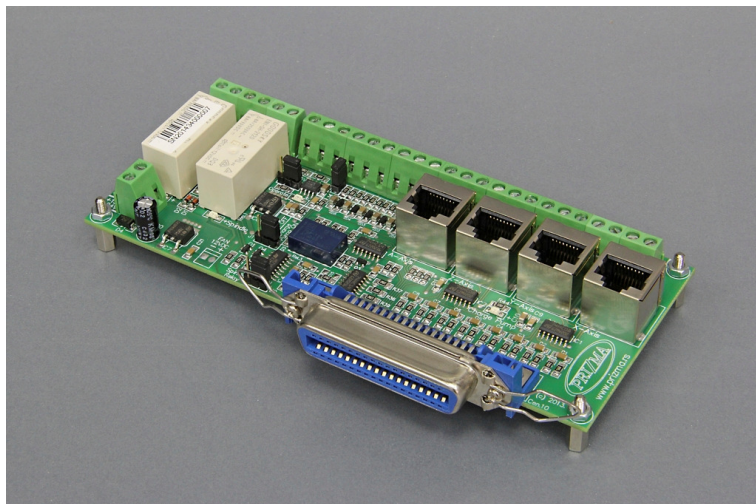


IO3-R2

BREAKOUT BOARD

DESCRIPTION



Breakout board IO3-R2 (Revision R2) has digital buffer for STEP/DIR/ENA command signals and as such it is particularly suitable for the connection up to 4 microstep drives MST-107 and/or DC servo drives DCS-3010 directly to PC. This breakout board can also be used with all drives that have opto-isolated STEP/DIR/ENA inputs.

On board charge pump prevents undesirable state changes in case of loss of communication with computer.

Breakout board IO3-R2 has two relay outputs that can be used to activate the two output devices (electric motor for the main spindle and/or vacuum pump for chips removing, etc.). Indication of the

relay condition is performed by the two LEDs which are located on the board.

One of the relay outputs can optionally be converted to analog output with a voltage range of 0–5 V or 0–10 V. This output could be used to control of spindle motor revolution speed.

Up to 5 limit switches can be connect to the breakout board. **Digital inputs for limit switches are opto-insulated and also have input filter for noise suppression, which is important improvement compared to previous version of breakout board IO3.**

PC connection is performed via the parallel (printer, LPT) port. Breakout board IO3-R2 has centronics (IEEE1284) connector, so that connection to the PC uses a standard printer cable.

Breakout board IO3-R3 is specially developed to be used with software for generating STEP/DIR command signals via parallel port such as: Mach2, Mach3, LinuxCNC (free), TurboCNC (free), KCam, etc.

SPECIFICATIONS

Number of axis	4 (X, Y, Z and A-axis)
Axes control	By STEP/DIR command lines separately for each axis, common ENA (enable) line for all axis
Output current of STEP/DIR command lines	15 mA max
Number of limit switches	5
Number of relay outputs	2
Analog output	Optionally 0–5 V DC or 0–10 V DC via jumper
The capacity of one relay output	250 V AC / 8 A max
Supply voltage	15–24 V DC / 500 mA
Dimensions (W x L x H)	173 mm x 63 mm x 20 mm
Weight	~120 g

NOTE: specifications are subject to change without notice



Table 1 DESCRIPTION OF INPUT–OUTPUT PINS

Description – function	Pin number on the PC side (connector DB25)	Line type on the side of PC	Annotation
X axis STEP	2	Output	-
X axis DIR	3	Output	-
Y axis STEP	4	Output	-
Y axis DIR	5	Output	-
Z axis STEP	6	Output	-
Z axis DIR	7	Output	-
A axis STEP	8	Output	-
A axis DIR	9	Output	-
ENA (enable)	17	Output	-
Safety signal (charge pump)	14	Output	Can be optionally switched on and off
Spindle – Relay 1	1	Output	Optionally analog output of 0–5 V or of 0–10 V
Coolant – Relay 2	16	Output	-
Limit switch 1 (SW1)	10	Input	-
Limit switch 2 (SW2)	11	Input	-
Limit switch 3 (SW3)	12	Input	-
Limit switch 4 (SW4)	13	Input	-
E-Stop – Limit switch 5 (SW5)	15	Input	-

WIRING DIAGRAM OF BREAKOUT BOARD IO3-R2 WITH MICROSTEP DRIVES MST-107

On the breakout board IO3-R2 is possible to connect from 1 to 4 microstep drives MST-107. Connection of STEP/DIR/ENABLE command lines to microstep drives MST-107 is shown on Figure 1.

For power supply of breakout board IO3-R2 and up to 4 microstep drives MST-107 it is recommended to use power supply board with motor brake PSB-1 (Figure 2). More details about this power supply board can be found in the PSB-1 user manual.

Users can also provide their own power supply source. In that case on Figure 3 is shown recommended power supply connection with breakout board IO3-R2 and up to 4 drives MST-107. Power supply must have two independent (isolated) power sources, one for power supply of breakout board IO3-R2 (15–24VDC/500mA) and other for power supply of MST-107 drives with supply voltage 20–40VDC (electric current of this power supply depends on the used step motors – see manual for microstep drive MST-107). On +V supply wire, for each drive MST-107, is recommended usage of fast blow fuse to protect drives in case of overload.

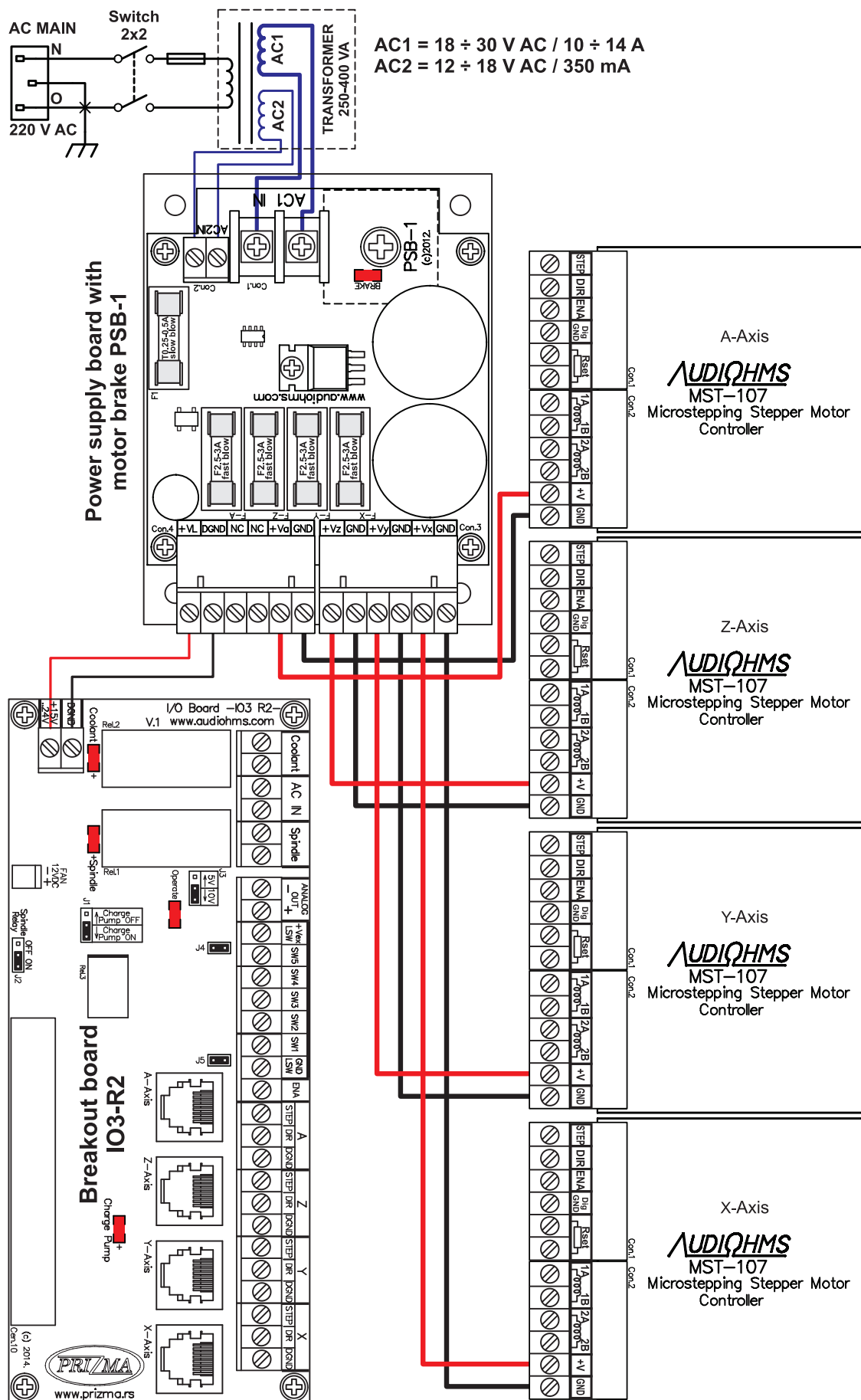


Figure 2

Installation of breakout board IO3-R2 with PC, connection of relays output and analog output is shown in Figure 4.

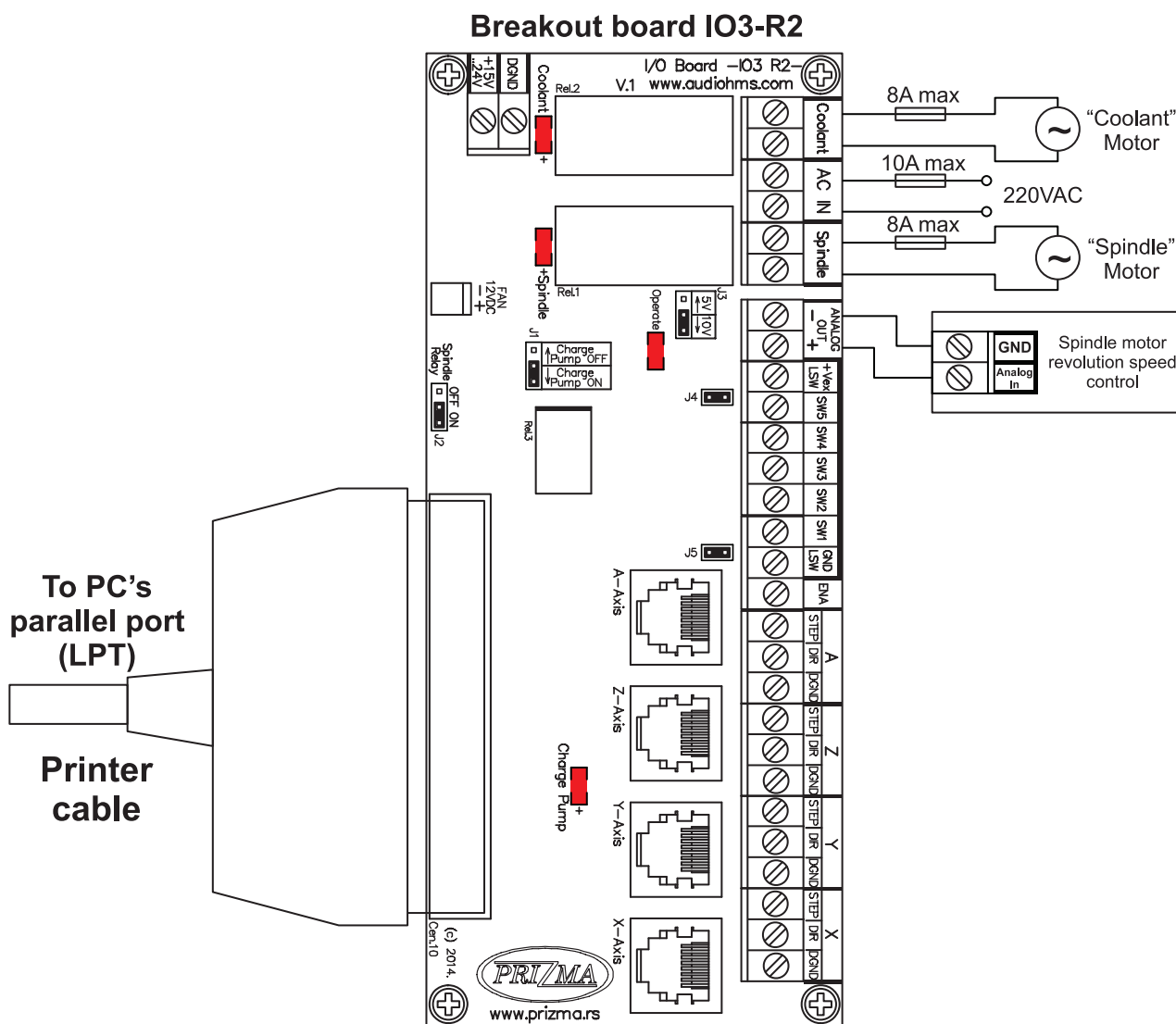


Figure 4

Maximum allowable current through each relay is 8A max, where total electric current should not be over 10A max. It is recommended that for electric current above 5A to be used external relays with larger capacity or contactors, and in that case contactors will be switched on by relays that are placed on breakout board IO3-R2.

NOTE: Negative output of Analog out is connected to the ground of breakout board IO3-R2.

LIMIT SWITCHES CONNECTION

There are two modes of limit switches connection on breakout board IO3-R2:

- Non-insulated mode, and
- Opto-insulated mode.

Non-insulated mode of connection of electro-mechanical type of limit switches are shown on figure 5, while connection of inductive type of limit switches with PNP output configuration can be found on figure 6.

IMPORTANT NOTICE: Leave jumpers J4 and J5 on their position if you connect limit switches as it has been shown on Figures 5 and 6.

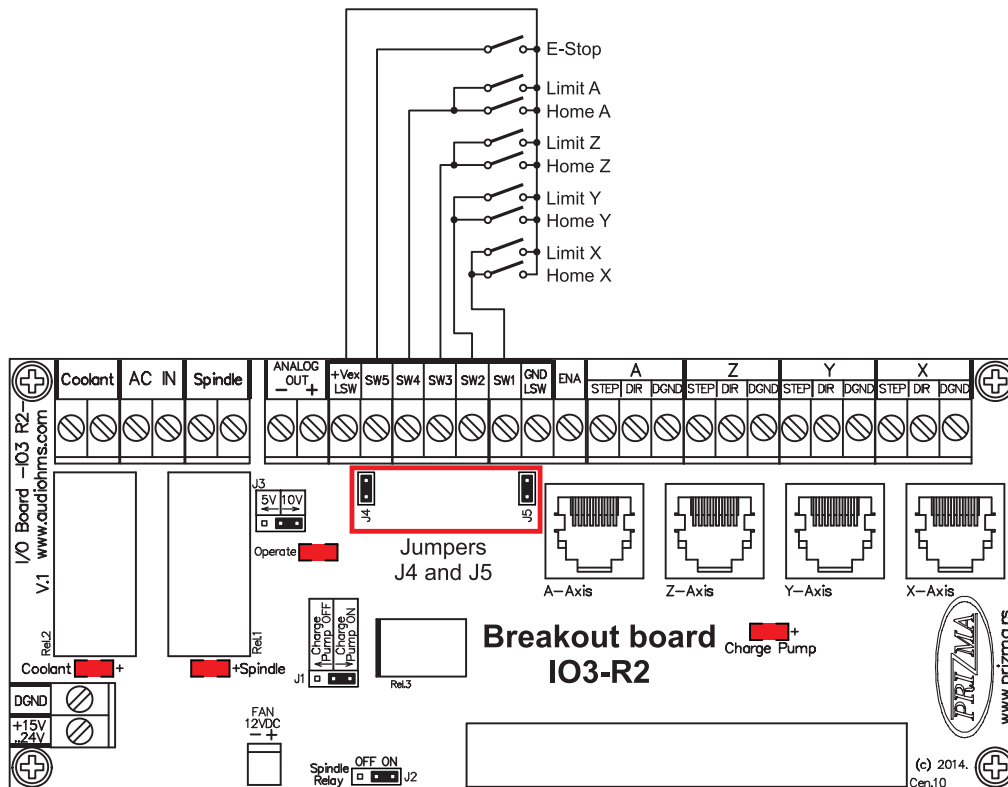


Figure 5

NOTE: According to wiring diagram shown on Figure 5 each axis has two limit switches which are connected in parallel. When it is performed "Home" positioning on that axis one of switches has Home switch function. In any other case, the activation of any of the two switches leads to stopping the machine. E-Stop (Emergency Stop) switch is placed at the switch SW5.

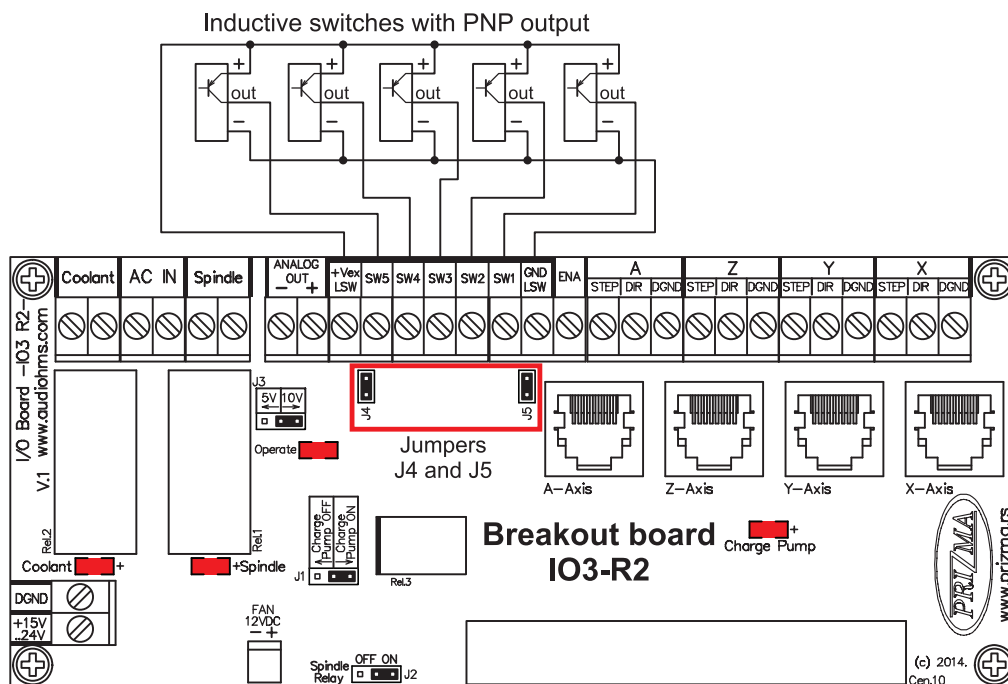


Figure 6

Connection of electro-mechanical type of limit switches in **opto-insulated mode** are shown on figure 7, while connection of inductive type of limit switches with PNP output configuration in **opto-insulated mode** can be found on figure 8. External power supply of 24 VDC is needed in both cases.

IMPORTANT NOTICE: Remove jumpers J4 and J5 if you connect limit switches as it has been shown on Figures 7 and 8.

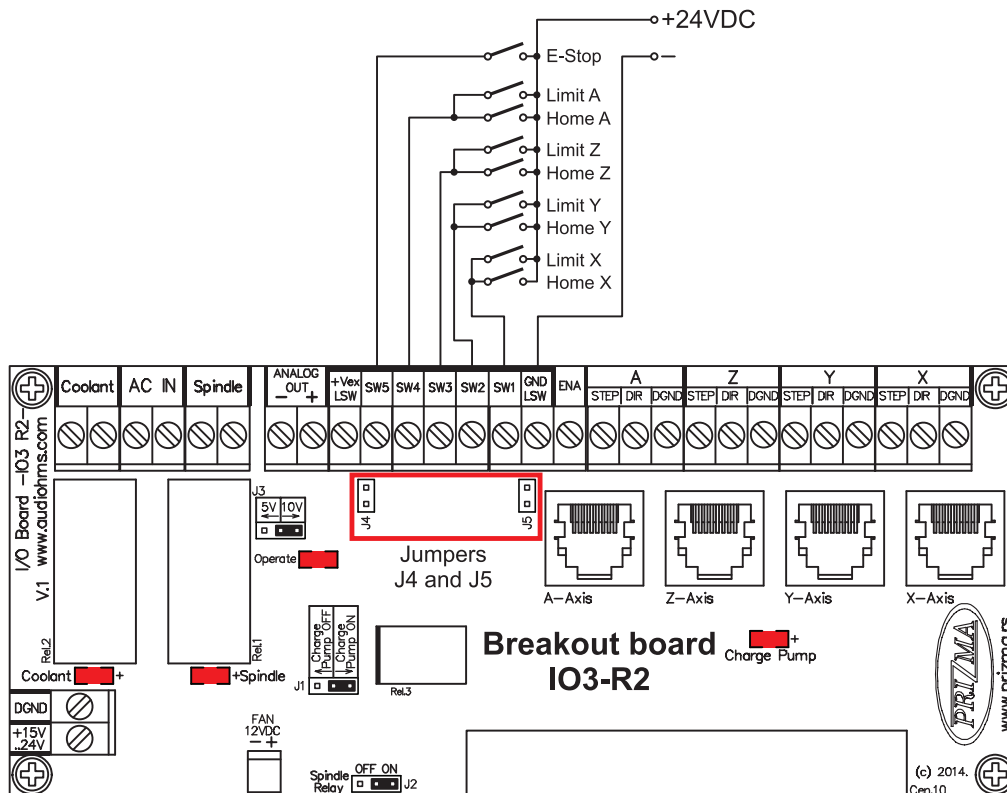


Figure 7

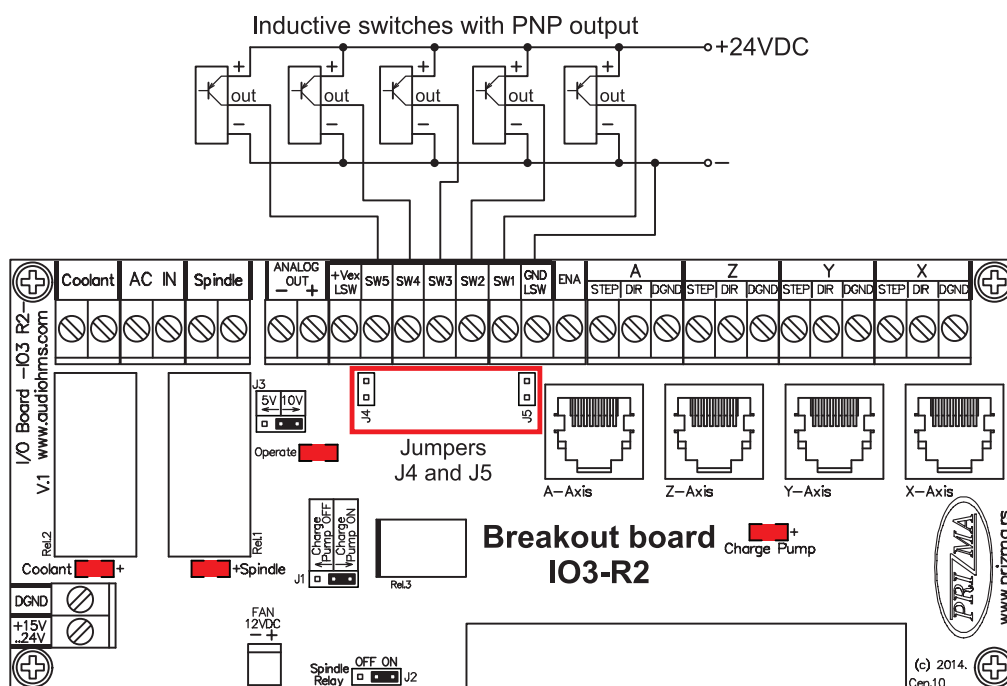


Figure 8

BREAKOUT BOARD IO3-R2 WITH DC SERVO DRIVES DCS-3010 – WIRING DIAGRAM –

Recommended wiring diagram of breakout board IO3-R2 with 3 DC servo drives DCS-3010 is shown in Figure 9. More details about this configuration can be found in user manual for DC servo drive DCS-3010.

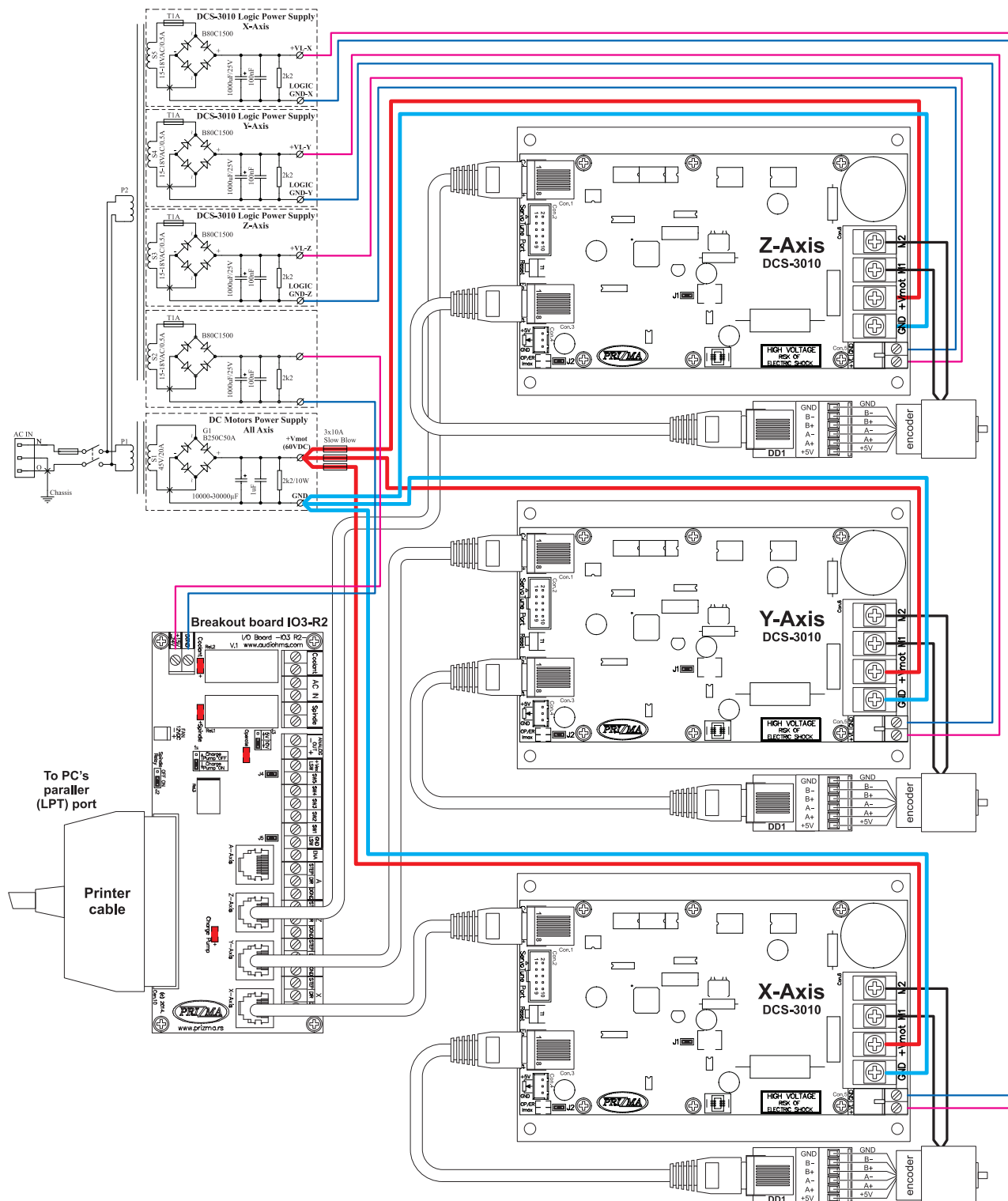


Figure 9

Using breakout board IO3-R2 with Mach3 –setup–

Demo version of the software Mach3 can be downloaded from the official site www.machsupport.com. As it is already mentioned breakout board IO3-R2 is connected with PC by using parallel (LPT) port. For proper operation it is necessary to perform the required settings. All settings are in accordance with the schedule of input-output pins, which is shown in Table 1.

Selection of the parallel port is performed in dialog box **Config** ⇒ **Ports and Pins** (Figure 10).

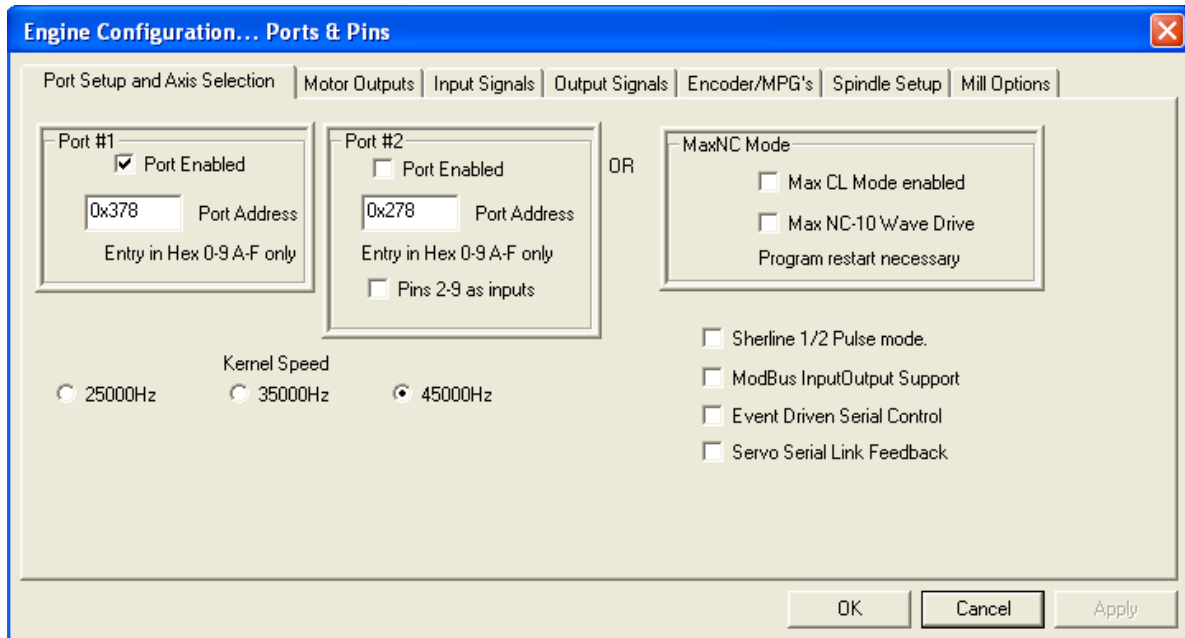


Figure 10

Setting of the STEP/DIR command lines for all axes is performed in dialog that opens by choosing option **Config** ⇒ **Ports and Pins** ⇒ **Motor Outputs** (Figure 11). In case of using microstep drive MST-107, considering that its step occurs on falling edge of STEP signal, it is necessary to select option **Step Low Active** (Figure 11).

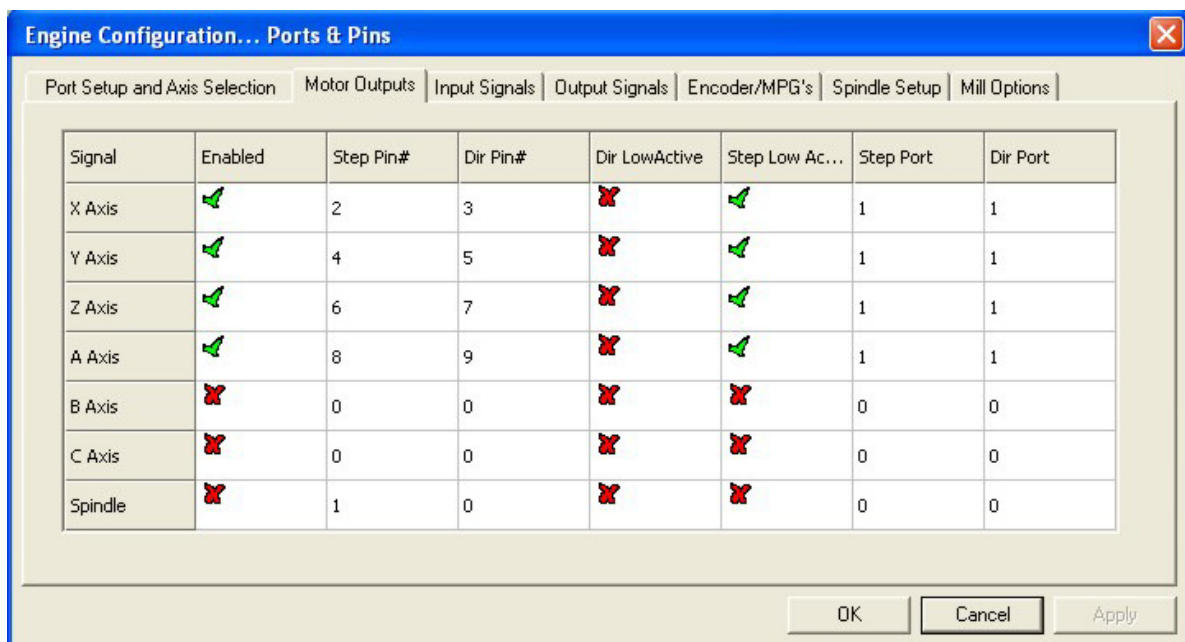


Figure 11

Setup for ENA (enable) command line is shown in Figure 15.

Setup of step motor parameters depends of great number of factors: step motor type, applied drive (choice of microstep options), type of transmission (screw spindle, timing belt, etc.), mass of the moving parts of the machine etc. One potential setup is shown in Figure 12. Dialogue is opened by selecting **Config** ⇒ **Motor Tuning**.

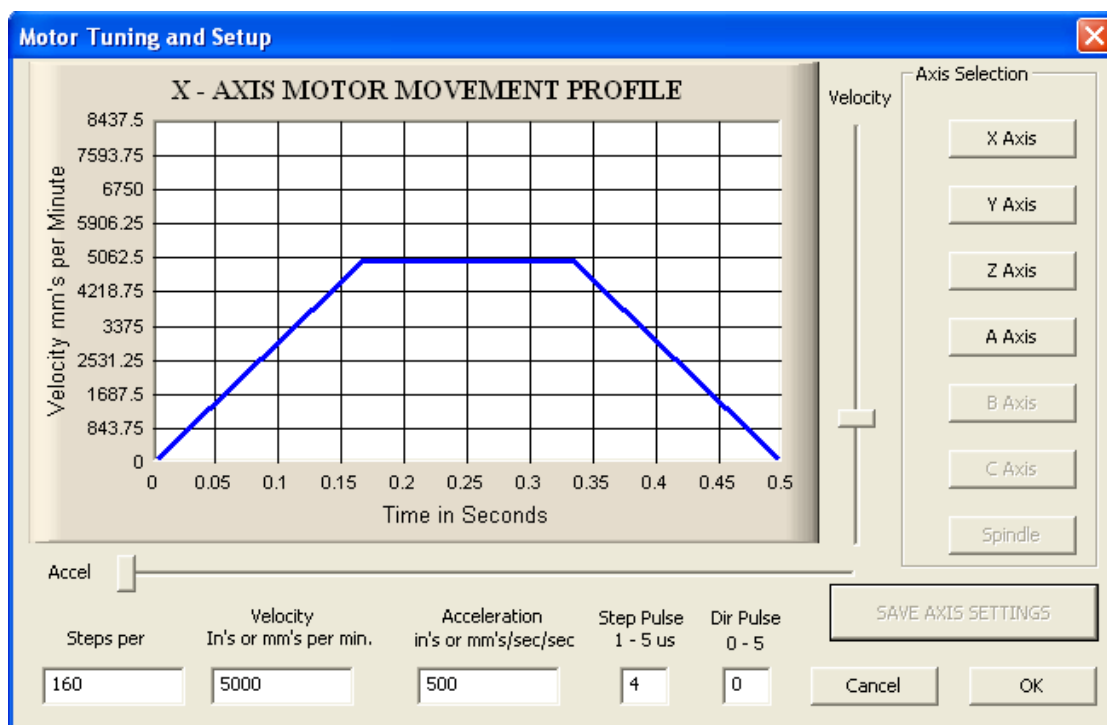


Figure 12

Example for the limit switches settings via option **Config** ⇒ **Ports and Pins** ⇒ **Input Signals** is shown in Figures 13 and 14. Setup refers to the connection of limit switches as shown in Figure 5.

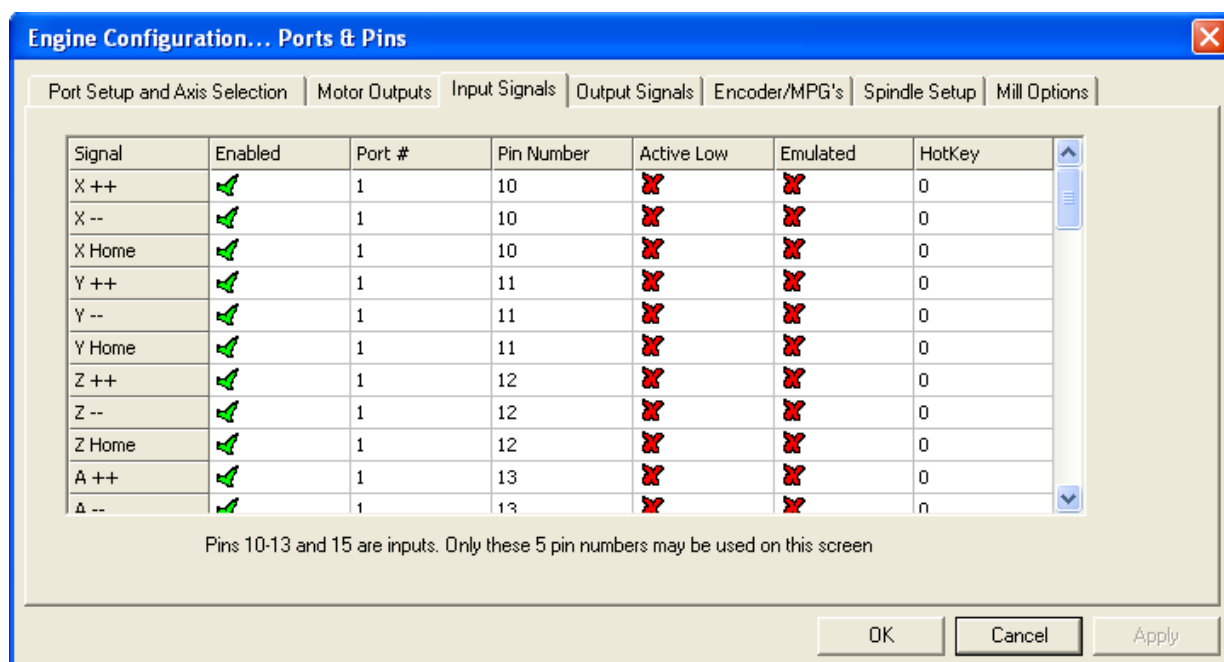


Figure 13

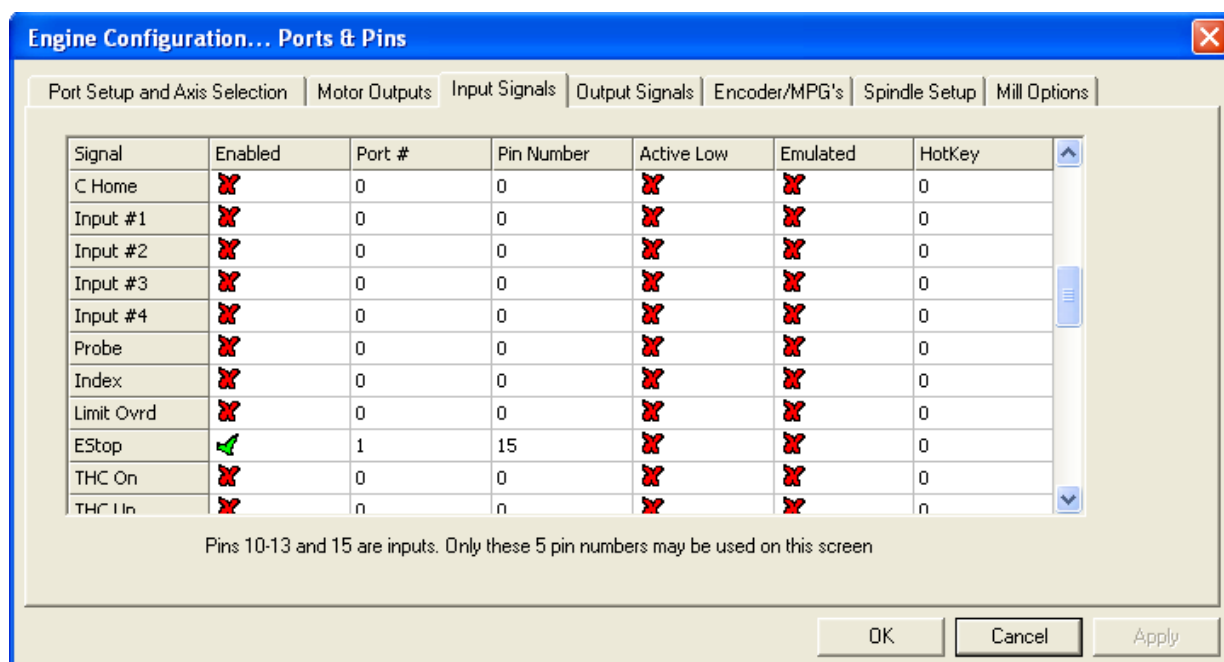


Figure 14

Setup of relay outputs is performed in two steps. The first, by choosing the option **Config** ⇒ **Ports and Pins** ⇒ **Output Signals** (Figure 15) selects outputs that is used (in this particular case **Output #2** i **Output #3**). Then it is needed to set the parameters under **Config** ⇒ **Ports and Pins** ⇒ **Spindle Setup** (Figure 16 area indicated by rectangle).

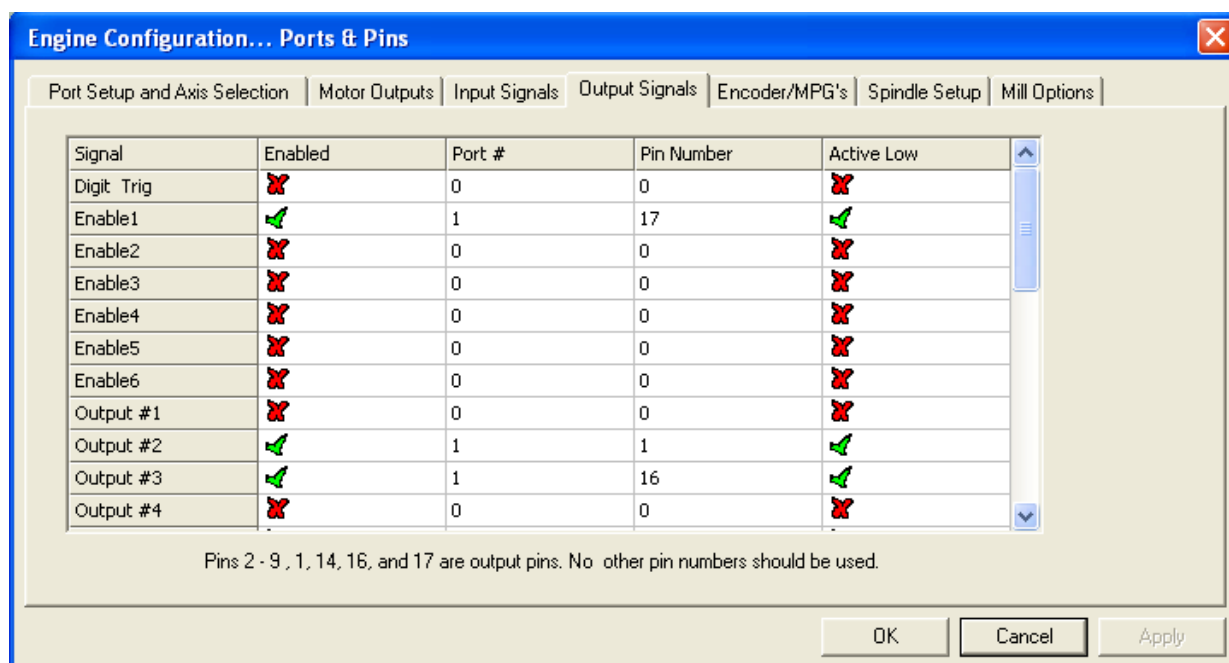


Figure 15

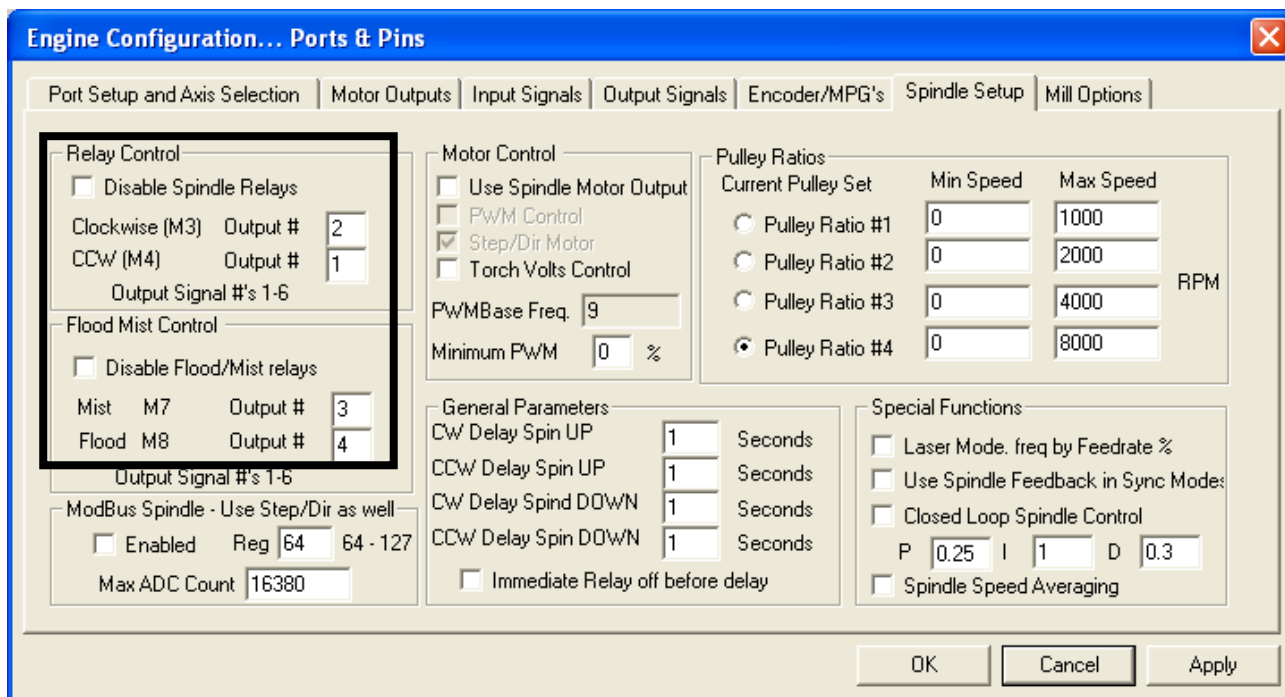


Figure 16

Safety signal – Charge Pump

By starting the software Mach3 the state of the output pins on the parallel port are not clearly defined. So, for example, a logic zero at the output pins 1 and 16 activates relay on the breakout board IO3-R2, namely spindle motor, or some other output device, which in some cases may be a dangerous event. In order to avoid this situation use the **safety signal** (charge pump signal) that represents pulse trains that are generated after the successful start-up of control software (in case of using Mach3 software frequency of the charge pump signal is 12.5 kHz).

To activate the use of the safety signal it is necessary to set the jumper J1 to position **Charge Pump ON** (see Table 2).

TABLE 2 Positions of jumper J1

Charge Pump J1	Charge Pump OFF – Circuit for charge pump signal is switched off. The output signals (Step, Dir, Enable and Analog out) are active no matter if the charge pump signal is present or not. LED diode Charge Pump is switched on.
Charge Pump J1	Charge Pump ON – Circuit for charge pump signal is switched on. In the absence of the charge pump signal all logic outputs (Step, Dir and Enable) will be at logic zero state, while the Analog out voltage will be 0V. LED diode Charge Pump is switched off. When the charge pump signal is present, safety circuit will be activated and the output signals (Step, Dir, Enable and Analog out) will be active. LED diode Charge Pump is switched on.

Setup of the safety signal (charge pump signal) is performed by selecting **Config ⇒ Ports and Pins ⇒ Output Signals** (Figure 17).

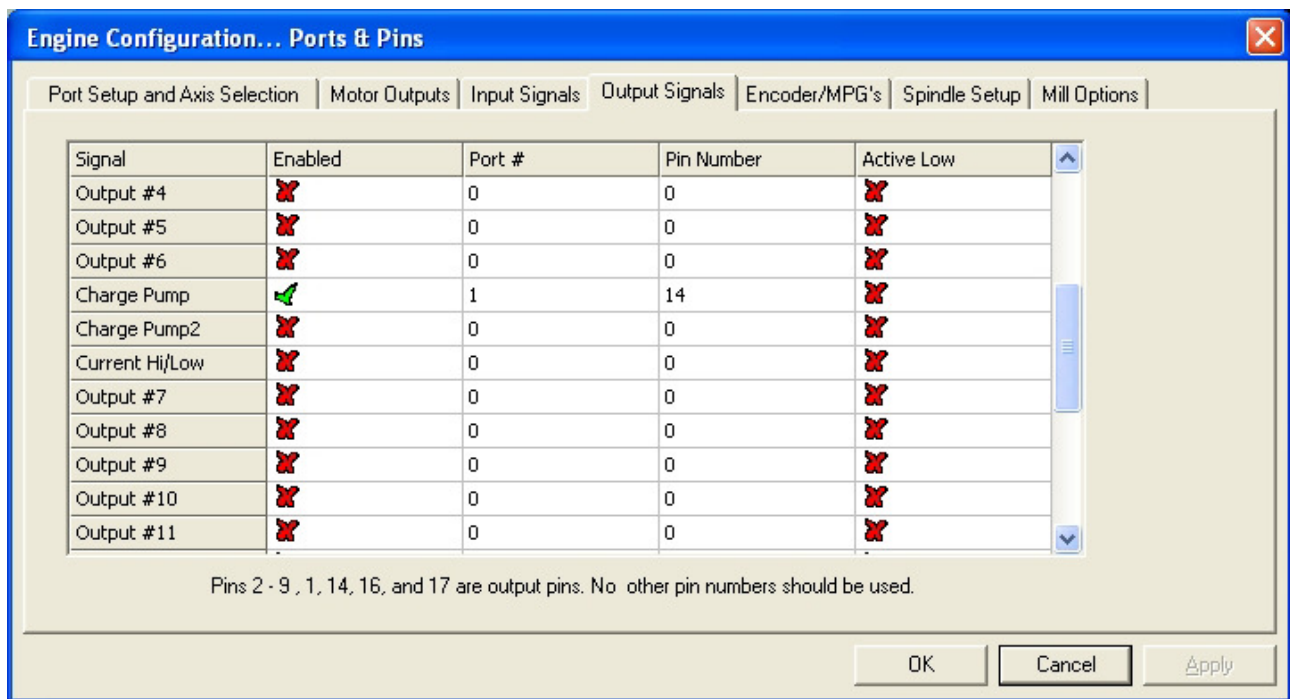


Figure 17

Analog output

Software Mach3 has the capability of generating Pulse-width modulation (PWM) signal. Pulse-width modulation is a method of control in which the frequency of the control signal does not change. Regulation is done by changing of the signal/pause ratio.

To convert the PWM signal to an analog signal (voltage level), breakout board IO3-R2 use active low pass filter. This filter smooths out the signal, filling in the gaps during the off periods of the PWM. The level of the analog signal depends on the signal/pause ratio. If the width of the signal is for example 10%, and width of the pause is 90%, analog voltage will be 10% of maximum voltage. This analog signal can be used for control of spindle motor revolution speed.

The use of analog output requires hardware setup of breakout board IO3-R2 via jumpers J2 and J3 (see Table 3), and setting up of parameters in Mach3 software.

TABLE 3 Position of jumpers J2 and J3 for configuration of analog signal.

	Jumper J2 should be in OFF position.
	Jumper J3 defines the voltage level on the analog output. It can be in voltage range of 0–5 V or 0–10 V.

NOTE: If analog output is in use, than it is not possible to use relay output named Spindle. For that reason it is necessary to put the jumper J2 in OFF position. Otherwise the PWM signal would go to the coil of the relay and buzzing from this relay will be heard.

Software setup is performed by selecting **Config** ⇒ **Ports and Pins** ⇒ **Output Signals** as it is showed in Figures 18, 19 and 20.

Engine Configuration... Ports & Pins

Port Setup and Axis Selection | Motor Outputs | Input Signals | Output Signals | Encoder/MPG's | Spindle Setup | Mill Options

Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac...	Step Port	Dir Port
X Axis		2	3			1	1
Y Axis		4	5			1	1
Z Axis		6	7			1	1
A Axis		8	9			1	1
B Axis		0	0			1	1
C Axis		0	0			0	0
Spindle		1	0			1	0

OK Cancel Apply

Figure 18

Engine Configuration... Ports & Pins

Port Setup and Axis Selection | Motor Outputs | Input Signals | Output Signals | Encoder/MPG's | Spindle Setup | Mill Options

Signal	Enabled	Port #	Pin Number	Active Low
Digit Trig		0	0	
Enable1		1	17	
Enable2		0	0	
Enable3		0	0	
Enable4		0	0	
Enable5		0	0	
Enable6		0	0	
Output #1		0	0	
Output #2		1	1	
Output #3		0	0	
Output #4		0	0	

Pins 2 - 9 , 1, 14, 16, and 17 are output pins. No other pin numbers should be used.

OK Cancel Apply

Figure 19

Engine Configuration... Ports & Pins

Port Setup and Axis Selection | Motor Outputs | Input Signals | Output Signals | Encoder/MPG's | Spindle Setup | Mill Options

Relay Control

☐ Disable Spindle Relays

Clockwise (M3) Output #

CCW (M4) Output #

Output Signal #'s 1-6

Flood Mist Control

☒ Disable Flood/Mist relays

Mist M7 Output #

Flood M8 Output #

Output Signal #'s 1-6

ModBus Spindle - Use Step/Dir as well

☐ Enabled Reg - 127

Max ADC Count

Motor Control

☒ Use Spindle Motor Output

☒ PWM Control

☐ Step/Dir Motor

☐ Torch Volts Control

PWMBase Freq.

Minimum PWM %

General Parameters

CW Delay Spin UP Seconds

CCW Delay Spin UP Seconds

CW Delay Spind DOWN Seconds

CCW Delay Spin DOWN Seconds

☐ Immediate Relay off before delay

Pulley Ratios

Current Pulley Set	Min Speed	Max Speed
☒ Pulley Ratio #1	0	3000
☐ Pulley Ratio #2	0	2000
☐ Pulley Ratio #3	0	4000
☐ Pulley Ratio #4	0	8000

RPM

Special Functions

☐ Laser Mode. freq by Feedrate %

☐ Use Spindle Feedback in Sync Modes

☐ Closed Loop Spindle Control

P I D

☐ Spindle Speed Averaging

OK Cancel Apply

Figure 20

In Figure 20 it is seen that chosen fundamental frequency of PWM signal is 250 Hz. It is important to notice that the parameters relating to the **Pulley Ratio #1** is here set from 0–3000 RPM. This means that for signal/pause ratio of 0%, RPM will be 0, for 10% it will be 300 RPM and so on, while for 100% the spindle revolution speed will be 3000 RPM.

Commands related to the Spindle are on the main screen in the section called **Spindle Speed** (framed part in Figure 21). In the **S** field is required to enter the desired RPM (in Figure 21 it is 1000 RPM). Starting the spindle is achieved by pressing the **Spindle CW F5** button or by pressing the F5 key on the computer keyboard. By pressing the + and – there is a continuous increase or decrease of RPM of the spindle for the size of specified increment.

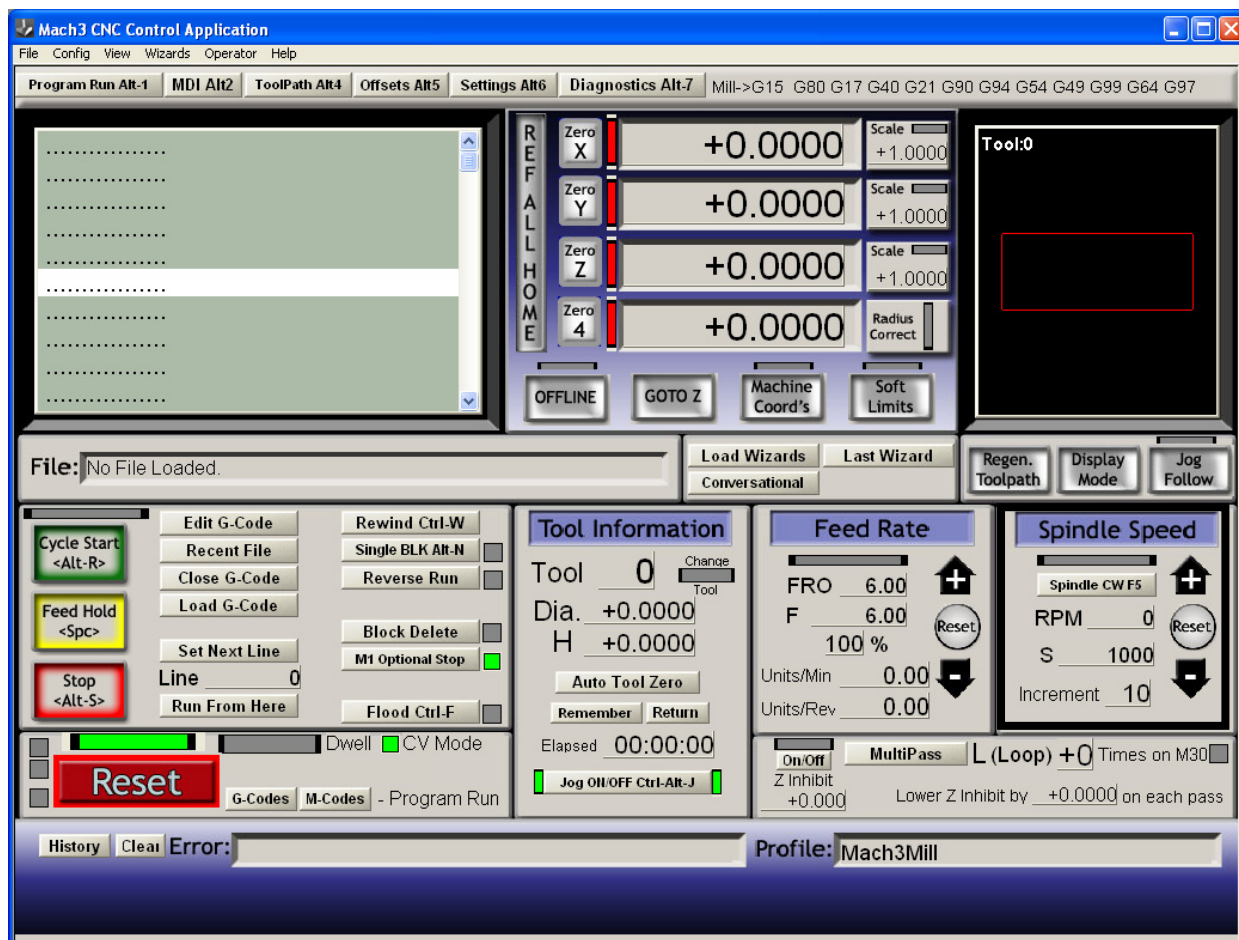


Figure 21

DOCUMENT REVISION HISTORY

December 2014.	V1.0 Initial version
January 2015.	V1.1 Minor corrections

