PiDi-3805

User Guide

DIAMS s.r.o.
Černyševského 26, 851
01 Bratislava, SR

04/2017 – Rev. 0

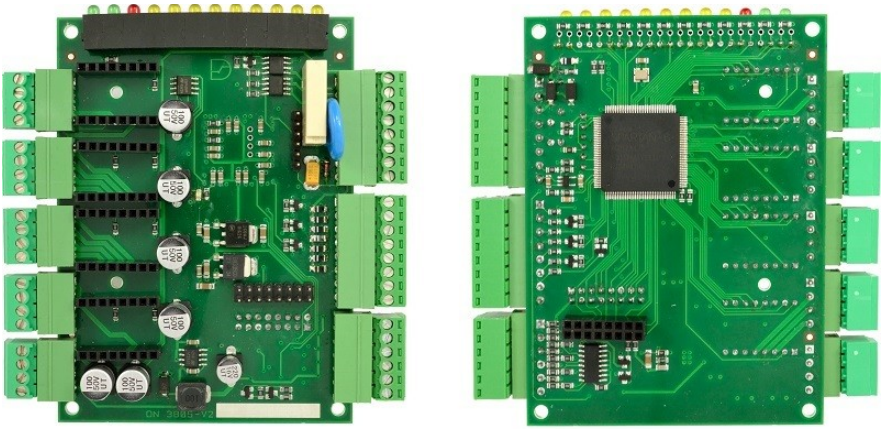
Table of Contents

1. Control Board PiDi-3805

Board PiDi-3805 is designed for control of various CNC machines. It allows control of machine movement and IOs:

- 4 stepper motors, expandable up to 7
- 5 binary input (24V)
- 7 binary output (24V, max. 200mA)
- 3 power binary output (24V, max. 2,5A)
- 1 relay output (230V, max. 5A)
- 1 analog output 12bit 0-10V

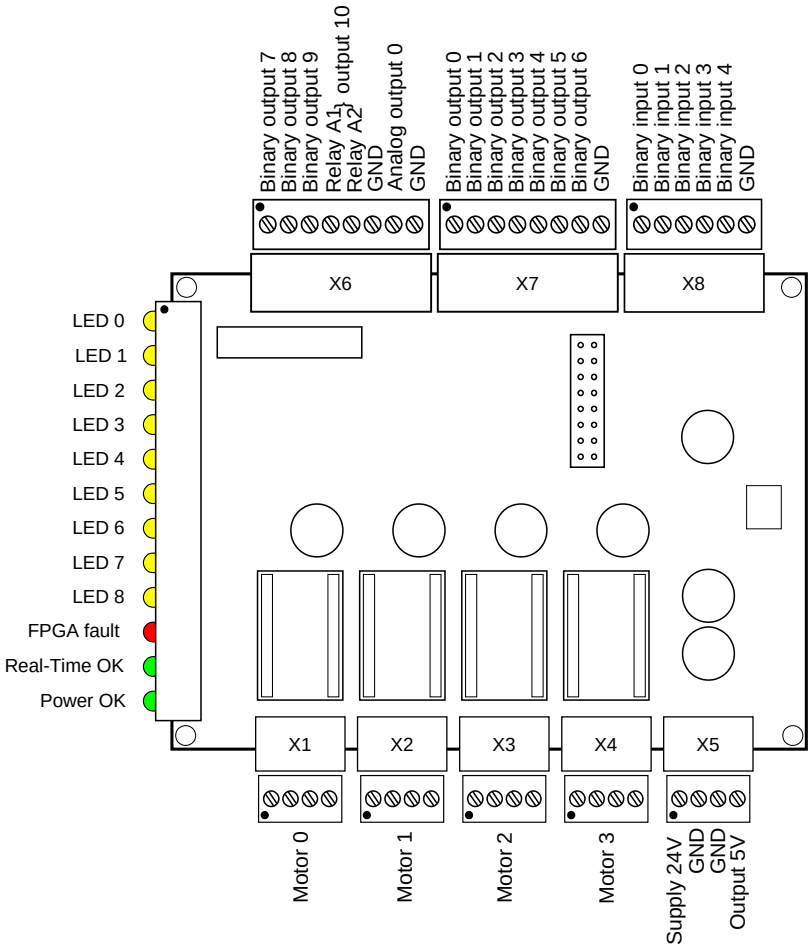
Combination of inputs and outputs is designed to fully control of small and hobby CNC machines. In case of insufficient number of motors or binary IOs, the system can be expanded with more boards like PiDi-3805 or PiDi-3809.



Pic. 1: Board PiDi-3805

1.1 Description of connectors

The connectors are located on the top and the bottom of the card for better availability of cables to the cable channel.

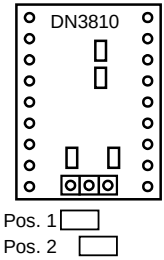


Pic. 2: Description of connectors of PiDi-3805

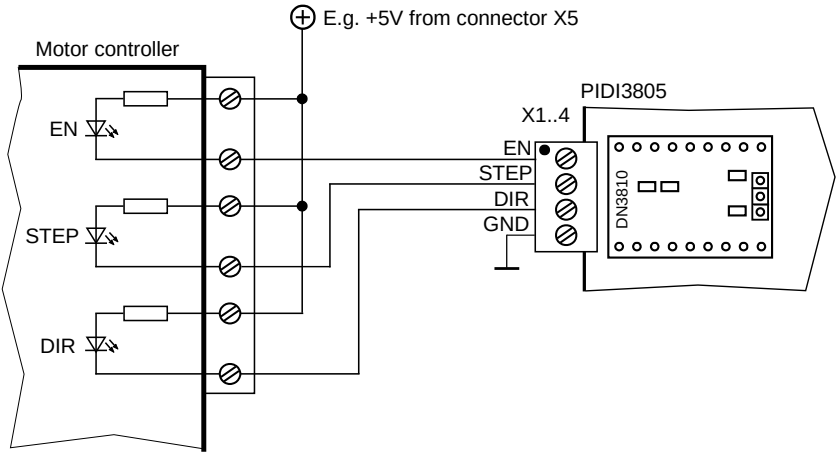
1.2 Motor outputs

For the purpose of stepper control, it is possible to use either external power drivers, that communicate in a mode of STEP/DIR, or miniature driver modules DRV8825 POLOLU, which have four slots ready on boards.
In case module PiDi-3810 is used, connectors X1 to X4 enable connecting STEP/DIR external driver. This module includes a jumper for choosing a polarity of output signal ENABLE

- Pos. 1 - ENABLE = TRUE, means OPEN COLLECTOR = OFF
- Pos. 2 - ENABLE = TRUE, means OPEN COLLECTOR = ON

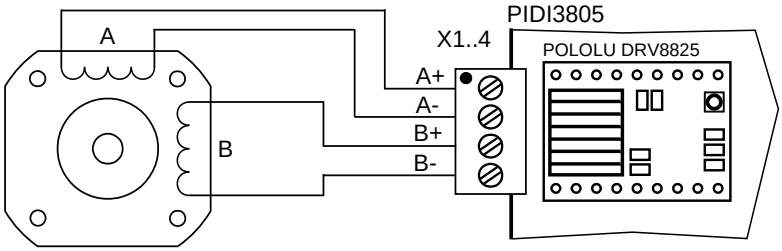


Pic. 3: Module PiDi-3810



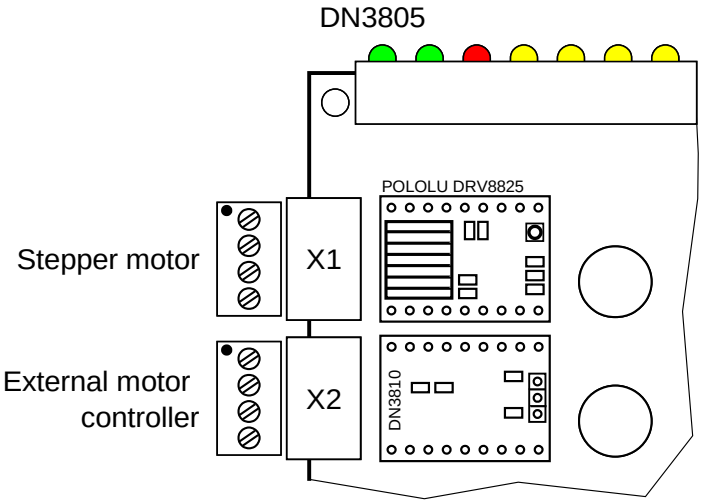
Pic. 4: Connection of external driver

In case POLOLU DRV8825 module is used, it is possible to directly connect stepper motors of appropriate power (e.g. NEMA17) to connectors X1 to X4.



Pic. 5: Connection of stepper motor

Removable modules are inserted into the slots by each connector and PiDi-3805 board allows any connection combination of the modules. Orientation of modules is illustrated in the picture below.



Pic. 6: Orientation of PiDi-3810 module and POLOLU DRV8825 module

1.2.1 Control of motor outputs

Movement of stepper motor is controlled by this output variable:

pidi-3805.N.step.M.speed

from which frequency of impulses is calculated by formula:

$$impulse\ \ freq\ \ [imp/s] = speed\ \ [mm/s] * scale\ \ [imp/mm]$$

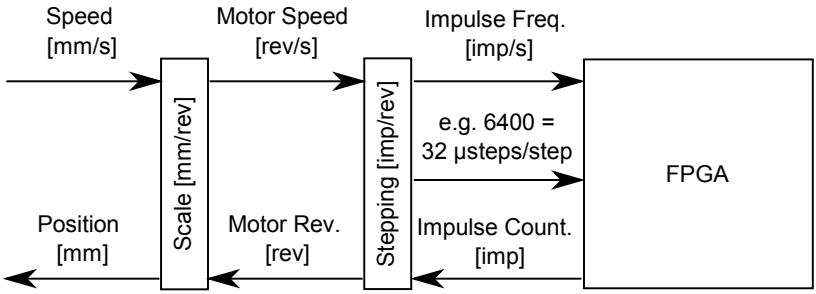
For feedback calculation an input variable is used:

pidi-3805.N.step.M.position

from which position is calculated by formula:

$$position\ \ [mm] = \frac{impulse\ \ Count\ \ [imp]}{scale\ \ [imp/mm]}$$

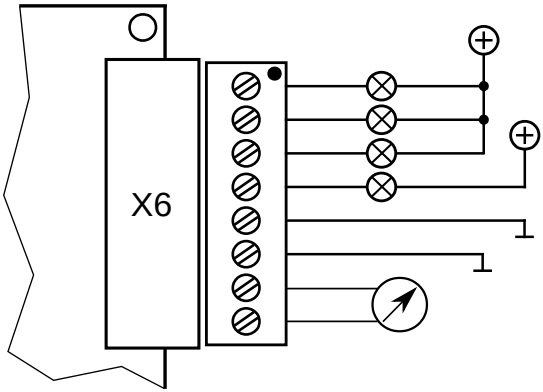
Constant *pidi-3805.N.step.M.scale is* ratio of number of pulses to unit of distance and it is specified in machine units per revolution.
Constant *pidi-3805.N.step.M.stepping* determines the number of microsteps per revolution. When using the POLOLU internal driver, the board will automatically set the switches for this module.



Pic. 7: Motor control relations

1.3 Binary outputs

Output connector X6 contains 3 power outputs which can be loaded by current up to 2.5A and 1 relay output, 230V, 5A. Outputs are protected by diodes against overvoltage peaks.



Pic. 8: Example of using outputs on connector X6

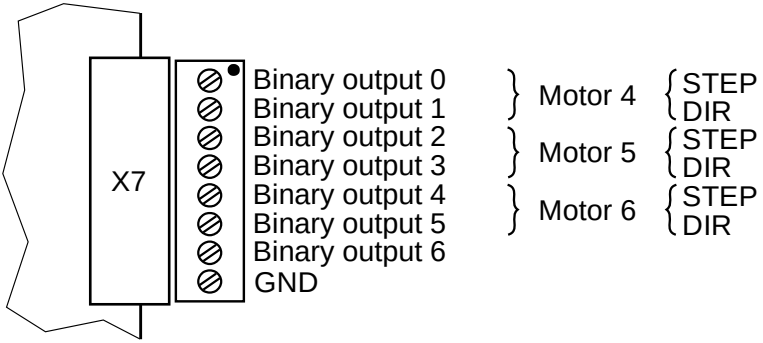
Connector X7 contains 7 binary outputs which can be loaded by current up to 0.2 A. Each of the outputs can be standard binary output and, depending on settings, can also operate in following modes:

- PWM output with frequency 40kHz and 0-100% ratio
- RC servo, control of standard model servo
- Stepper motor, control of stepper motor (a pair of outputs)

Modes of outputs are set by parameter in HAL file of LinuxCNC. Outputs can be set to all modes or any mode combination. However, binary output no.6 can not be set as „Stepper motor“.

1.3.1 Setting of the binary output mode

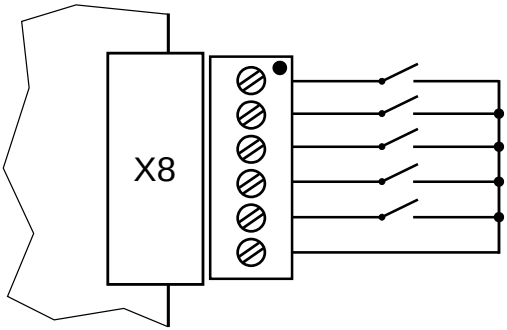
Modes of binary outputs on connector X7 are set by parameter „BoardMode“ during configuration of PiDiCNC in HAL. Mode for stepper motor control automatically occupies 2 outputs for 1 motor: one for step pulses STEP and second for the direction of DIR rotation.



Pic. 9: Assignment of motors to binary outputs

1.4 Binary inputs

Connector X8 contains 5 digital inputs with common ground. Maximal input voltage is 24V.



Pic. 10: Example of using of binary inputs

1.5 Analog output

For control of spindle or a similar tool speed, the board contains an analog output. The output voltage is in the range of 0-10 with 12-bit resolution.

1.6 Signaling LED

There are yellow LEDs attached to the front side of the board. They are not permanently assigned to a specific input or output as they can variably display any of them after configuration by a HAL file. Parameter "*pidi-3805.N.bled.M.out*" is a variable output for displaying status on the LED. Other LEDs that indicate the status of the device are:

- **Fault FPGA** – Faulty firmware at FPGA
- **Real-Time OK** – Cyclic communication is OK
- **Power supply OK** – Supply voltage is OK

1.7 Overview of input-output variables and parameters

BoardN

It defines the mode of each binary outputs 0-6 as follows:

1 = Binary output

2 = PWM output with frequency 40kHz, with ratio 0-100%

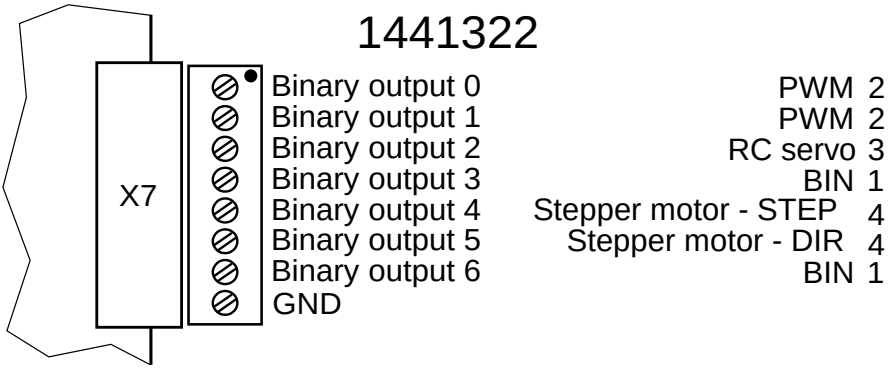
3 = RC servo, controlling of standard model servo

4 = Stepper motor, controlling of stepper motor (a pair of outputs)

Mode of PiDi-3805 board binary outputs is set by parameter ***BoardN*** and it is defined as number composed of digits assigned to each mode of the binary output. Mode for binary output 6 is most significant number and mode for binary output 0 is least significant number.

E.g. mode for Board0=3805,11111,1441322 means following:

- Binary output 0 is in mode 2 = PWM
- Binary output 1 is in mode 2 = PWM
- Binary output 2 is in mode 3 = RC servo
- Binary output 3 is in mode 1 = Binary output
- Binary output 4 is in mode 4 = Stepper
- Binary output 5 is in mode 4 = Stepper
- Binary output 6 is in mode 1 = Binary output



Pic. 11: An example of output mode set up

pidi-3805.N.bin.M.in

Status of binary input, where:

- N – order of board in system N=0,1...n-1
- M – order of binary input M=0,1...4

pidi-3805.N.bin.M.in-not

Status of inverted inputs.

pidi-3805.N.bout.M.out

Board contains 7+3+1 binary outputs, where:

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1...10

pidi-3805.N.bout.M.invert

Bit for inverting of binary output in modes BIN, PWM a RC

pidi-3805.N.bout.M.pwm-duty-cycle

Duty cycle - percentage share between turn-on phase and whole period. It is in range 0.0 - 1.0 (0-100%). Applies to PWM mode.

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…6

pidi-3805.N.bout.M.angle

Angle of RC servo rotation, values are in the range from -π/2 to + π/2 in radians. Applies to RC mode.

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…6

pidi-3805.N.bout.rc-center

Defines RC servo rotation (with impulse in ms) for angle = 0. Applies to all RC servos on the board.

- N – order of board in system N=0,1...n-1

pidi-3805.N.bout.rc-range

Defines range for maximum rotation of RC servo (range of impulse in ms) for angle = ± π/2. Applies to all RC servos on the board.

- N – order of board in system N=0,1...n-1

pidi-3805.N.bled.M.out

Output variable for indicating status on LEDs:

- N – order of board in system N=0,1...n-1
- M – order of led M=0,1...8

pidi-3805.N.step.M.speed

Output variable of speed stepper motor in mm/s, inch/s

- N – order of board in system N=0,1...n-1
- M – order of motor output M=0,1…6

pidi-3805.N.step.M.scale

Number of microsteps to unit (mm, inch).

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…6

pidi-3805.N.step.M.stepping

Number of microsteps per one step. Applies only to outputs which are occupied by POLOLU DRV8825 module. Possible values: 1, 2, 4, 8, 16, 32.

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…3

pidi-3805.N.step.M.position

Position of stepper motor in millimeters. Position is counted by FPGA

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…6

pidi-3805.N.step.M.status

POLOLU driver status, where: 0 – Error and 1 – OK

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…6

pidi-3805.N.step.M.enable

Enable stepper motor driver, applies for motor output 0 až 3

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…3

pidi-3805.N.dac.M.enable

Enable of analog output converter. If false, the output is set to 0V.

- N – order of board in system N=0,1...n-1
- M – order of binary output M=0,1…6

pidi-3805.N.dac.0.value

Desired output value. Output value of DAC is affected by variables in following equation:

u[V] = (value + offset) * scale * hw_scale + hw_offset

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.scale

Scale of physical value to voltage

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.offset

Shift of voltage output value of analog output

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.hw_offset

Hardware calibration of dac output. It is used to compensate the error of the output voltage analog converter.

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.hw_scale

Hardware calibration of dac output. It is used to compensate the error of the output voltage analog converter.

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.high_limit

Limit of highest voltage of analog output.

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.low_limit

Limit of lowest voltage of analog output.

- N – order of board in system N=0,1...n-1

pidi-3805.N.dac.0.bit_weight

The smallest step of analog voltage in volts.

1.8 Variables and parameters table

Dir	Name of variable	Default
OUT	pidi-3805.N.bin.M.in	0
OUT	pidi-3805.N.bin.M.in-not	1
IN	pidi-3805.N.bled.M.out	0
IN	pidi-3805.N.bout.M.out	0
IN	pidi-3805.N.bout.M.invert	0
IN	pidi-3805.N.bout.M.pwm-duty-cycle	0.5
IN	pidi-3805.N.bout.M.angle	0.0
IN	pidi-3805.N.bout.rc-center	1.5
IN	pidi-3805.N.bout.rc-range	0.5
OUT	pidi-3805.N.dac.0.bit_weight	2,44E-004
IN	pidi-3805.N.dac.0.enable	0
IN	pidi-3805.N.dac.0.high_limit	10.0
IN	pidi-3805.N.dac.0.hw_offset	0.0
IN	pidi-3805.N.dac.0.hw_scale	1.0
IN	pidi-3805.N.dac.0.low_limit	0.0
IN	pidi-3805.N.dac.0.offset	0.0
IN	pidi-3805.N.dac.0.scale	1.0
IN	pidi-3805.N.dac.0.value	0.0
OUT	pidi-3805.N.step.M.position	0.0
IN	pidi-3805.N.step.M.scale	1.0
IN	pidi-3805.N.step.M.speed	0.0
OUT	pidi-3805.N.step.M.status	0
IN	pidi-3805.N.step.M.stepping	32
IN	pidi-3805.N.step.M.enable	0
IN	pidi.N.type	3805

Tab. 1: Overview of variables and parameters