IO3 BREAKOUT BOARD

DESCRIPTION



Breakout board IO3 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 to connect 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 has two relay outputs that can be used to activate the two customers (electric motor for the main spindle and/or electric motor for vacuuming chips, etc.). Indication of the relay is performed using the two LEDs which are located on the board.

One of the relay outputs can optionally be converted to analog output with a range of 0-5 V or 0-10 V which allows software to control of spindle motor revolution speed.

Up to 5 limit switches can be connect to the breakout board.

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

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

For power supply of the card uses the source 15–24 V DC / 500 mA. The breakout board has the voltage regulator for the proper operation.

Description – function	Pin number on the side of PC (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	-

DESCRIPTION OF INPUT-OUTPUT PINS



Prizma doo, Kumanovska str. 8, 34000 Kragujevac, Serbia Tel. +381 34 330 200, web: <u>www.prizma.rs</u> e-mail: <u>prodaja@prizma.rs</u> Page 1 of 14

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	Choice 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

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

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

Users can also provide their own power source. In that case on Figure 3 is shown recommended power supply connection for breakout board IO3 and to 4 drives MST-107. Power supply must have two independent (isolated) power sources, one for power supply of breakout board IO3 (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 1





PRIZMA Priz



Figure 3

Installation of breakout board with PC, connection of end switches, connection of relays output and analog output is shown in Figure 4.

NOTE: On the displayed scheme 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 switch is placed at the switch SW5.



Breakout board IO3

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.

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



DIAGRAM OF BREAKOUT BOARD IO3 WITH DC SERVO DRIVES DCS-3010

Recommended installation diagram of breakout board IO3 with 3 DC servo drives DCS-3010 is shown in Figure 5. More details about this configuration can be found in user manual for DC servo drive DCS-3010.



Figure 5

PRIZMA

Using breakout board IO3 with Mach 3 -setup-

Demo version of the software Mach3 can be downloaded from the official site <u>www.machsupport.com</u>. As it is already mentioned breakout board IO3 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** \emptyset **Ports and Pins** (Figure 6).

Engine Configuration Ports & Pins	
Port Setup and Axis Selection Motor Outputs Input Signals Output Port #1 Port Enabled [0x378 Port Address Entry in Hex 0-9 A-F only Pins 2-9 as inputs Kernel Speed C 25000Hz C 35000Hz C 45000Hz	ut Signals Encoder/MPG's Spindle Setup Mill Options OR MaxNC Mode Max CL Mode enabled Max NC-10 Wave Drive Program restart necessary Sherline 1/2 Pulse mode. ModBus InputOutput Support Event Driven Serial Control Servo Serial Link Feedback
	OK Cancel Apply

Figure 6

Setting of the STEP/DIR command lines for all axes is performed in dialog that opens by choosing option **Config** \varnothing **Ports and Pins** \varnothing **Motor Outputs** (Figure 7). 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 7).

ine Config	uration Po	orts & Pins					
ort Setup and	Axis Selection	Motor Outputs	Input Signals 0	Output Signals En	coder/MPG's Sp	oindle Setup	Mill Options
Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac	Step Port	Dir Port
X Axis	4	2	3	X	4	1	1
Y Axis	4	4	5	X	4	1	1
Z Axis	4	6	7	X	4	1	1
A Axis	4	8	9	X	4	1	1
B Axis	X	0	0	X	X	0	0
C Axis	×	0	0	X	X	0	0
Spindle	×	1	0	X	×	0	0
1		A.		1			
					0	к [I	Cancel Apply
					0	K	Cancel



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 8. Dialogue is opened by selecting **Config** \varnothing **Motor Tuning**.





Figure 8

Proposal for setting the limit switches via option **Config** \emptyset **Ports and Pins** \emptyset **Input Signals** is shown in Figure 9 and 10. Setup refers to the connection of limit switches as shown in Figure 4.



Figure 9

Signal	Enabled	Port #	Pin Number	Active Low	Emulated	HotKey	^
- Home		0	0		<u> </u>	0	_
input #1	•••	0	0	•••	•	0	_
input #2	¥	0	0	<u>w</u>	2000	0	
input #4	¥	0	0	× ·	×	0	=
Probe	2	0	0	8	X	0	
index		0	0	X		0	_
imit Ovrd.	X	0	0	X	X	0	
EStop	4	1	15	4	X	0	
[HC On	2	0	0	X	X	0	
(HC Un	2	n	0	2	2	n	×
Hilm	Pins 10-13 and	d 15 are inputs. Or	nly these 5 pin num	bers may be used	on this screen		

Figure 10

Setup of relay outputs is performed in two steps. The first, by choosing the option **Config** \varnothing **Ports and Pins** \varnothing **Output Signals** (Figure 11) selects outputs that is used (in this particular case **Output #2** i **Output#3**). Then it is needed to set the parameters under **Config** \varnothing **Ports and Pins** \varnothing **Spindle Setup** (Figure 12 area indicated by rectangle).

Eng	Engine Configuration Ports & Pins								
P	ort Setup and Axis Selec	ction Motor Outputs	Input Signals Output	t Signals Encoder/M	PG's Spindle Setup	Mill Options			
	Signal	Enabled	Port #	Pin Number	Active Low	<u>^</u>			
	Digit Trig	X	0	0	X				
	Enable1	4	1	17	4	=			
	Enable2	X	0	0	X				
	Enable3	X	0	0	X				
	Enable4	X	0	0	X				
	Enable5	X	0	0	X				
	Enable6	X	0	0	X				
	Output #1	X	0	0	X				
	Output #2	4	1	1	4				
	Output #3	4	1	16	4				
	Output #4	X	0	0	X	v			
	Pins 2	-9,1,14,16, and 17 (are output pins. No oth	ier pin numbers should l	De usea.				
—									
					ОК С	Cancel Apply			

Figure 11

Engine Configuration Ports & Pins								
Engine Configuration Ports & Pin Port Setup and Axis Selection Motor Ou Relay Control Disable Spindle Relays Clockwise (M3) Output # CCW (M4) Output # Output Signal #'s 1-6 Flood Mist Control Disable Flood/Mist relays	tputs Input Signals Output Signals Encoder/MPG's Spindle Setup Mill Options Motor Control PWM Control PWM Control PWM Base Freq. 9 Minimum PWM 0 %							
Mist M7 Output # 3 Flood M8 Output # 4 Output Signal #'s 1-6 ModBus Spindle - Use Step/Dir as well Enabled Reg 64 64 - 127 Max ADC Count 16380	General Parameters Special Functions CW Delay Spin UP 1 Seconds CW Delay Spin UP 1 Seconds CW Delay Spin UP 1 Seconds CW Delay Spin DOWN 1 Seconds CCW Delay Spin DOWN 1 Seconds CCW Delay Spin DOWN 1 Seconds CCW Delay Spin DOWN 1 Seconds Immediate Relay off before delay 9 0.25 1 1 0 0.3 OK Cancel Apply							



Safety signal – Charge Pump

When you start the computer and when you start the software Mach3 state of the output pins of 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, 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 management software (in case of using Mach3 software frequency of the charge pump signal is 12.5 kHz).

To activate the use of the security signal it is necessary to set the jumper J1 to position **Charge Pump ON** (see Table 1).

DDI MA	Prizma doo, Kumanovska str. 8, 34000 Kragujevac, Serbia	Page 10 of 14
T MA T	el. +381 34 330 200, web: <u>www.prizma.rs</u> e-mail: <u>prodaja@prizma.rs</u>	

TABLE 1 Jumper position J1

L Charge Charge Pump OFF Pump OFF	Charge Pump OFF – Circuit for charge pump signal is switched off. The output signals (Step, Dir, Enable and Analog out) are active no matter the charge pump signal is present or not. LED diode Charge Pump is switched on.
L Charge Charge VPump OFF	 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 the security signal (charge pump signal) is performed by selecting **Config** \emptyset **Ports and Pins** \emptyset **Output Signals** (Figure 13).

Eng	ngine Configuration Ports & Pins 🛛 🔀								
P	ort Setup and Axis Selec	tion Motor Outputs	Input Signals Output	t Signals Encoder/MF	PG's Spindle Setup	Mill Options			
	Signal	Enabled	Port #	Pin Number	Active Low				
	Output #4	X	0	0	*	-			
	Output #5	X	0	0	8				
	Output #6	X	0	0	2				
	Charge Pump	4	1	14	X				
	Charge Pump2	X	0	0	*				
	Current Hi/Low	X	0	0	*				
	Output #7	X	0	0	*				
	Output #8	X	0	0	*				
	Output #9	X	0	0	*				
	Output #10	X	0	0	X				
	Output #11	X	0	0	X	~			
	Pins 2 · 9 , 1, 14, 16, and 17 are output pins. No other pin numbers should be used.								
					ОК	Cancel Apply			
			Figur	o 12					



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 a analog signal (voltage level), breakout board IO3 use active low pass filter. This filter smooth 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 90%, analog voltage will be 10% of maximum voltage. This analog signal can be used as a control spindle motor revolution speed.

The use of analog output requires hardware setup of breakout board IO3 via jumpers which are in Table 2, and setting up of parameters in Mach3 software.

TABLE 2 Jumpers position J2 and J3 if it is chosen analog signal.

Spindle OFF ON Relay J2	Jumper J2 should be switched to OFF.
	Jumper J3 defines the voltage level on the analog output. It can be in range of 0–5 V or 0–10 V.
\sim	

Software setup is performed by selecting **Config** \varnothing **Ports and Pins** \varnothing **Output Signals** as it is showed in Figure 14, 15 and 16.

NOTE: If it is used analog output, 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.



Figure 14





In Figure 16 it is seen that chosen fundamental frequency of PWM signal 250 Hz. It is important to notice the parameters relating to the **Pulley Ratio#1** which 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.

PRIZMA

Engine Configuration Ports & Pin Port Setup and Axis Selection Motor Ou	s puts Input Signals Output Signals Encoder/MPG's Spindle Setup Mill Options	
Relay Control □ Disable Spindle Relays Clockwise (M3) Output # 1 0 CCW (M4) Output # 0 0 Utput Signal #'s 1-6 Flood Mist Control ✓ Disable Flood/Mist relays Mist M7 Output # 3 Flood M8 0 Output # 4	Motor Control Pulley Ratios ✓ Use Spindle Motor Output Current Pulley Set Min Speed Max Speed ✓ PWM Control Step/Dir Motor 0 3000 2000 ✓ Torch Volts Control C Pulley Ratio #2 0 2000 RPM PWMBase Freq. 250 C Pulley Ratio #3 0 4000 RPM Minimum PWM 0 % C Pulley Ratio #4 0 8000 RPM General Parameters CW Delay Spin UP 1 Seconds E Laser Mode, freq by Feedrate % CCW Delay Spin UP 1 Seconds Image: Use Spin UP spin UP Seconds Image: Use Spin UP spin UP Seconds	
ModBus Spindle - Use Step/Dir as well Enabled Reg 64 64 - 127 Max ADC Count 16380	CW Delay Spind DOWN 1 Seconds I Closed Loop Spindle Control CCW Delay Spin DOWN 1 Seconds I Closed Loop Spindle Control Immediate Relay off before delay 9 0.25 I 1 D 0.3 Immediate Relay off before delay 0K Cancel Apply	

Figure 16

Commands related to the Spindle are on the main screen in the section called **Spindle Speed** (framed part in Figure 17).

In the **S** field is required to enter the desired RPM (in Figure 15 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 reduction of RPM of the spindle for the size of specified increment.

Mach3 CNC Control Application		
File Config View Wizards Operator Help Program Pum Att 1 MDI Alt2 ToolPath Att 1 Officiate Att5 Settinger	ABS Diagnostics Alt 7 Mills 045, 000 047 040 004 00	
Trogram Rain Aler MDT AIL2 TOOL all Aler Offsets All3 Settings		0 694 604 649 699 684 697
·	$rac{R}{F}$ $rac{Zero}{X}$ +0.0000 $rac{Scale}{F}$ +1.0000	Tool:0
	+0.0000 +1.0000	
	L Zero	
	H Z +0.0000 +1.0000	
	E 4 + 0.0000 Correct	
	Machine Soft	
·····	OFFLINE GOTO Z Coord's Limits	
	Load Wizards Last Wizard	Person Dicplay log
File: No File Loaded.	Conversational	Toolpath Mode Follow
Edit G-Code Rewind Ctrl-W	Tool Information Feed Rate	Spindle Speed
Cycle Start Recent File Single BLK Alt-N		spinate speed
Close G-Code Reverse Run		Spindle CW F5
Feed Hold Load G-Code	Dia. +0.0000 F 6.00 Res	RPM 0 Reset
Set Next Line M1 Optional Stop	H <u>+0.0000</u> <u>100</u> %	s 1000
Stop Line0	Auto Tool Zero Units/Min 0.00	Increment 10
Run From Here Flood Ctrl-F	Remember Return Units/Rev 0.00	
Dwell CV Mode	Elapsed 00:00:00 On/Off MultiPass	L (Loop) + O Times on M30
G-Codes M-Codes - Program Run	Jog ON/OFF Ctrl-Alt-J	Inhibit by +0.0000 on each pass
History Clear Error:	Profile: Mach3Mill	

Figure 17

Prizma doo, Kumanovska str. 8, 34000 Kragujevac, Serbia Tel. +381 34 330 200, web: <u>www.prizma.rs</u> e-mail: <u>prodaja@prizma.rs</u>

Doc: IO3_man_en Ver.1, January 2014. © by PRIZMA

DOCUMENT REVISION HISTORY

January 2014. English version

