# PoKeys57CNCpro4x25
# User's manual

Version: v1.00

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# Contents

## 1. Introduction

PoKeys products line consists of simple, easy-to-use USB and network devices with the extended list of features making them powerful input/output devices.

PoKeys57CNCpro4x25 is a PoKeys device dedicated for stepper motor controller operation. The device has four built-in 2.5 A stepper motor drivers, allowing the stepper motors to be directly connected and used in various applications with the addition of powerful PoKeys device features. The device also features four galvanically-isolated open-collector outputs and 0 to 10 V analog output. Additional peripherals devices can be connected by the means of the CAN bus interface.

PoKeys57CNCpro4x25 features both USB and Ethernet connectivity, giving user an option to select the preferred connection for the application. The device is highly adjustable and as such requires no complex knowledge on device programming.

The device runs the PoIL core and is compatible with PoBlocks graphical programming software, bringing Programmable Logic Controller to a motor controller board. PoBlocks can be used to simply automate different peripherals and interchange data with other software applications that are using PoKeys57CNCpro4x25 device.

As with other PoKeys devices with USB connectivity, the device integrates support for virtual USB keyboard and USB joystick, which can be used to emulate a standard USB keyboard and joystick. Digital input pins can be mapped to virtual keyboard and joystick keys, while analog inputs can be mapped to virtual joystick axes. Configuration is simple by using our intuitive graphical PoKeys configuration application, where each function can also be tested.

Third-party application developers that are adding the support for PoKeys devices, are encouraged to use the supplied communication DLL that can be simply used in the different .NET framework based applications and various other programming languages that provide support for ActiveX interface. There is even an open-source cross-platform C library available at https://github.com/PoLabsEE/PoKeysLib.

To aid developers that are communicating with PoKeys devices on the low-level, the extensive documentation on device communication protocol can be downloaded free of charge from the product webpage.

## 2. Features

- 4 dedicated digital inputs (24 V compatible) for connecting home/limit switches,
- 1 dedicated digital input (24 V compatible) for probe input,
- 1 analog input (12-bit, 0-10 V range) with analog low-pass filter with 1.9 kHz cut-off frequency,
- dedicated encoder input for the spindle encoder,
- high performance 4-axis 125 kHz pulse engine with dedicated bipolar stepper motor connectors,
- dedicated 5 V PWM output,
- CAN bus interface (for kbd48CNC keyboard and other peripheral devices),
- fail-safe support in case of communication interruption,
- Compatible with USB 1.1/2.0 HID standard,
- standard English USB keyboard simulation (with triggering support for up/down keys),
- standard USB joystick simulation (6 axes, 32 buttons with triggering support),
- Ethernet 10/100 with DHCP client or fixed IP support,
- TCP or UDP connection with the device,
- Modbus TCP support (access to digital IO, analog inputs, encoder values, digital counters values, PWM outputs, LCD display, PoExtBus devices, matrix keyboard status),
- web interface with dashboard and I/O status display with multiple user accounts,
- intuitive and user-friendly software,
- third-party support via communication DLL library and extensive protocol specification document that allows porting to other systems.

## 3. Device hardware description - PoKeys57CNCpro4x25 v1.00
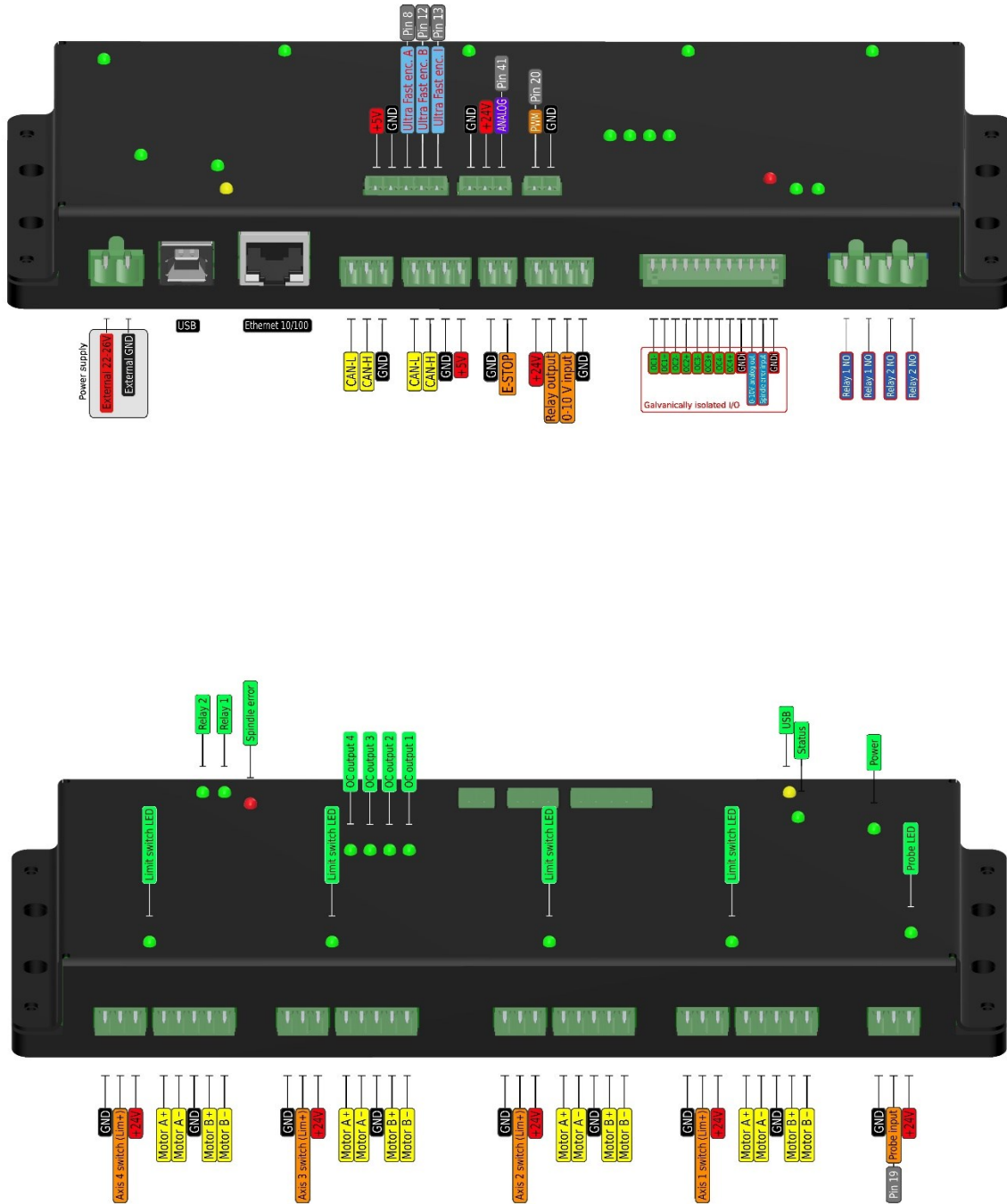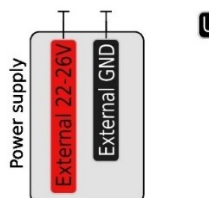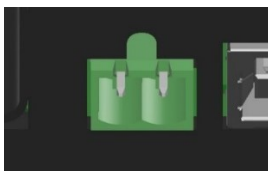
## 4. PoKeys57CNCpro4x25 connector pinout

### 4.1.  Pin types

| Type code | Description |
|-----------|-------------|
| DO5_D | 5 V digital output without series resistor |
| DI33 | 3,3 V digital input without filtering |
| OCOC | Opto-coupled open-collector output |
| OCR | Open-collector for relay |
| REL | Relay output |
| AI10F | 10 V analog input with 1,9 kHz low-pass filtering |
| AO10F | 10 V analog output with low-pass filtering |
| DINPN | Digital input NPN |
| MOT | Stepper motor output |
| PWR24 | 24 V sensor power supply (output) |

### 4.2.  Power supply

| Pin | Type | Function |
|-----|------|----------|
| 1 | Supply input | Positive power supply 22-26V (marked with +) |
| 2 | Supply input | Negative power supply (ground) |

PoKeys57CNCpro4x25 requires external 22-26V power supply to be connected to the board in order for the device to operate correctly. The power supply provides power for the electronics as well as stepper drivers. The power supply should be capable of providing at least 150 W (e.g. 24 V 6 A power supply).



Power supply for PoKeys57CNCpro4x25 is powering the device as well as the motors with motor drivers. It is designed for 24 V power supply which is then distributed to motor drivers and limit switches.

## 4.3. Relay connector
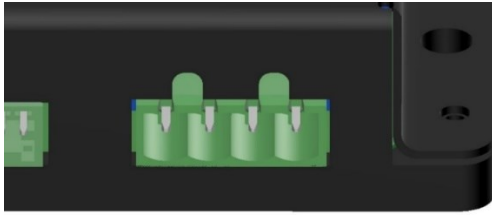
| Pin | Type | Function |
|---|---|---|
| 1 | REL | Relay 2 NO |
| 2 | REL | Relay 2 common |
| 3 | REL | Relay 1 NO |
| 4 | REL | Relay 1 common |

Relay connectors are normally open (NO) configuration and enable you to switch higher loads on/off.

## 4.4. Galvanically isolated I/Os

This connector contains special I/O signals that are galvanically isolated from the rest of the board. Signals on pins 2 and 3 for the spindle should only be referenced to GNDi points (available on pins 1 and 4). The spindle error signal should be connected to the pure NPN output of the frequency drive.
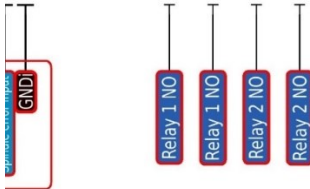
| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | GNDi | GNDi | Isolated ground connection (for use only with signals on this connector) |
| 2 | DINPN | SpErr | Spindle error input |
| 3 | AO10F | 10V | 0-10V analog output |
| 4 | GNDi | GNDi | Isolated ground connection |
| 5 | OCOC | OC4+ | Open collector output 4 |
| 6 | OCOC | OC4- | |
| 7 | OCOC | OC3+ | Open collector output 3 |
| 8 | OCOC | OC3- | |
| 9 | OCOC | OC2+ | Open collector output 2 |
| 10 | OCOC | OC2- | |
| 11 | OCOC | OC1+ | Open collector output 1 |
| 12 | OCOC | OC1- | |
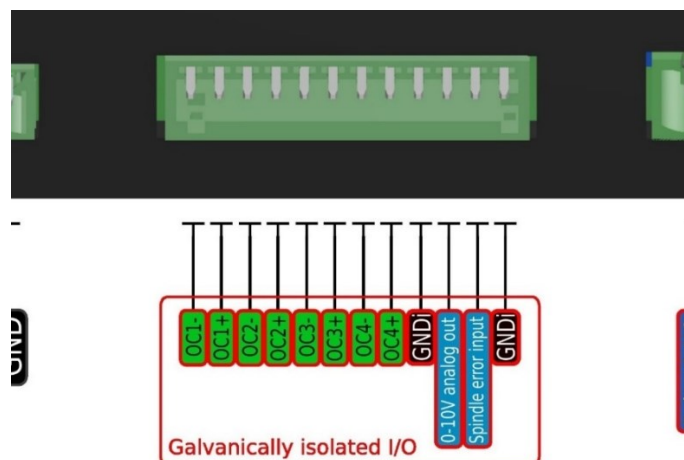
### 4.5. CAN connector

| Pin | Type | Label | Function |
|-----|------|-------|----------|
| 1 | / | CAN-L | CAN low signal |
| 2 | / | CAN-H | CAN high signal |
| 3 | GND | GND | Ground |

| Pin | Type | Label | Function |
|-----|------|-------|----------|
| 1 | / | CAN-L | CAN low signal |
| 2 | / | CAN-H | CAN high signal |
| 3 | GND | GND | Ground |
| 4 | +5V | +5V | +5 V power supply to CAN bus |

The CAN bus on PoKeys57CNCpro4x25 is intended for all the peripheral devices that we already offer and that we will add in the future. There are two connectors, one with additional power supply of 5 V. Maximum current on 5 V CAN supply is limited to 300 mA.
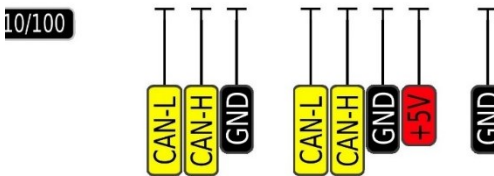
### 4.6. Encoders connector

| Pin | Type | Label | Function |
|-----|------|-------|----------|
| 1 | +5V | +5V | +5 V power supply |
| 2 | GND | GND | Ground |
| 3 | DI33 | uFEA | Ultra-fast encoder A-channel signal input, also used as PoKeys pin 8 |
| 4 | DI33 | uFEB | Ultra-fast encoder B-channel signal input, also used as PoKeys pin 12 |
| 5 | DI33 | uFEI | Ultra-fast encoder index signal input, also used as PoKeys pin 13 |
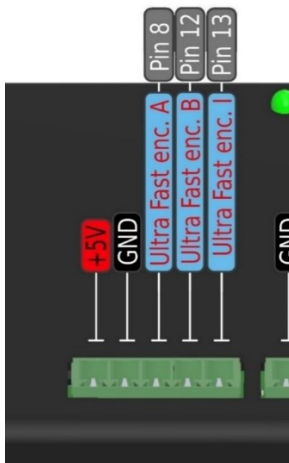
Encoder is intended for use with lathe for spindle speed measurement and threading or for other purposes.

### 4.7. Analog input
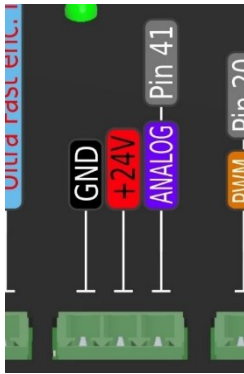
| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | GND | GND | Ground |
| 2 | PWR24 | 24V | Power supply for analog sensor |
| 3 | AI10F | Ain | Analog input 10 V range |

Analog input with 0-10 V range as industry standard. Intended for connecting peripheral sensors and devices with analog voltage output.

### 4.8. PWM output

| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | DO5_D | PWM | PWM output with 5 V logic level (output only) |
| 2 | GND | GND | Ground |

PWM output for laser control or any other peripheral device control. 5 V logic level. It can be used only as an output.

### 4.9. Motor connectors 1-4

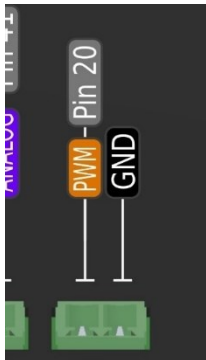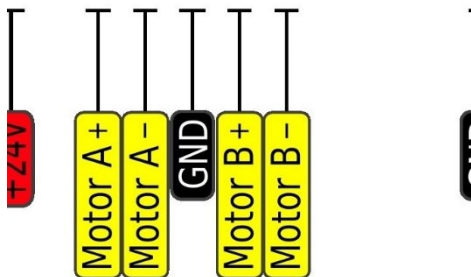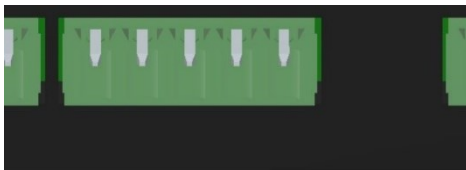| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | MOT | A+ | Motor coil A+ |
| 2 | MOT | A- | Motor coil A- |
| 3 | GND | GND | Ground |
| 4 | MOT | B+ | Motor coil B+ |
| 5 | MOT | B- | Motor coil B- |

Motor outputs are intended for bipolar stepper motors (or properly connected unipolar motors). The output current of the drivers is determined and set up in the software.

There are additional motor driver error signals (digital inputs) for each of the motor output. These are mapped to the following PoKeys pins

| Motor | Motor driver error signal |
|---|---|
| 1 | Pin 28 |
| 2 | Pin 18 |
| 3 | Pin 30 |
| 4 | Pin 29 |

### 4.10.  Axis limit switches connector 1-4

| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | GND | GND | Ground |
| 2 | DINPN | SIG | Signal input from limit switch NPN type |

| Axis | Limit pin (PoKeys pin input) |
|---|---|
| 1 | Pin 26 |
| 2 | Pin 25 |
| 3 | Pin 24 |
| 4 | Pin 23 |

| Pin | Type | Label | Function |
|---|---|---|---|
| 3 | PWR24 | 24V | 24 V limit switch power supply |

Dedicated limit+ switch connectors are located next to each motor output. They have 24 V supply output and optically isolated input. Mechanical switch should be wired between signal and GND. For any other active limit switches, they should be of NPN type and 24 V rated.

The 24 V power supply can be used for powering the sensors. The sum of the power supply currents for all 4 limit switches and probe should not exceed 100 mA.

### 4.11.  Probe input
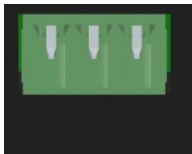
| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | GND | GND | Ground |
| 2 | DINPN | SIG | Signal input from probe NPN type |
| 3 | PWR24 | 24V | 24 V probe switch power supply |

Probe input is the same as limit switch inputs. It is connected to the PoKeys pin 19.

The 24 V power supply can be used for powering the sensors. The sum of the power supply currents for all 4 limit switches and probe should not exceed 100 mA.

## 4.12. E-stop input

| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | GND | GND | Ground |
| 2 | DINPN | SIG | Signal input for E-stop NPN type |

E-stop connector is wired the same as limit switch and probe, but there is no power supply on the connector. The ordinary switch should be wired between signal and GND input. It is recommended to use NC switch for safety reasons.
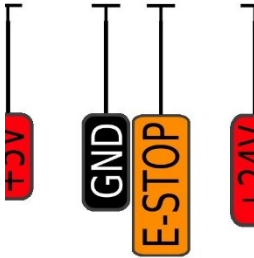
## 4.13. Plasma connector
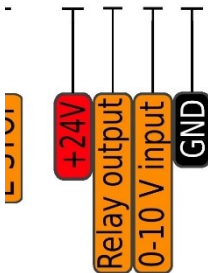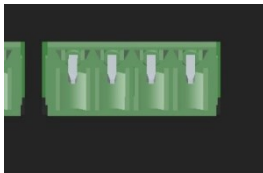
| Pin | Type | Label | Function |
|---|---|---|---|
| 1 | PWR24 | 24V | 24 V probe switch power supply |
| 2 | OCR | Relay | Open collector for plasma relay on/off |
| 3 | AI10F | Ain | Analog input for plasma voltage |
| 4 | GND | GND | Ground |

Plasma connector is intended for use with PoLabs PlasmaDiv THC interface board for plasma cutters. The pinout is meant for direct connection to the PlasmaDiv. In case of use with other plasma solutions, the 0-10 V input is for voltage measurement (1/50 divided with mandatory galvanic isolation) and relay output is open collector output with protection for relay on/off.

## 4.14. Pin types and specifications

*Type DO5_D: 5 V digital output without resistor*
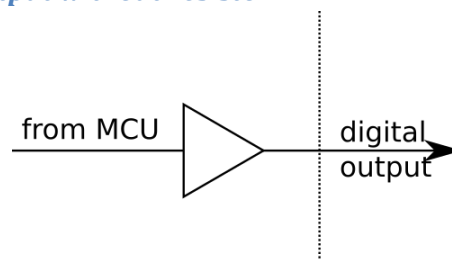
| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $I_{DO5\_D,MAX}$ | maximum current supplied by DO5 pin | - | 50 | mA |
| $V_{DO5\_D,LOW}$ | voltage of LOW state (no current) | - | 0,1 | V |
| $V_{DO5\_D,HIGH}$ | voltage of HIGH state (no current) | 4,9 | - | V |

### Type DI33: 3,3 V digital input

Digital pin directly connected to MCU with series resistor.

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{DI5,MAX}$ | maximum voltage applied to DI5 pin | - | 5,0 | V |
| $V_{DI5,LOW}$ | applied voltage for LOW state | - | 0,8 | V |
| $V_{DI5,HIGH}$ | applied voltage for HIGH state | 2,0 | - | V |

### Type OCOC: opto-coupled open-collector output
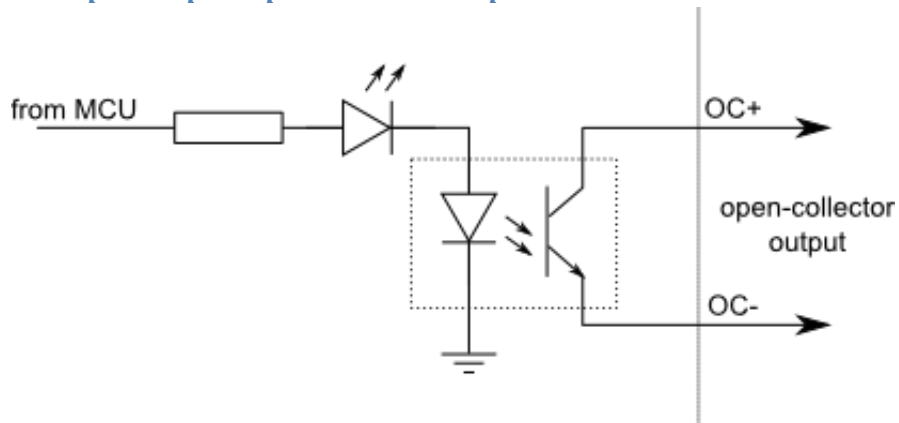


| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $I_{OCOC,MAX}$ | maximum output current | - | 50 | mA |
| $V_{OCOC,DIFF}$ | maximum voltage applied between OC+ and OC- | - | 50 | V |
| $V_{OCOC,ISO}$ | isolation voltage (AC for 1min, R.H. 40-60%) | - | 3000 | $V_{RMS}$ |

### Type OCR: Open-collector for relay
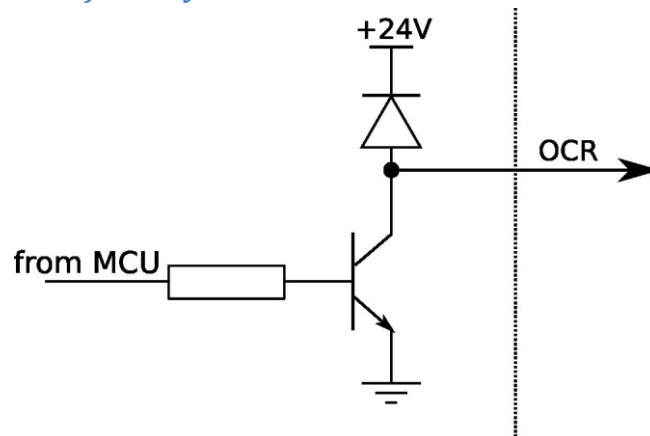


| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $I_{OCR,MAX}$ | maximum output current | - | 200 | mA |
| $V_{OCR,DIFF}$ | maximum voltage applied between output and GND | - | 40 | V |

## Type REL: relay output
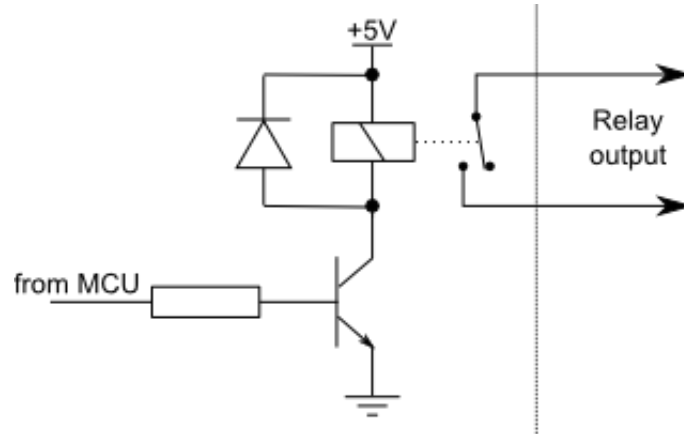


| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $I_{REL,28VDC}$ | maximum current switching at 28 VDC | - | 10 | A |
| $I_{REL,125VAC}$ | maximum current switching at 125 VAC | - | 10 | A |
| $I_{REL,240VAC}$ | maximum current switching at 240 VAC | - | 7 | A |
| $V_{REL,MAX}$ | maximum voltage of the load | - | 240 | VAC |

## Type AI10F: 10 V analog input with 1,9 kHz low-pass filtering
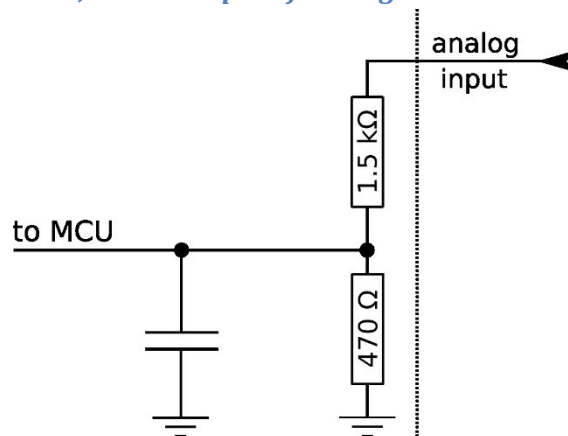


| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{IA}$ | analog input voltage on ADC related pins | -0.5 | 10 | V |

### Type AO10F: 10 V analog output with low-pass filtering
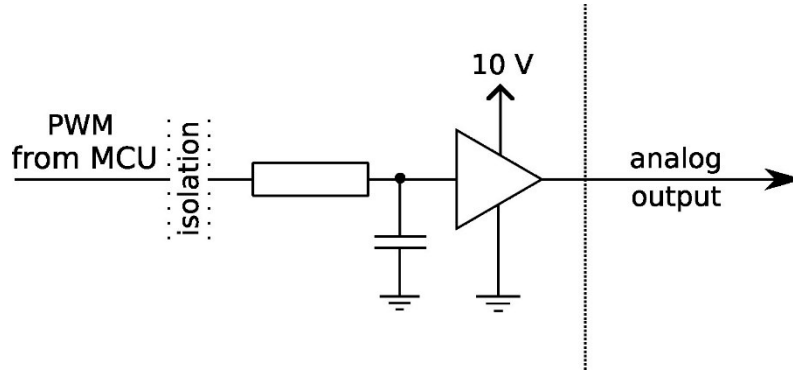


| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{OA}$ | analog output voltage | 0 | 10 | V |

### Type DINPN: Digital input NPN
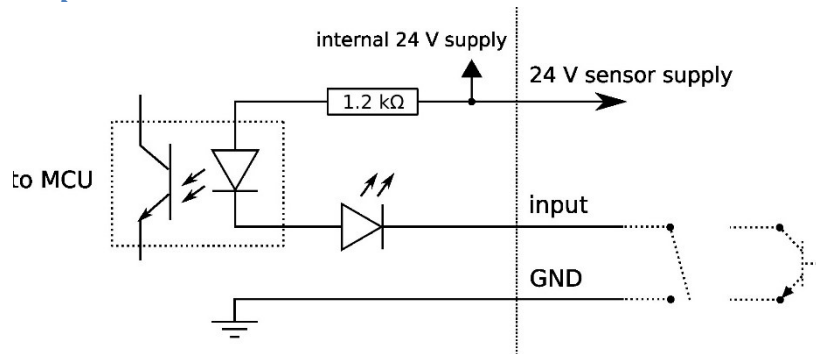


| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| | Input activation current | 5 | 30 | mA |
| | Maximum sensor power supply current (combined on all limit and probe sensor power supply ports) | / | 100 | mA |

### Type AN33F: 3.3 V analog input with low-pass filter

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{IA}$ | analog input voltage on ADC related pins | -0.5 | 3.3 | V |
| $f_{LP}$ | cut-off frequency of the analog low-pass filter | 1.6 | 2.2 | kHz |

### 4.15.  Status LEDs

There are multiple status LEDs on the cover that indicate the state of some inputs. The markings are laser engraved beside each LED.
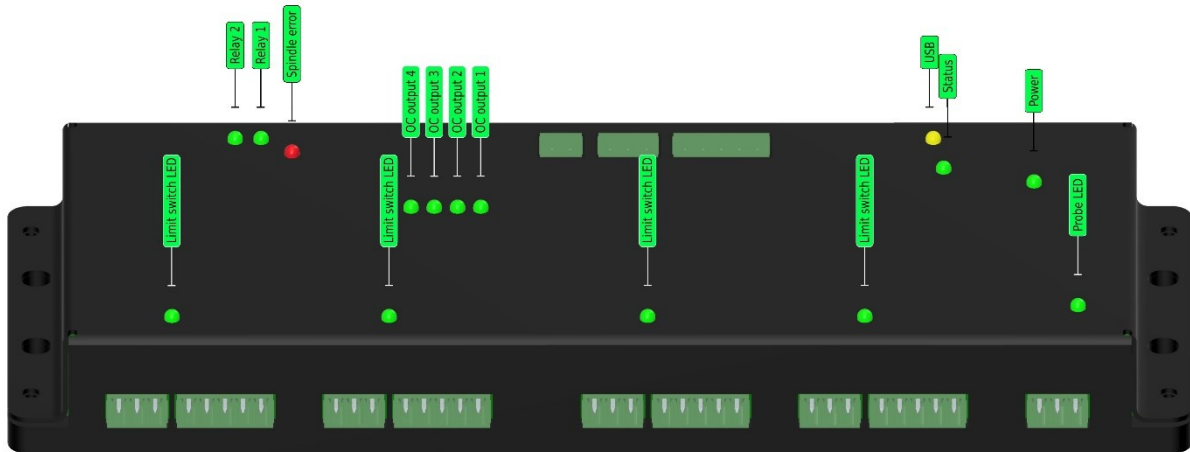


### 4.16.  Grounding of the enclosure – protective earth

The relay output is rated up to 230 VAC, so there is a risk of electric shock for the user. Therefore proper grounding of the metal enclosure is mandatory. For that purpose, we prepared the screw connection for protective earth connection to the enclosure for grounding it. The serrated washer should be placed between grounding ring terminal and enclosure cover as shown in the picture.
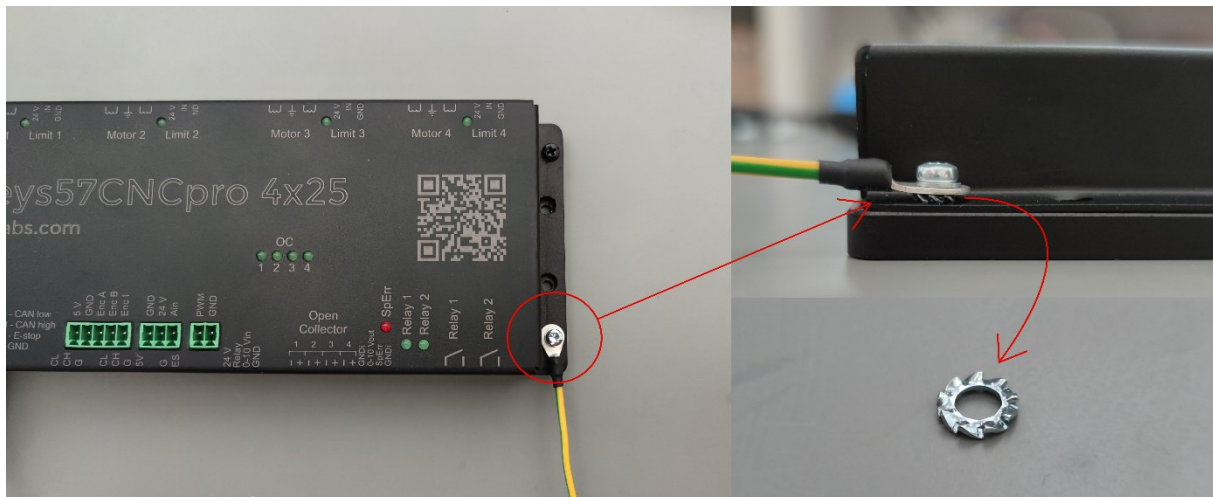


## 5.  Requirements

- 22 V - 26 V power supply with 150 W or more,
- Ethernet or USB 2.0 connection between host computer and PoKeys57CNCpro4x25 device
- Included software requires Windows XP/Vista/7/8/8.1/10/11 with .NET framework 3.5 installed.

# 6. Technical specifications

## 6.1. PoKeys57CNCpro4x25 dimensions

Measurements are in mm.
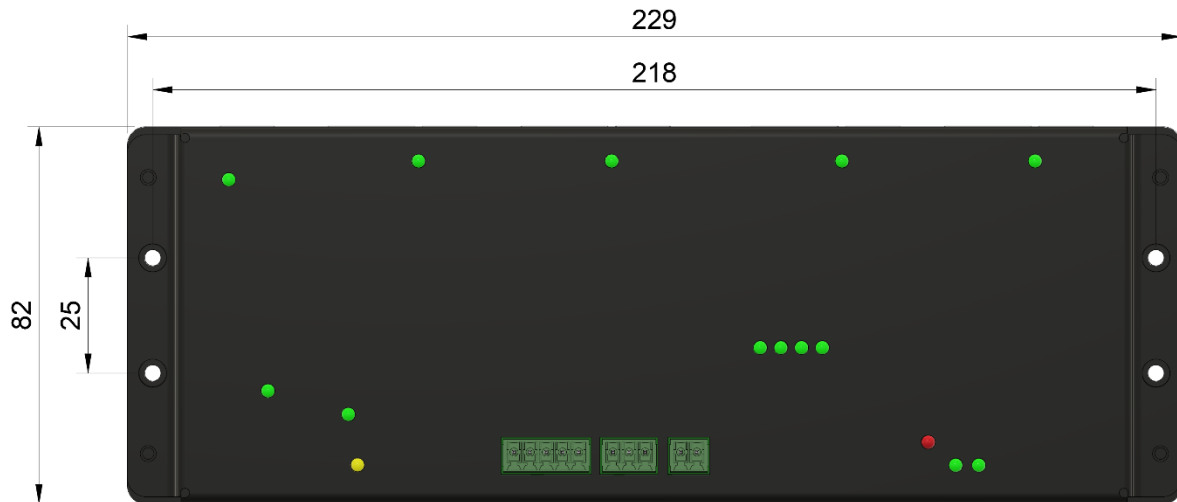


## 6.2. Electrical and environment specifications

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Power supply range | 22 | - | 26 | V |
| Operating temperature | 0 | - | 60 | °C |
| Storage temperature | -40 | - | 85 | °C |
| Humidity | 5 | - | 95 (non-condensing) | % RH |

# 7. Installation

## 7.1. Using USB

PoKeys57CNCpro4x25 is a USB 2.0 compliant device.
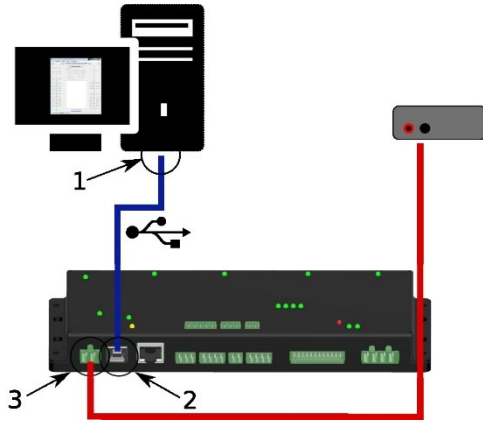
**Step 0 (prerequisite):** install PoKeys setup package (version 4.7.9 or newer), including USB device driver option

**Step 1**: Locate a free USB 2.0 port on your computer (1) and PoKeys57CNCpro4x25 board (2) and connect them with a standard USB cable.

**Step 2**: Connect the PoKeys57CNCpro4x25 board to an appropriate power supply (3). The computer will find a new device and search for drivers. See FAQ section of the manual if driver installation fails.

**Step 3**: use PoKeys software to update the firmware of the device

**Note: USB connection is not galvanically isolated**

## 7.2. Using Ethernet - direct connection between PoKeys57CNCpro4x25 and computer

Network firewalls must allow all traffic on TCP/UDP port 20055 between PoKeys57CNCpro4x25 device and PoKeys-related software running on a computer.
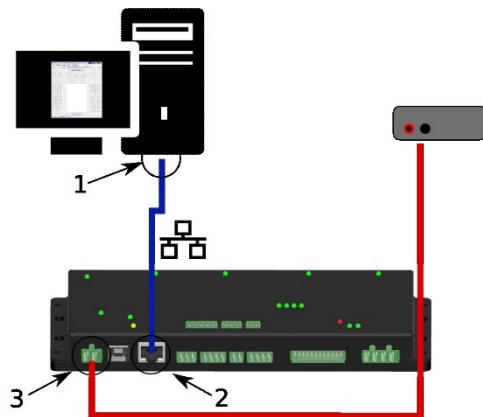
**Step 0 (prerequisite):** install PoKeys setup package (version 4.7.9 or newer)

**Step 1**: Locate ethernet ports on your computer (1) and PoKeys57CNCpro4x25 board (2) and connect them with RJ-45 cable (standard network cable).

**Step 2**: Connect the PoKeys57CNCpro4x25 board to an appropriate power supply (3).

**Step 3**: Configure your computer's network card with a static IP address in the 192.168.x.x range

**Step 4:** Start PoKeys software, select the PoKeys57CNC device in the list and click on 'Configure' button. Select the unique IP address for the PoKeys57CNCpro4x25 device in the same range as the computer's network card

**Step 5**: use PoKeys software to update the firmware of the device

## 7.3.    Using Ethernet - PoKeys57CNCpro4x25 connected to a network with DHCP server

Network firewalls must allow all traffic on TCP/UDP port 20055 between PoKeys57CNCpro4x25 device and PoKeys-related software running on a computer.
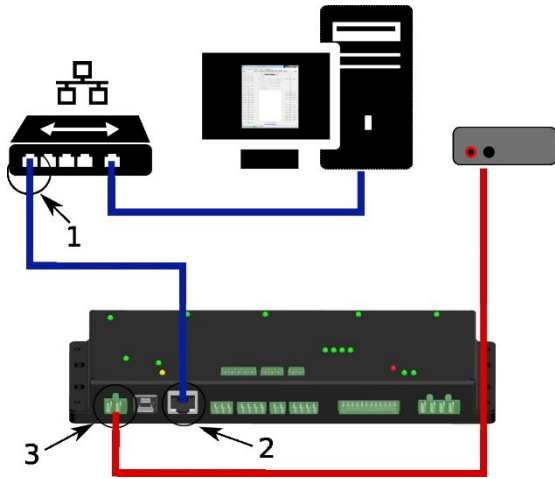
**Step 0 (prerequisite):** install PoKeys setup package (version 4.7.9 or newer)

**Step 1**:  Locate ethernet ports on your router (1) and PoKeys57CNCpro4x25 board (2) and connect them with RJ-45 cable (standard network cable).

**Step 2**: Connect the PoKeys57CNCpro4x25 board to an appropriate power supply (3).

**Step 3:** use PoKeys software to update the firmware of the device

## 7.1.    Using USB and Ethernet

PoKeys57CNCpro4x25 device can be connected to the computer by using both the USB and Ethernet connection. In this case, applications will detect two instances of PoKeys57CNCpro4x25 devices and USB connection will be selected by default by third-party applications.

Follow the above instructions on connecting the PoKeys57CNCpro4x25 device over Ethernet and USB.

# 8. PoKeys configuration options

## 8.1. Digital inputs and outputs

Unlike generic PoKeys devices, PoKeys57CNCpro4x25 doesn't have generic pin headers with fully customizable pin functions. Certain pins of the PoKeys57CNCpro4x25 can be reused for other purposes if not used by the specific peripheral device. See the connector pinout diagram to discover which pins can be reused as digital inputs or digital outputs. Pin numbers were assigned according to the available functions of each pin in order to keep the device backwards-compatible with third-party software and other PoKeys devices.

---

**Note: When using Mach3 or Mach4, all I/O pin configuration must be done in PoKeys plugin for Mach3 or Mach4. PoKeys application can still be used for testing the setup and diagnostic.**

---

*Pin numbering*

The configurable PoKeys I/O pins are labelled as 'P*in <ID>*' in the pinout diagram (e.g. Pin 8 on the encoder connector). Other signal pins (e.g. CAN bus pins, OC outputs etc.) have a special function and can not be freely used for other purposes.

**Note**: if PoPendant is connected to the PoKeys57CNCpro4x25 over CAN, PoKeys pins 3-6, 9-11 and 15-16 will represent the state of the PoPendant signals (axis and step selection switches), as in PoKeys57CNC.

*PoKeys configuration software usage*

There is graphical representation for configuration of each PoKeys device's configurable pin on left and right side of main window. To change pin function, click on pin name and change its function in central 'Pin settings' frame.
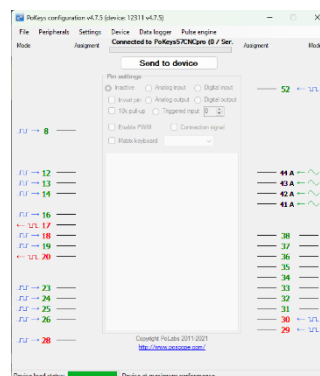


**Figure 1: PoKeys configuration window**

There are 6 main pin functions possible: inactive, digital input, triggered digital input, digital output, analog input, depending on the capabilities of each pin.

**Inactive**

Any pin (except those fixly mapped to an activated peripheral) can be set as inactive. Inactive pin is put in high-Z state with internal pull-up resistors enabled.

---

**Digital input**

Any free pin can be configured as digital input by selecting 'Digital input' option box. If the pin polarity is wished to be inverted, check the 'Invert pin' box.

There are several additional possibilities for digital input pin functions.

**Digital output**

Selected pins can be configured as digital output by selecting 'Digital output' option box. If the polarity of the pin is wished to be inverted, check the 'Invert pin' box. To use the outputs, SetPinData should be called before attempting to set the output state. However, there is an option to disable this behaviour - use the 'Settings > Initialize outputs on startup' option to either enable or disable output activation on PoKeys startup.

**View status of digital inputs and outputs**

Go to 'Peripherals > Digital inputs and outputs…' to display the status dialog as shown below.
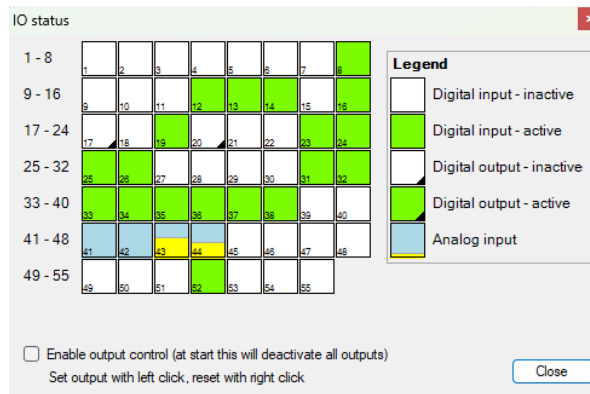


Figure 2: Input and output status dialog

There are 55 pins represented as colored squares in the dialog, organized in the rows of 8 pins. Each square contains a pin index number in the lower left corner, while the lower right corner is used to indicate a digital output (small black triangle is displayed on pins, configured as digital outputs). The color of the square resembles the current state of the pin – green for the activated (HIGH state) and white for the unactivated (LOW state).

Not all squares that are rendered in this display represent an actual pin on the PoKeys57CNCpro4x25.

To change the digital output state, first enable 'Enable output control' option, then either left or right click with mouse on the square representing the digital output to activate or deactivate this output.

## 8.2. Encoders

Ultra-fast encoder support is available on pins 8, 12 with the optional index signal input on pin 13. This feature uses hardware specialized hardware decoder and can handle high resolution encoders (up to 5 MHz tick frequency with digital filtering disabled), but only x2 and x4 step multiplication factors are available. The 4x mode increments encoder value on every signal edge and increases the resolution of the encoder for a factor of 4.

Fast encoders are not intended to be used natively on PoKeys57CNCpro4x25 because of the lack of extenally available digital IO pins.
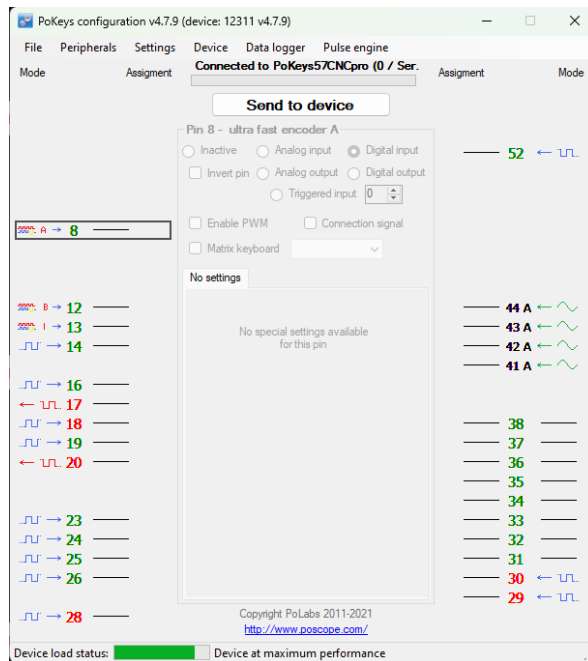


**Figure 3: Encoder settings in PoKeys application**

## Enabling ultra-fast encoders

To enable ultra-fast encoders, go to menu 'Peripherals > Fast encoders settings', then check 'Enable ultra-fast encoders' option. There are additional options to enable 4x step multiplication and inverting the encoder direction. Digital filter sampling delay slider enables setting the digital filter delay parameter - leftmost position equates to no digital filtering, rightmost position equates to digital filtering with filter delay constant set to 1000 (sampling frequency reduced to less than 25 kHz).
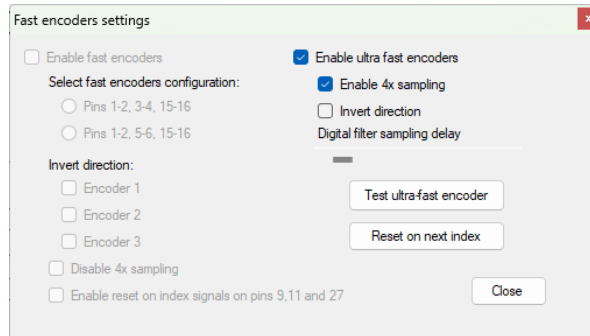


## Displaying encoder raw values

To open encoder raw values dialog, go to Peripherals menu and select 'Encoder RAW values'. The following dialog below appears. It simply shows the list of all encoders and their current values. In additional column, current encoder speed is displayed.

Fast encoders are disabled so only ultra fast encoder is relevant. At the bottom of the window, there is a command button that can be used to reset the encoders' values.

**Note**: if PoPendant is connected to the PoKeys57CNCpro4x25 over CAN, encoder 1 will represent the encoder on the PoPendant itself.



**Figure 4: Encoders' RAW values**

### 8.3.  Pulse engine

PoKeys57CNCpro4x25 is a hybrid device between a PoKeys57CNC device and a set of PoStep25-256 stepper motor drivers. As such, it contains an external pulse generator on-board, which is driving 4 stepper motor drivers by STEP/DIR signals with maximum pulse frequency of 125 kHz.

The pulse engine is fully configurable in terms of:

- Axis switches configuration: limit switch can be independently enabled, inverted and positioned either on dedicated pins (pin value of 0) or standard PoKeys pins that are listed in the device pinout
- Axis motion control configuration: each axis can be configured to optionally use an internal motion controller in either position or speed mode
- Homing/referencing procedure: motion of the reference position search can be inverted if home/ref switch is positioned in the positive end of the axis travel. The speed of the homing procedure can be configured in percents of the maximum axis speed.
- Internal motion controller parameters: such as maximum speed, acceleration and deceleration can be individually configured for each axis.
- Integrated MPG jog mode: where PoKeys can handle the MPG jogging directly - encoder index and step multiplier can be individually configured
- Other axis settings: axis enable signals, direction inversion, soft limits, etc.

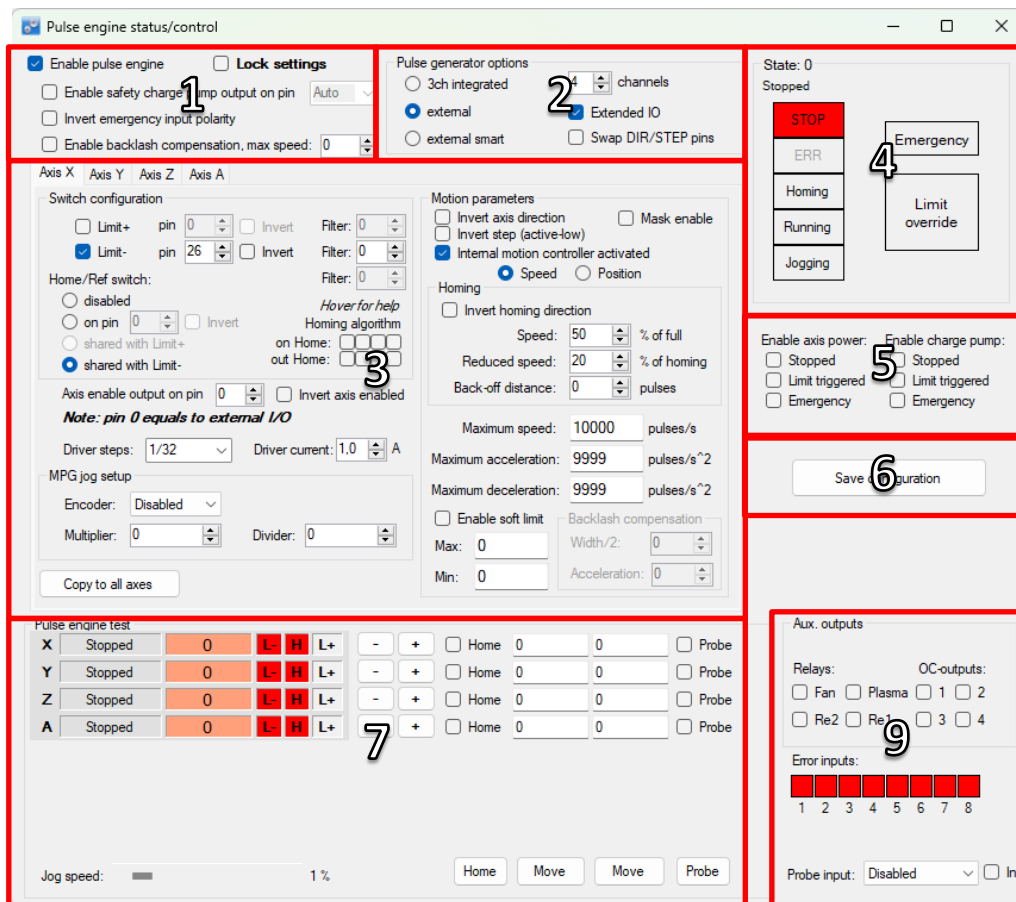See the description of the Pulse engine status/control dialog on the next page.



**Figure 5: Pulse engine status/control dialog**

*Pulse engine status/control dialog parts*

1. Main Pulse engine settings:
    a. Enable pulse engine: main switch to enable or disable Pulse engine functionality
    b. Lock: when Lock is enabled, the main Pulse engine settings and Pulse generator settings are disabled
    c. Enable safety charge pump output: configure the pin for the charge pump output
    d. Invert emergency input polarity: PoKeys expects NC (normally closed switch to be used as emergency switch) and HIGH signal state on emergency input indicates an emergency. If NO switch is used, the polarity of the signal must be inverted by selecting this option
    e. Enable backlash compensation: check this option to enable the backlash compensation in PoKeys device.
2. Pulse generator options: PoKeys57CNCpro4x25 contains an external pulse generator on-board, thus external pulse generator option with 'Extended IO' must be selected. 4 axes are enabled by default.
3. Axis configuration - see next page
4. Pulse engine state display and control: this panel displays current PoKeys Pulse engine state and allows the user to change between the states
    a. STOP: stopped mode - the Pulse engine is deactivated momentarily and produces no pulses. Transition to STOP mode is instantaneous - if there is any motion being executed, the pulse generation will cease immediately after switching to STOP mode.
    b. ERR: error mode - if PoKeys detects any event that results in error (emergency stop, limit stop, etc.), this mode will automatically be activated. As STOP mode, the transition is instantaneous
    c. Homing: in this mode, PoKeys is executing the homing procedure. The selected axes are referenced in regards to the position of Home/Ref switch. PoKeys executes homing procedure in two steps - in first step, course position of the switch is located using faster motion in the negative direction of the axes (unless Homing direction is inverted in the settings). When the switch is located, the fine position of the reference position is located using slower motion in the positive direction of the axis (again, if not inverted in the settings) until the Home/Ref switch is released.
    d. Running: normal operating mode
    e. Jogging: jogging mode - in this mode, PoKeys Pulse engine can use the values from the encoders to directly jog the configured axes
    f. Emergency: this field indicates whether device entered Emergency state
    g. Limit override: switch that allows the user to activate the limit override
5. Enable axis power and enable charge pump: these options select, when the axis enable and chargepump output signals are activated (besides normal operating modes)
6. **Save configuration** button: after the settings are changes, this button must be clicked to send the settings to device and save them to the on-board non-volatile memory. Since this operation may produce interruptions in the motion, it is suggested to stop any motion before commencing configuration save.
7. Pulse engine testing panel:
8. Additional configuration options - here, additional configuration dialogs can be opened
9. Auxilary outputs: these can be used to test the on-board auxilary outputs

a. Relays 1 and 2 control the relays on board.
b. Plasma controlls the plasma output for relay on PlasmaDiv
c. OC-outputs control the galvanically isolated open-collector outputs

### Axis configuration panel

This panel contains settings for each axis.

1. Limit switch configuration: individual limit switch (on axis positive and negative ends) can be individually enabled and inverted (in NO switches are used). Since PoKeys57CNC uses external pulse generator with extended IO, 0 should be selected as pin number.

2. Home/Ref switch configuration: this switch can be configured as a separate switch or shared with either Limit+ or Limit- switches. See below for Homing algorithm description.

3. Axis enabled output: pin 0 should be selected in dedicated signal pin on motor connector is to be used. The state of the signal can be inverted if motor drivers require it.

4. Current and microstep settings: driver setting for the PoStep stepper motor drivers on board. Up to 2.5A current can be set with maximum 1/256 microstepping.

5. MPG jog setup: select encoder and multiplier factor to setup direct MPG jogging that is active in Jogging operating mode

6. Copy to all axes: all settings are copied to all other axes by clicking on this button

7. Motion configuration: axis direction can be inverted here. Optionally, internal motion controller can be activated, allowing PoKeys device to produce the motion signals based on position or speed reference setup. The 'Mask enable' option is for testing purposes and enables third-party software to enable individual axes independently.

8. Homing configuration: use these settings to invert homing direction and set the speed of the motion during homing procedure

9.  Motion parameters: use these fields in case that Internal motion controller is enabled to setup the maximum speed, acceleration and deceleration values. When the value is entered into the fields, **confirm the value by pressing 'Enter' ('Return') key** - the field will change color from red to white.

10. Soft limits configuration: optionally, soft limits can be configured for each axis. When internal motion controller detects the current position has gone out of these limits, the motion is softly stopped and only motion in the out-of-limit direction is allowed.

11. Backlash compensation: PoKeys devices support backlash compensation feature. Enter the size of the backlash (in pulses) and the maximum acceleration used for compensation.

### *Homing algorithm configuration*

PoKeys devices support customization of the homing algorithm. The algorithm is based on executing selected actions on different events:

-   On Home event (home switch contact is detected) - this event happens when the machine touches and activates the home switch (configured in the options above)
-   Out Home event (home switch contact is released) - this event happens when the machine backs off the switch or gets past the home switch.

On these two events, the combination of the following actions can be configured (selection boxes from left to right):

-   Stop and reset the position - this action marks last position as home position and commands the motion to stop. It also finishes the homing procedure for the axis
-   Arm the encoder index for stop - this action arms the encoder index input for the selected axis. On the next encoder index signal, the position of the axis is marked as home, axis is commanded to stop and the homing procedure for the axis is finished. Fast encoders index inputs 1, 2, 3 (pins 9, 10 and 11 on PoKeys57CNC and 9, 11 and 27 for other PoKeys devices) are used for axes 1, 2, 3, while ultra fast encoder index input is used for axis 4.
-   Reverse direction - reverse the homing direction
-   Slow down - slow down the homing speed to the reduced speed, as configured
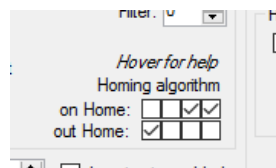


**Figure 7: Homing algorithm selection boxes - default configuration (reverse and reduce speed on home and stop on home release)**
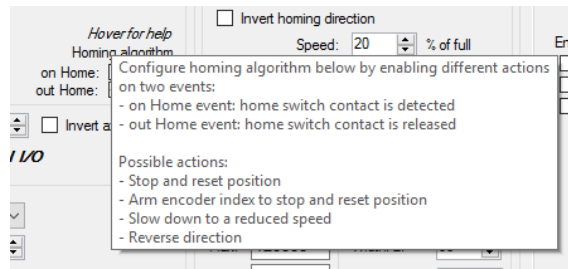
**Figure 8: Built-in help**

## Common homing algorithm configurations

Although the homing algorithm is configurable, there are some standard configurations that fit most CNC machine configurations:

1. Standard homing configuration
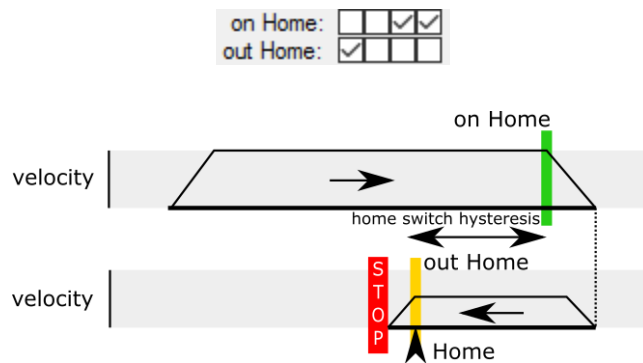


2. Homing without reverse
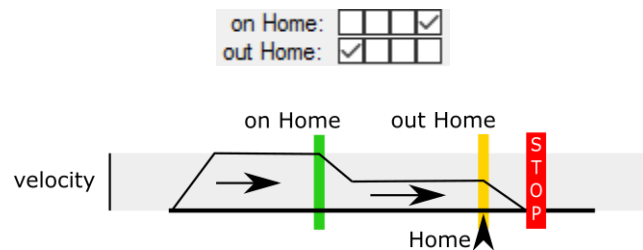


3. Homing with encoder index - standard
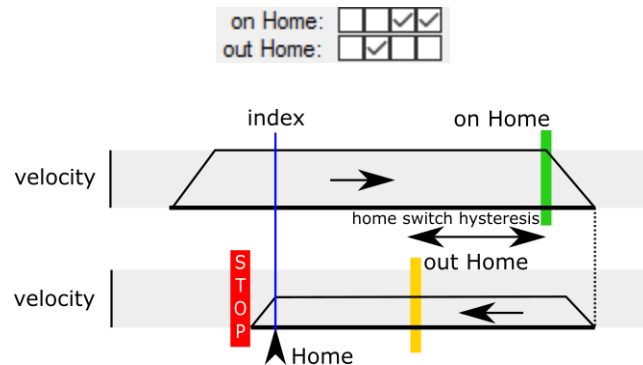


4. Homing with encoder index - without reverse
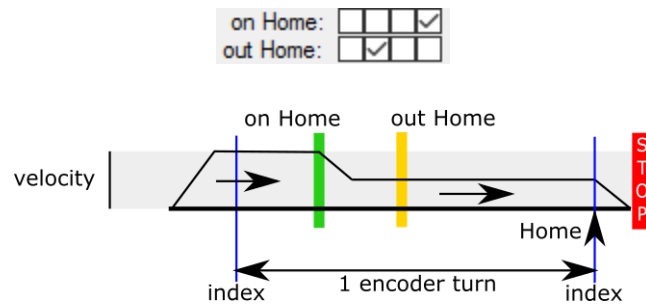
### Limit and home switch filters

The limit and home switch inputs support digital filtering. The filter value defines the minimum time for the limit or home switch signal activation (1 unit equals to 100 μs = 0.0001 s) - possible values are between 0 (no filtering) to 254 (25.4 ms).

## 8.4.    Analog inputs

Analog input function is only available on pins 41 and 42. The pin 41 is available on the dedicated analog connector, pin 42 is intended for plasma voltage input. There are two more analog channels on PoKeys57CNCpro4x25 for monitoring temperature and input supply voltage to the board.

Analog inputs have a resolution of 12 bits and are sampled at a fixed rate of 10 kHz.

### PoKeys configuration software usage

To open analog inputs dialog, go to Peripherals menu and select 'Analog inputs and outputs'. Dialog below appears. To enable display of analog input channel, check the appropriate check box. It is enabled only when the input is set up as analog input.

These two are also available in Mach plugin.

The progress bar displays the current voltage at the pin with the maximum at 3.3V. Below the input selection boxes user can set low-pass filtering for analog inputs. When analog input signal appears to be flickering or jumping due to analog signal noise, move the value for the filter to the right towards label 'slow signals' and then press Set button.
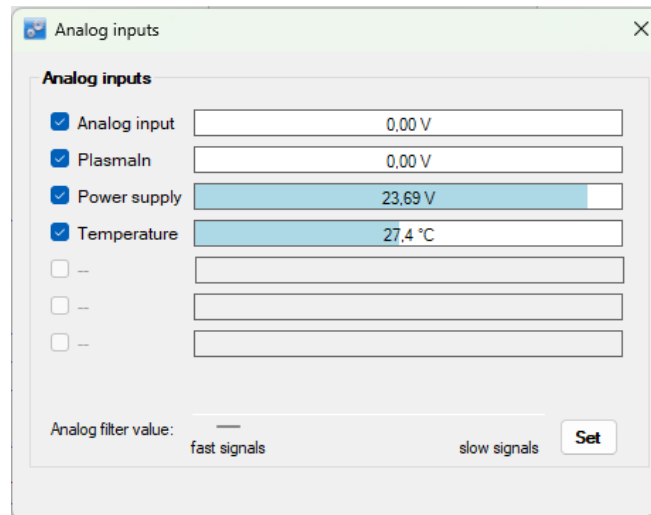
**Figure 9: Analog inputs and outputs dialog**

## 8.5. PWM outputs

PoKeys57CNCpro4x25 device supports PWM output function on pins 17 and 20. Pin 17 is wired to 0-10 V output for spindle control – the output voltage is proportional to the duty cycle of the PWM output. PWM output on pin 20 is located on dedicated connector and can be easily amplified using an external transistor and used for controlling the loads with increased current demand – we offer MOSFET power switch adapter for such purposes in PoLabs online store.

The frequency of the generated PWM signal can be changed – for the analog output functionality on pin 17 to operate as designed, a PWM frequency of 20 kHz is suggested. However, if needed, the frequency of PoKeys PWM outputs can be reduced – e.g. to drive various R/C servo motors that accept PWM signal with 50 Hz frequency (20 ms PWM period) and duty cycles between 5 and 10 % (1 to 2 ms). In such case, analog output on pin 17 will not be operational.

PoKeys devices have a built-in PWM module that operates at a fixed clock frequency of 25 MHz. Both the PWM period and the PWM duty cycles must be expressed as number of module clock cycles (i.e. 20 ms PWM period equates to 0.020 x 25 000 000 = 500 000).
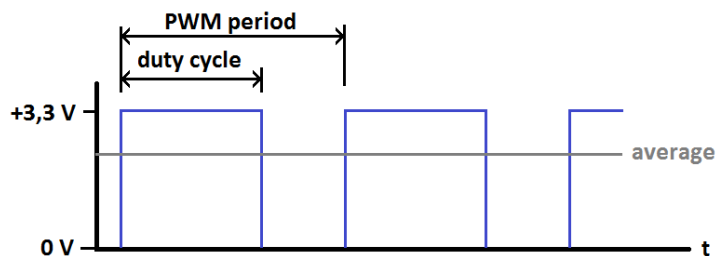


**Figure 10: PWM output**

*PoKeys configuration software usage*
PoKeys device's PWM (pulse width modulation) module can be setup via Peripherals > PWM outputs….

Figure 11: PWM outputs settings

In this window, user can enter PWM period and set PWM duties for each channel. Channels can be independently enabled or disabled. After a change is made, user must click 'Set values' button or check 'Send to device on change' checkbox. Left position of a slider means 0% and right position 100% respectively.

## 8.6. Failsafe settings

PoKeys devices support the configuration of the failsafe state for the digital outputs, PWM outputs, PoExtBus devices and PoKeys Pulse engine.

When the communication with the device is interrupted for longer than a period defined in the failsafe configuration, peripherals listed above enter the failsafe mode, which can be setup in 'Failsafe settings' dialog (Peripherals > Failsafe settings…)

| Peripheral | Failsafe setting |
|---|---|
| Digital outputs | Active Off / Active On |
| PoExtBus outputs | Active Off / Active On |
| PWM outputs | Fixed duty cycle in % |
| Pulse engine | No setting – Pulse engine enters emergency mode on failsafe activation |
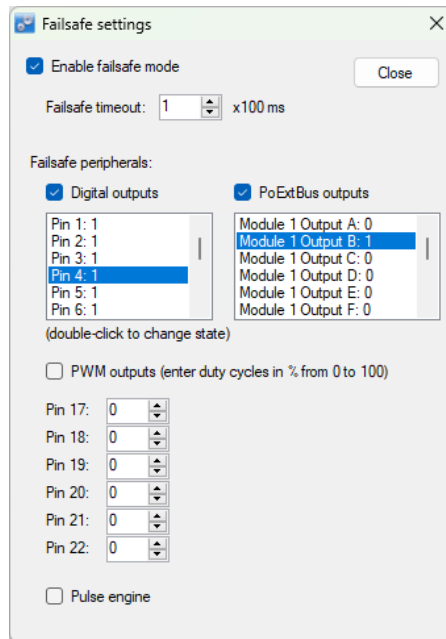
Figure 12: Failsafe settings dialog

## 8.7. Peripheral communication protocols

### CAN bus

PoKeys57CNCpro4x25 also features CAN bus. CAN bus is a robust communication bus standard designed for use in automotive and industrial environments. CAN bus in PoKeys devices is used to support PoCAN communication protocol between PoKeys devices and peripherals. It is intended for devices such as PoRelay8 or kbd48CNC keyboard and others. PoCAN is enabled via Peripherals > PoExtBus Smart / PoCAN menu in the PoKeys application.

## 8.8. USB interface configuration

The operation of the USB PoKeys devices can be adjusted in the Device > USB interface', as shown on the figure below.
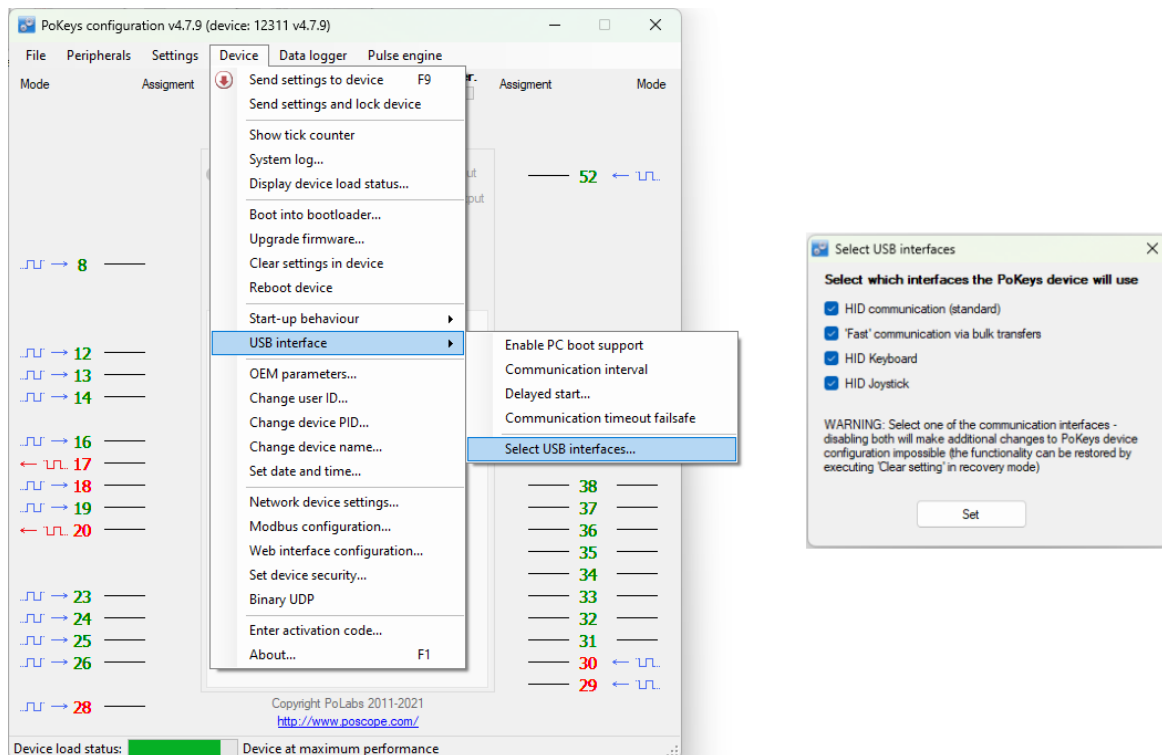


Figure 13: Accessing USB interface options

By adjusting these options, the user is given the possibility to configure how device reacts on the system start, change the communication interval and configure which interfaces are visible to the system. In some situations, omitting the unused interfaces can result in achieving better performance of the device due to lower load to the system drivers.

### Start options

USB PoKeys devices can be configured to either report the support for boot operation or not. Some PC BIOS versions have problems configuring non-simple (plain keyboard and mouse) devices and may halt the boot sequence if such device is present. By omitting the PC boot support, this is usually overcome.

If this however does not fix the problems during the boot sequence, delayed start option give the possibility to delay the PoKeys device registration on USB for the predetermined delay, which will result

in BIOS not detecting the device and continuing the boot sequence. Adjust the value according to your system in this case.

*Communication interval*

By default, PoKeys USB devices use 1 millisecond communication interval for the communication interface. If for any reason slower communication is required, it can be adjusted using the Communication interval settings dialog. Communication intervals between 1 millisecond and 20 milliseconds can be configured.

*Enabling/disabling the interfaces*

Each USB PoKeys device uses 4 USB interfaces (i.e. USB devices) and thus appears as 'USB Composite Device' in the Device manager. If not needed, some (or all) interfaces can be disabled.

**Note**: if all communication interfaces are disabled, configuration of the device will no longer be possible. In that case, follow the instructions in the section 'Restoring factory defaults' to restore the device's functionality.

## 8.9. Network device functionality

PoKeys57CNC device can be connected to Ethernet 10/100 network with standard RJ-45 cable.

By default, the device is set to use the DHCP functionality of the network router. User can later turn on or off the DHCP support. If DHCP is not required or available, fixed IP address must be defined for the device. To set the network settings of the device, go to Device menu and click Network device settings...
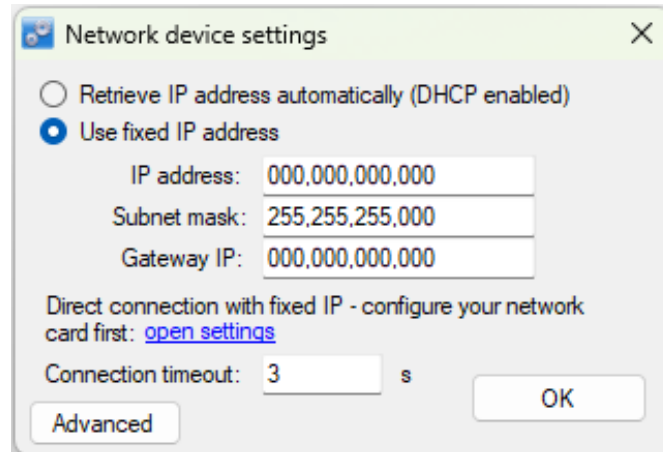


Figure 14: Device network settings

The device communicates using TCP and UDP port of 20055. **Please ensure the firewall settings allow communication with this port. Also, please make sure that your network card (which you have connected the PoKeys device to) has an IP address assigned with the subnet mask 255.255.255.0 (check it in IPv4 settings in your system).**

By default, PoKeys device is configured to close the connection with the host after 3 seconds of inactivity. This connection timeout value can be set in the dialog, shown in Figure 14.

### Device discovery

Unless PoKeys device is configured with a fixed IP address or static DHCP lease option is enabled on the router, user has no direct display of what IP the PoKeys device is configured or assigned with. Therefore, PoKeys device feature an automatic discovery mechanism that uses discovery packets sent from software looking for PoKeys device and discovery response packets that PoKeys device constructs as an answer to a discovery. The discovery response packet contains vital PoKeys device information that can be used to identify and find the PoKeys device in the network.

In case the DHCP server is not available in the network or if discovery packet was received from different subnet than the one used by PoKeys device, the device will change to a temporary IP address from the same subnet (defaulting to 255.255.255.0 subnet mask) that the request was sent from. This temporary address can be recognized by ending in .250 and should only be used to find a misconfigured device and setup it with proper network configuration. The discovery process can be disabled under Device > Network device settings by clicking 'Advanced' button.

More information on this mechanism can be found in the Protocol specification document.

## Default network settings

| DHCP: | enabled |
|---|---|
| Port: | 20055 |
| Security: | Full access |

### Connecting to device in other network

When the device is not detected automatically (either there is a firewall blocking the UDP broadcast messages or the device is not in the same network as a computer), custom IP address of the device can be entered by clicking on the 'Network settings... ' button on the 'Connect to device' dialog. The following dialog appears.
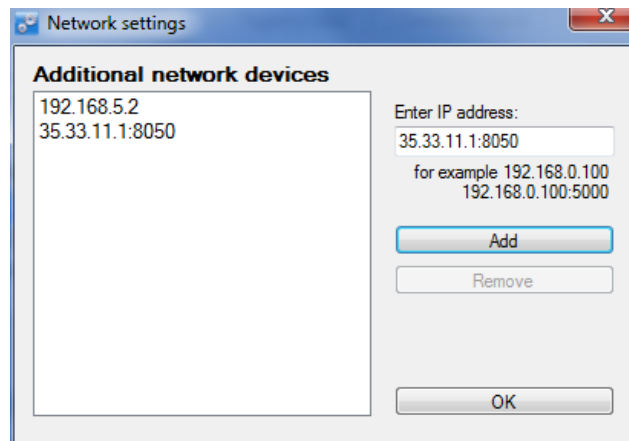


**Figure 15: Additional network settings**

IP address of the device can be entered in the text box on the right and added to the list by clicking the button 'Add'. The list of additional devices is saved on application exit.

## Security

Due to exposed nature of a network device, an authentication mechanism was implemented in network PoKeys that allows three levels of access rights:

- Full access (default): the device is fully accessible from the network
- Read-only access: unauthorized users are allowed only to fetch a limited set of data from the device, while an authenticated users can acccess all functions of the device
- Full lock: unauthorised users can not neither read or write to the device. A user password is required to unlock access.

The security is set up in PoKeys configuration software – on the Device menu, click Set device security... The password can contain any character and can be up to 32 characters long.



**Figure 16: Device security settings window**

*Modbus*

PoKeys57CNCpro4x25 device supports slave (server) operation of Modbus TCP communication protocol. Modbus TCP compatible devices on the network can read the values from the device and set the outputs. To elevate the security, user can define which peripherals are accessible via Modbus TCP.

Modbus TCP uses TCP protocol on port 502 (default), which can be changed in Modbus settings (accessible from the menu Device – Modbus configuration...). The Modbus TCP connection is disconnected after 3 seconds of inactivity (this default value can be changed in the Modbus settings).

## Discrete inputs/outputs

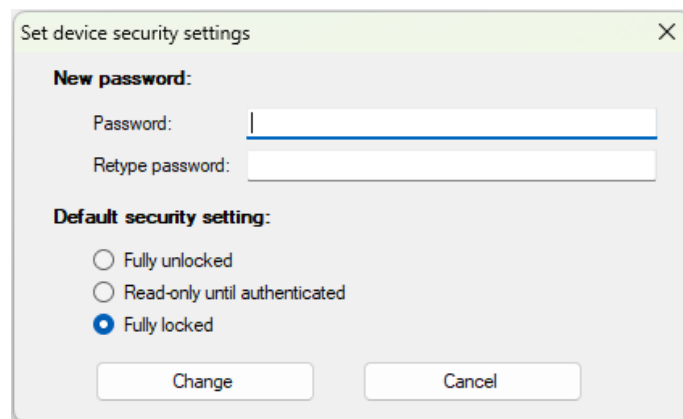*Supported operations:*
0x01: Read coils
0x02: Read discrete input
0x05: Write single coil
0x0F: Write multiple coils

| Address (0-based) | Access (R – Read, W – Write) | Description |
|---|---|---|
| 0-54 | R/W | 55 pin inputs/outputs |
| 100-126 (100-149 on PoKeys57 series) | R | Sensor OK statuses |
| 200-263 | R/W | PoIL shared data (binary data) - overlapped with 32-bit PoIL shared data at 1000-1127 (16-bit) |
| 1000-1127 | R | Matrix keyboard inputs |
| 1400-1527 | W | I2C Matrix keyboard LED |
| 1600-1727 | R/W | LED matrix |
| 2000-2079 | R/W | PoExtBus |
| 2000 | | Device 10 – Output H |
| 2001 | | Device 10 – Output G |
| ... | | |
| 2079 | | Device 1 – Output A |

## Registers

*Supported operations:*
0x03: Read holding register
0x04: Read input register
0x06: Write single register
0x10: Write multiple registers

| Address (0-based) | Access (R – Read, W – Write) | Description |
|---|---|---|
| 0-1 | R | Serial number of the device (PoKeys57 only) |
| 10-16 | R | Analog inputs |
| 20-45 | RW | Encoder counter values (lower 16-bit) |
| 100-154 | RW | Digital counter values |
| 200-213 | RW | PWM |
| 200,201 | | PWM period (MSB first) |

| | | |
|---|---|---|
| **202,203** | | PWM duty1 (MSB first) – pin 22 |
| **...** | | |
| **212,213** | | PWM duty6 (MSB first) – pin 17 |
| **300-304** | RW | PoExtBus |
| **400-453 (400-499 on PoKeys57 series)** | R | Sensors (32-bit values, LSB first) |
| **600** | R | Tick counter (lower 16-bit) |
| **700-751** | R[W] | Digital encoder values (32-bit values, LSB first) - any write to these registers causes the reset of the encoder value to 0 |
| **800-909** | RW | Digital counter values (32-bit values, LSB first) |
| **1000-1127** | RW | PoIL shared data (32-bit, LSB first) |

## PoExtBus channel mapping:

| Address (0-based) | Register description | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **300** | A | B | C | D | E | F | G | H | A | B | C | D | E | F | G | H |
| | | | | **Device 10** | | | | | | | | **Device 9** | | | | |
| **301** | A | B | C | D | E | F | G | H | A | B | C | D | E | F | G | H |
| | | | | **Device 8** | | | | | | | | **Device 7** | | | | |
| **302** | A | B | C | D | E | F | G | H | A | B | C | D | E | F | G | H |
| | | | | **Device 6** | | | | | | | | **Device 5** | | | | |
| **303** | A | B | C | D | E | F | G | H | A | B | C | D | E | F | G | H |
| | | | | **Device 4** | | | | | | | | **Device 3** | | | | |
| **304** | A | B | C | D | E | F | G | H | A | B | C | D | E | F | G | H |
| | | | | **Device 2** | | | | | | | | **Device 1** | | | | |

where

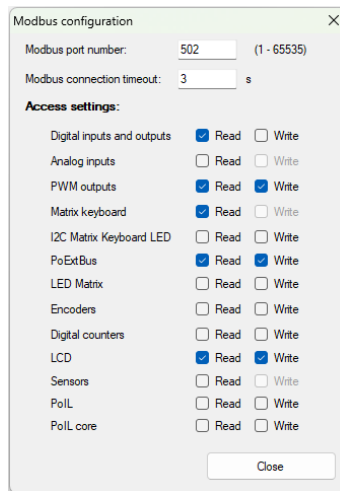| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | **Modbus word bit** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | A | B | C | D | E | F | G | H | PoExtBus device bit mapping |
| | | | **Device 10** | | | | | | **Device 9** | | | | | | | |

**Figure 17: Modbus configuration**

### 8.10. Changing User ID number

Users can freely assign their own User ID number that represents a specific PoKeys device (enables distinguishing between different PoKeys devices in case there is more than one connected to a single host PC). To change the User ID number, go to 'Device' > 'Change user ID' menu. Simply enter any number between 0 and 255, and click the 'Change user ID' button.
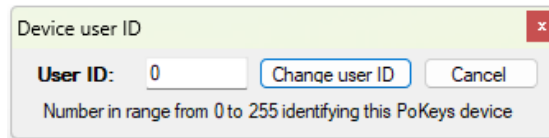


**Figure 18: Device user ID dialog**

### 8.11. Saving current configuration to file

To save the current configuration to a file, go to 'File' > 'Save' menu and select a new filename. To reload a saved configuration from a file, go to 'File' > 'Open' menu and select the appropriate file. To transfer new settings to the device, click on the 'Save to device' button.

### 8.12. PoIL core functionality

PoKeys57CNC contains PoIL core that is fully compatible with other PoKeys devices. Read the separate PoIL core documentation for more information.

Due to the omission of the 3V lithium backup battery, PoKeys57CNCpro4x25 does not support value retention in case of power failure.

# 9. Device recovery mode

If configuration editor cannot be used to reconfigure the device, use the following steps to start the device in the recovery mode. Recovery mode can be used to clear the configuration or update the firmware.

1. Disconnect PoKeys57CNCpro4x25 device from USB and remove power supply. Unscrew and remove the aluminium cover of the device to access the PCB board and the jumper.
2. Locate the jumper between the USB and ETHERNET connector on the PoKeys57CNCpro4x25 device and short the pins as shown below:
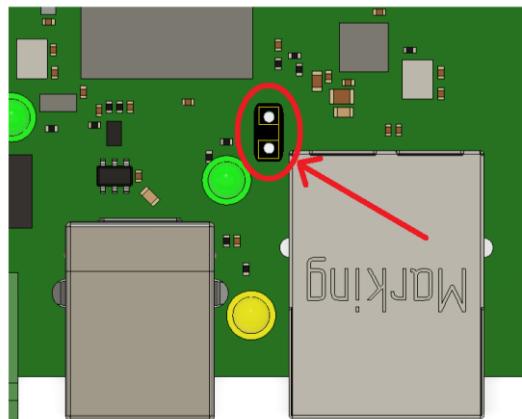


3. Reconnect the PoKeys device to USB or Ethernet and reconnect power
4. After a few seconds, green status light should start flashing rapidly and PoKeys device will connect in recovery mode
5. Open PoKeys configuration application
6. PoKeys configuration application should detect PoKeys57CNCpro4x25 device in recovery mode.
    a. To reset the device configuration, use the option 'Clear settings'. By clicking this button and confirming your decision on the next dialog, settings will be erased.
    b. To recover from bad firmware update, click 'Recover'.
7. After completing the operation, unplug PoKeys device and remove the short from the jumper connector
8. If resetting the configuration, ensure the device is properly cleared – replug PoKeys57CNCpro4x25 device, connect to it and execute Device > Clear settings in device.

# 10. Frequently asked questions

**What software must be installed to operate the device?**
On first use or when reconfiguring the device, the supplied software must be installed. If USB connection is to be used, device driver must be used that should be automatically installed by the setup package.

**Can I use both USB and Ethernet connections?**
Yes, both USB and Ethernet connections can be connected at the same time, but USB connection will have a priority over Ethernet.

**Windows can not find drivers for PoKeys57CNCpro4x25 device**
The drivers should automatically be installed by PoKeys setup package. If this is not the case and Windows reports unknown device, install the drivers manually by instructing the Windows device setup wizard to look for drivers in PoKeys installation folder (*C:\Program Files\PoLabs\PoKeys\* by default).

**I misconfigured the device and device no longer responds. What can I do?**
If you misconfigured the device in such a way that configuration utility cannot be used to repair the configuration, see the section 'Quick resetting the device configuration' in this manual.

**There is spontaneous triggering of some of the pins. What is wrong?**
Although the device implements basic noise filtering on the digital inputs, long wires between PoKeys device and switches can cause spontaneous triggering if those wires are located near high-power electrical wiring. Use twisted pair wires, shielding and try to route the signal wires away from power supply wires.

**The connection with the PoKeys device cannot be established with 10BASE-T router**
Please check that you are using proper cable that is supported by 10BASE-T standard. The following diagram shows the correct wiring for different connection standards.
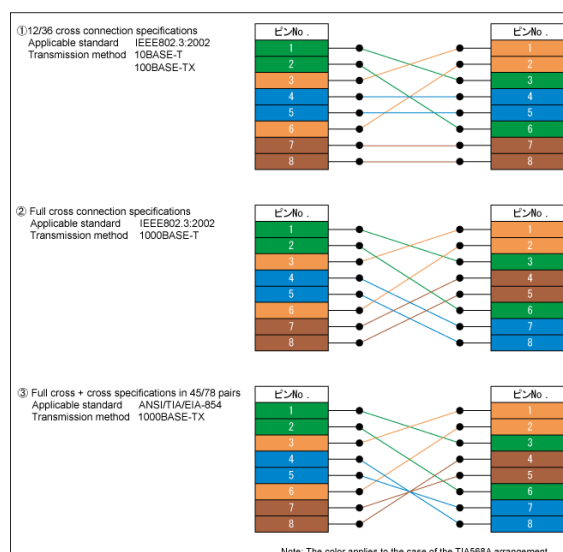


(source: http://www.okidensen.co.jp/en/prod/cable/lan/img/cate6_n_fig05.gif)

## 11. Errata information

## 12. Change log

V1.00 initial revision

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