • | | | • | • | • | same |
| mod | % | | • | | | • | • | | same |
| not | ! | • | | • | • | • | • | | same |
| and | & | | • | | • | • | • | | same |
| or | \| | | • | | • | • | • | | same |
| xor | ^ | | • | | • | • | • | | same |
| shl, shr | << >> | | • | | | • | • | | same |
| rol, ror | | | • | | | • | • | | same |
| = | == | | • | | • | • | • | • | bit |
| <> | != | | • | | • | • | • | • | bit |
| <, <= | | | • | | | • | • | • | bit |
| >, >= | | | • | | | • | • | • | bit |
| := | | | • | | • | • | • | • | same |

### Flow control

if...then...else

```
if <expression> then
  <statements>;
elsif <expression> then
  <statements>;
else
  <statements>;
end_if;
```

case...of

```
case <expression> of
  <value>: <statements>;
  <value>: <statements>;
else
  <statements>;
end_case;
```

for...do

```
for <var>:=<expression> to <expression> do
  <statements>;
end_for;
```

while...do

```
while <expression> do
  <statements>;
end_while;
```

### Edge detect

positive edge detect (zero to one)

```
fp(b:bit):bit;
```

negative edge detect (one to zero)

```
fn(b:bit):bit;
```

### Type conversion

evaluate expression and convert to desired data type

```
int(expression):int;    // convert expression to integer
long(expression):long;  // convert expression to long, respect sign
ulong(expression):long; // convert expression to long, assume unsigned
real(expression):real;  // convert expression to float
blong(expression):long; // assume bit pattern as long, no conversion
breal(expression):real; // assume bit pattern as real, no conversion
```

### Serial ports

port select

```
com_select(port:int); // 1-COM1, 2-COM2, 3-COM3, 4-RFM, 5-ETH
```

transmit

```
tx_bufwr(pos:int, data:int); // write data byte to tx buffer
tx_bufrd(pos:int):int; // read data byte from tx buffer
tx_start(size:int); // send message
tx_stop();       // stop sending
tx_count():int;  // number of characters sent
tx_active():bit; // 0-stopped, 1-transmitting
```

receive

```
rx_start(beg_ch:char, end_ch:char, len:int, beg_tout:int, end_tout:int);   // COM
rx_start(dummy:char, dummy:char, group_hi:int, group_lo:int, timeout:int); // RFM
rx_start(protocol:char, dummy:char, port:int, autostop:int, timeout:int);  // ETH
rx_stop();       // stop receiving
rx_count():int;  // number of characters received
rx_active():bit; // 0-stopped, 1-receiving
rx_status():int; // 0-receiving, 1-stopped, 2-end char, 3-length, 4-timeout
```

parse received message

```
rx_bufrd(pos:int):int; // read data byte from rx buffer
rx_bufwr(pos:int, data:int); // write data byte to rx buffer
rx_strcmp(pos:int, str:string):bit; // compare rx buffer with string
rx_strpos(pos:int, str:string):int; // find string in rx buffer
rx_strtoi(pos:int):int; // read number from rx buffer
rx_strtol(pos:int):long; // read number from rx buffer
rx_strtor(pos:int):real; // read number with decimals from rx buffer
```

### Display functions

```
dclr(slot:int); // clear display
dprnc(slot:int, x:int, y:int, c:char); // print character
dprns(slot:int, x:int, y:int, str:string); // print string
dprnb(slot:int, x:int, y:int, c0:char, c1:char, value:bit); // print c0 or c1
dprni(slot:int, x:int, y:int, width:int, zb:bit, value:int); // print integer number
dprnl(slot:int, x:int, y:int, width:int, zb:bit, value:long); // print long number
dprnr(slot:int, x:int, y:int, width:int, dec:int, value:real); // print decimal number
```

Legend:

slot..... slot number (0-write to selected serial buffer)
x..... x position (0-left)
y..... y position (0-top)
width ..... number of characters to print
zb..... zero blanking (0-no, 1-yes)
dec..... number of decimal places
c..... single character
str ..... array of characters enclosed in single quotes
value..... data to print

### Network functions

```
get_nad():long; // read current A-bus address (alias or serial)
get_serial():long; // read controller serial number
get_ip():long; // read controller IP address
set_ip(ip_address:long, subnet:long, gateway:long, dns_server:long); // set IP address
```

### Return value

return value from a function

```
result := a + b; // return sum of a and b
```

# Program examples

### Library

Ready-made application or set of functions, that can be invoked to carry out the particular task. Generally, library functions are used as they are, without modifying the code.

| | |
|---|---|
| CybroDashboard | demonstration of controller features and quick test of main components |
| DaliConfigurator | assign short addresses, configure groups and set parameters |
| EnOceanGateway | gateway for EnOcean wireless devices, including configuration and usage |
| FunctionLibrary | collection of standard functions used to carry out common tasks |

### Template

Fully functional application that can be modified and included in the user program.

| | |
|---|---|
| AccessControl | reception desk, manage access for hotel rooms and spaces |
| DaliControl | use cybro controller to control DALI ballasts |
| DaliControl DT8 | control DALI DT8 RGB ballast, template for multiframe messages |
| HIQ Commander demo | use mobile phone to control cybro application over the internet |
| HTTP client | read variables from www.solar-cybro.com server |
| HTTP server | cybro controller as a simple web server, implementing HTTP protocol |
| ModbusRtuMaster | read power meter registers using serial communication |
| ModbusTcpMaster | fully functional application to read/write data from multiple slaves |
| RFM demo | configure cybro wireless devices and control WR-1 or WR-5 relay |
| TCP demo | send and receive custom TCP messages between two controllers |
| UDP demo | send and receive custom UDP messages between two controllers |

### Hardware demo

Fully functional application that shows how to use the particular hardware.

| | |
|---|---|
| DmxController | control professional lighting using COM-DMX module |
| ModbusRtuMaster w COM-MB | read power meter registers using COM-MB module |
| PhilipsWizControl | control Philips WiZ light bulb dimming using free programmable UDP port |
| Serial port w COM-PGM | free programmable serial port using COM-PGM module |

### Demo program

Short demonstration how a particular task can be implemented.

| | |
|---|---|
| DigitalFiltering | remove noise and create a smooth output response |
| PidController | simple implementation of PID (proportional integral derivative) controller |
| MaskDemo | shows how to enter parameters using the operator panel |
| MsTimerDemo | how to implement precise 1ms resolution timer |
| SetIpAddress | set controller IP address using PLC program |
| SocketDemo | connect two or more controllers using cybro sockets |
| SosBuzzer | send SOS message using Morse code |
| Sun position | calculate if sun is visible for given date, time and location on the globe |

# Function library

Function library is a collection of commonly used functions, written in structure text. It is a part of CyPro package, located in \CyPro\Examples\FunctionLibrary.cyp. To use a function, copy and paste from library (right click project tree) to your program. For more details, check function source.

bit manipulation

```
int_to_long(lo,hi: int):long; // two 16-bit integers into a single long
long_to_real(x: long):real;   // bit-to-bit copy, without conversion
real_to_long(x: real):long;   // bit-to-bit copy, without conversion
byte_to_real(byte3, byte2, byte1, byte0: int):real; // four bytes into float
ip_to_long(ip3, ip2, ip1, ip0: int):long; // four byte ip address into a single long
datetime(year, month, date, hour, min, sec: int):long; // 32-bit ms-dos datetime
```

elementary functions

```
abs(x: int):int;              // absolute value of integer
min(x, y: int):int;           // smaller of two integers
max(x, y: int):int;           // bigger of two integers
round(x: real):real;          // round to the closest integer
frac(x: real):real;           // return fractional part
sqrt(x: real):real;           // square root
```

trigonometric functions

```
sin(x: real):real;            // sine of x
cos(x: real):real;            // cosine of x
atan(x: real):real;           // arctangent of x
atan2(x, y: real):real;       // arctangent of x/y
```

exponential and logarithmic

```
exp(x: real):real;            // exponential of x
ln(x: real):real;             // natural logarithm of x (base e)
log10(x: real):real;          // logarithm of x with base 10
log(x, base: real):real;      // logarithm of x with given base
```

cyclic redundancy check

```
crc8(len: int):int;           // 8-bit cyclic redundancy check
crc16(len: int):int;          // 16-bit cyclic redundancy check
crc32(len: int):long;         // 32-bit cyclic redundancy check
```

pseudo-random generator

```
rnd(range: int):int;          // simple pseudo-random generator
```

other functions

```
display_bargraph(slot,x,y,width,min,max,val: int):void; // OP semi-graphic bargraph
```

# Instruction list summary

Move

| | |
|---|---|
| ld | move variable or constant to accumulator |
| ldn | move complement of variable to accumulator |
| st | move accumulator to variable |
| stn | move complement of accumulator to variable |
| set | set accumulator or variable |
| setc | if condition true set variable |
| res | clear accumulator or variable |
| resc | if condition true clear variable |

Logic

| | |
|---|---|
| cpl | complement accumulator or variable |
| and | logical and accumulator with variable or constant |
| andn | logical and accumulator with complement of variable or constant |
| or | logical or accumulator with variable or constant |
| orn | logical or accumulator with complement of variable or constant |
| xor | exclusive or accumulator with variable or constant |
| xorn | exclusive or accumulator with complement of variable or constant |
| shl | shift left accumulator, set LSB to zero |
| shr | shift right accumulator, set MSB to zero |
| rol | rotate left accumulator, copy MSB to LSB, 32-bit only |
| ror | rotate right accumulator, copy LSB to MSB, 32-bit only |
| fp | detect positive flank, accumulator only |
| fn | detect negative flank, accumulator only |

Arithmetic

| | |
|---|---|
| neg | change sign of accumulator |
| add | add variable or constant to accumulator |
| sub | subtract variable or constant from accumulator |
| mul | multiply accumulator with variable or constant |
| div | divide accumulator with variable or constant |
| mod | remains of dividing accumulator with variable or constant |

Compare

| | |
|---|---|
| eq | test if accumulator equal to value |
| ne | test if accumulator not equal to value |
| gt | test if accumulator greater than value |
| ge | test if accumulator greater or equal value |
| lt | test if accumulator lower than value |
| le | test if accumulator lower or equal value |

Branch

| | |
|---|---|
| jmp label | unconditional jump to position indicated by label |
| jmpc label | jump if condition true |
| jmpnc label | jump if condition not true |
| cal subroutine | call subroutine |
| calc subroutine | call subroutine if condition is true |
| calnc subroutine | call subroutine if condition is not true |

Type combinations

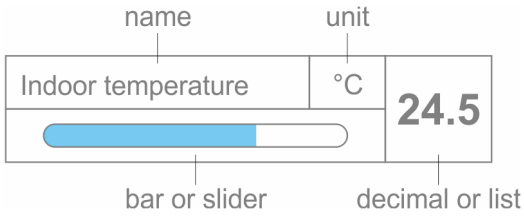
| | bit | int | long | real | acc | const | var |
|---|---|---|---|---|---|---|---|
| ld | + | + | + | + | | + | + |
| ldn | + | | | | | | + |
| st | + | + | + | + | | | + |
| stn | + | | | | | | + |
| set | + | | | | + | | + |
| setc | + | | | | | | + |
| res | + | | | | + | | + |
| resc | + | | | | | | + |
| cpl | + | | | | + | | + |
| and | + | + | + | | | + | + |
| andn | + | | | | | + | + |
| or | + | + | + | | | + | + |
| orn | + | | | | | + | + |
| xor | + | + | + | | | + | + |
| xorn | + | | | | | + | + |
| shl | | + | + | | + | | |
| shr | | + | + | | + | | |
| rol | | | + | | + | | |
| ror | | | + | | + | | |
| fp | + | | | | + | | + |
| fn | + | | | | + | | + |
| neg | | + | + | + | + | | |
| add | + | + | + | + | | + | + |
| sub | + | + | + | + | | + | + |
| mul | + | + | + | + | | + | + |
| div | | + | + | + | | + | + |
| mod | | + | + | | | + | + |
| eq | + | + | + | + | | + | + |
| ne | + | + | + | + | | + | + |
| gt | | + | + | + | | + | + |
| ge | | + | + | + | | + | + |
| lt | | + | + | + | | + | + |
| le | | + | + | + | | + | + |
| jmp | | | | | | + | |
| jmpc | | | | | | + | |
| jmpnc | | | | | | + | |
| cal | | | | | | + | |
| calc | | | | | | + | |
| calnc | | | | | | + | |
| x-to-y | + | + | + | + | + | | |

# Mobile app tags

### Binary object


type ..... object type, bit or int (default is bit for bit variables, int for others)
name ..... object name (default is variable name)
unit ..... short text displayed on the right (default is none)
icon ..... icon number, check appendix (default is 0)
action ..... 0-none, 1-write, 2-toggle (default is 0)
value ..... value that will be written by write action (default is 1)

### Integer object

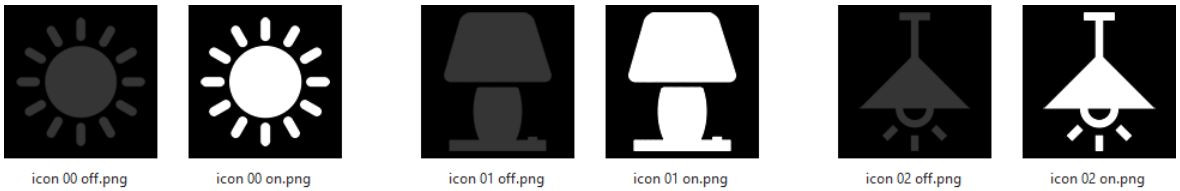



type ..... object type, bit or int (default is bit for bit variables, int for others)
name ..... object name (default is variable name)
unit ..... short text displayed on the right (default is none)
dec ..... number of digits after decimal point (default is 0)
list ..... list of strings, separated by 'or' symbol (OFF|HEAT|COOL, default is none)
bar ..... 0-none, 1-show bargraph (default is none)
min ..... minimum for increment, slider, spin edit (default is 0) and keypad (default is none)
max ..... maximum for increment, slider, spin edit (default is 100) and keypad (default is none)
step ..... step size for slider and spin edit (default is 1)
action ..... 0-none, 1-write, 2-toggle, 3-increment, 4-slider, 5-string list, 6-spin edit, 7-keypad (def 0)
value ..... value that will be written by write action (default is 1)

### Pages and order

spacer .... visual separator between objects in the list (default is none)
pages ..... tab names (OUTPUT|TEMPERATURE|SETTINGS, default is no tabs)
pos ..... position and page number (100, 101, 102, 200, 201, 300, 301...)

## Mobile app icons


icon 00 off.png


icon 00 on.png


icon 01 off.png


icon 01 on.png


icon 02 off.png


icon 02 on.png


icon 03 off.png


icon 03 on.png


icon 04 off.png


icon 04 on.png


icon 05 off.png


icon 05 on.png


icon 06 off.png


icon 06 on.png


icon 07 off.png


icon 07 on.png


icon 08 off.png


icon 08 on.png


icon 09 off.png

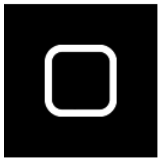

icon 09 on.png


icon 10 off.png


icon 10 on.png


icon 11 off.png


icon 11 on.png


icon 12 off.png


icon 12 on.png

icon 13 off.png

icon 13 on.png


icon 14 off.png


icon 14 on.png


icon 15 off.png


icon 15 on.png


icon 16 off.png


icon 16 on.png


icon 17 off.png


icon 17 on.png

# Operator panel characters

To enter character code, press Alt, type decimal character code preceded by 0, then release Alt. Numeric keypad should be used, Num Lock should be on.

Example:

According to table, symbol ° (degrees centigrade) hexadecimal code is DF, which is 223 decimal.

To enter the symbol:

- make sure num lock is on
- press Alt
- press consecutively 0223
- release Alt

Because of the character set, monitor displays "ß" character, but the LCD will show correctly.

```
dprns(1,0,0,'T=xx.xßC');
dprnr(1,2,0,4,1,cybro_temperature*0.1);
```


Codes 0..7 are reserved for bar-graph and national characters.

# Keyboard shortcuts

### General

| | |
|---|---|
| F1 | Help |
| F2 | Syntax check |
| F4 | Program settings |
| Shift-F4 | Environment settings |
| F5 | Hardware setup |
| F6 | Allocation editor |
| F7 | Mask editor |
| F8 | Socket editor |
| F9 | Send program to controller |
| Ctrl-F9 | Send without initializing variables |
| F10 | Open online monitor |
| F11 | Start PLC program |
| F12 | Stop PLC program |
| Ctrl-F12 | Pause PLC program |
| Ctrl-O | Open project |
| Ctrl-S | Save project |
| Ctrl-Shift-S | Save As |
| Ctrl-D | Connect/disconnect communication |
| Ctrl-L | Select NAD |
| Ins | Context sensitive insert |
| Delete | Context sensitive delete |
| Ctrl-Up | Move item up |
| Ctrl-Dn | Move item down |
| Ctrl-Tab | Next window |
| Ctrl-Shift-Tab | Previous window |
| Ctrl-F4 | Close window |
| Alt-F4 | Exit program |

### Text editor

| | | |
|---|---|---|
| Ctrl-space | | Insert variable or function |
| Ctrl-Z | Alt-Backspace | Undo |
| Shift-Ctrl-Z | | Redo |
| Ctrl-X | Shift-Del | Cut |
| Ctrl-C | Ctrl-Insert | Copy |
| Ctrl-V | Shift-Insert | Paste |
| Ctrl-A | | Select all |
| Ctrl-F | | Find |
| F3 | | Find next |
| Ctrl-R | | Replace |
| Ctrl-G | | Go to line |
| Ctrl-Shift-I | | Indent selection |
| Ctrl-Shift-U | | Unindent selection |
| Ctrl-Shift-C | | Comment/uncomment selection |