USB−MC−INT

USB Motion Controller
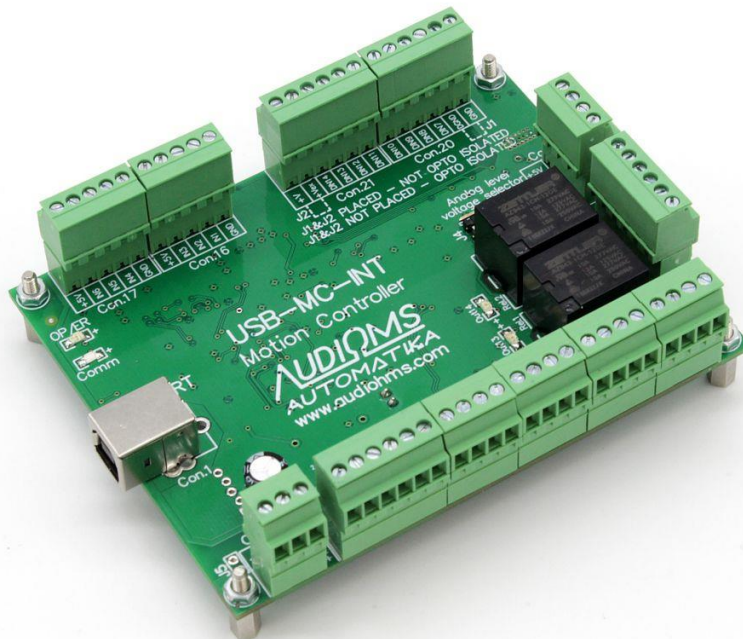
User's manual

AUDIOMS AUTOMATIKA

CONTENTS

1 Description

Con.16 and **Con.17**
General purpose TTL
digital inputs

Con.21 and **Con.22**
Opto isolated digital inputs
with 24V level voltage

LED indicators

Con.1
USB port to
computer

Con.15
Analog output 0-5V
or 0-10V Analog
input 0-5V

Con.22
Two relay outputs
220VAC/8A or
30VDC/8A

Con.2
Power supply
15-25VDC

Con.14
TTL digital
outputs

Con.10, Con.11, Con.12 and **Con.13**
STEP/DIR digital outputs to control up
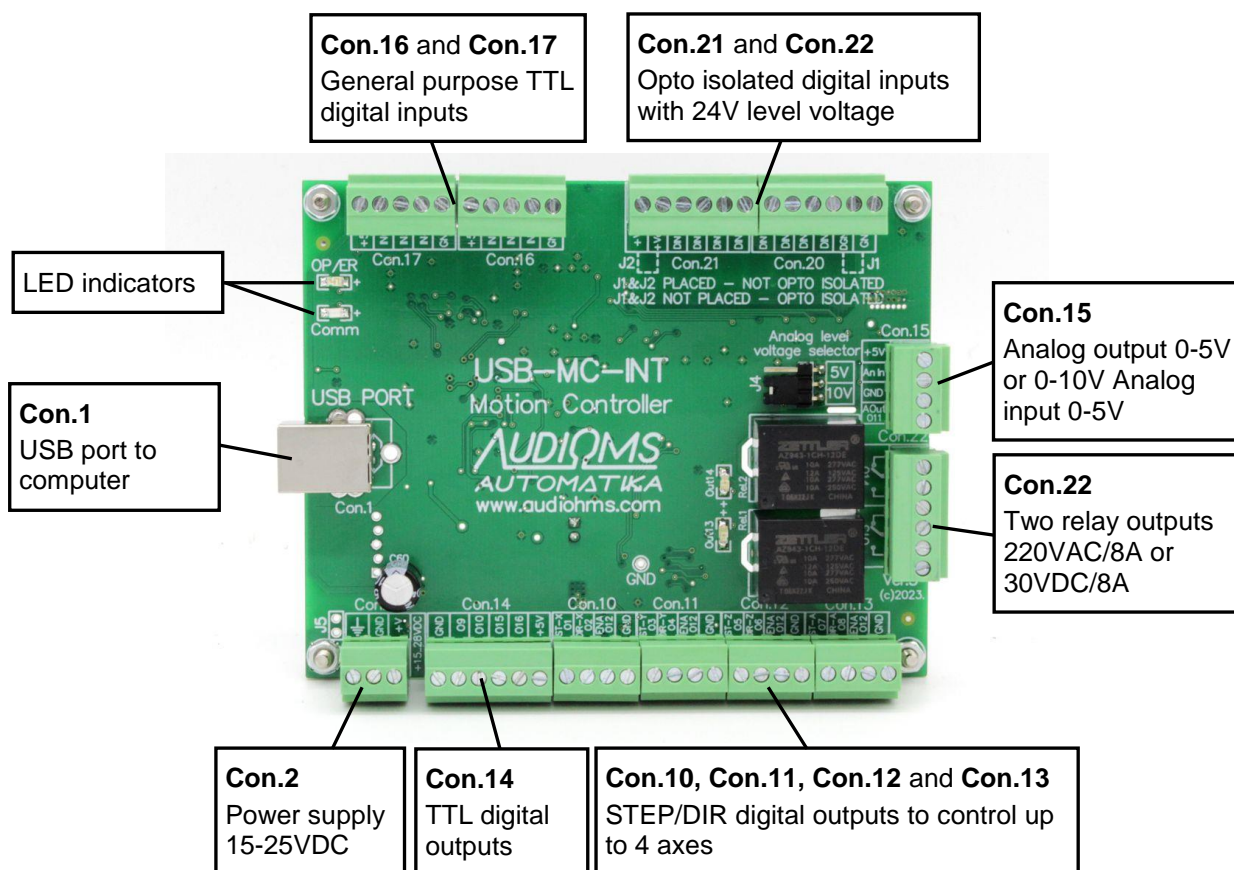to 4 axes

Figure 1.1 USB-MC-INT v.3 motion controller

USB-MC-INT v.3 is 6-axes motion controller (Figure 1.1) designed for use with the popular Mach3 CNC control software in Windows XP, Vista, 7, 8, 8.1 and 10 operating systems with 32-bit (x86) and 64-bit (x64) architectures. In order to provide reliable communication with computer, CMC filter (Common Mode Choke) has been built in on USB line, as well as TVS protection (Transient Voltage Suppressor). **The motion controller is supplied with a high-quality 1m long USB cable with two ferrite cores.**

Many years of experience in designing have enabled us to optimize the USB-MC-INT v.3 motion controller to meet all technical requirements, while being economically affordable.

USB-MC-INT motion controller could be also controlled with motion control software **mikroCNC**.

Motion controller USB-MC-INT takes over all real-time tasks that require precision timing. Thus, computer CPU is less loaded, so control software can now work on less powerful desktops, laptops, and even tablet computers. Considering that the controlling task does not need a high performance computer, the price for a complete control system can now be considerably reduced.

USB-MC-INT motion controller has:

- 16 digital outputs, two of them are relays outputs,
- 14 digital outputs, while 8 of them are opto-isolated outputs for voltage level of 24 V and 6 of them are TTL general purpose digital outputs,
- One analog output 0-5V or 0-10 V (selectable output level), and
- One analog input 0-5 V.

Maximum output frequency for step signal is 250 kHz, optionally 125 kHz.

Audioms Automatika doo	web: www.audiohms.com	Page 4 of 31
Kragujevac, Serbia	e-mail: office@audiohms.com	

USB-MC-INT v.3 Motion controller user's manual, July 2023

All inputs and outputs are available through terminal block connectors. That way it is easy to connect all peripherals on USB-MC-INT motion controller.

Mach3 plugin contains integrated latest compatible version of firmware so in case that firmware has to be updated, this process is automatic and easy for user. Since June 2019, the firmware version of motion controllers (Firmware v01.19 & Plugin v01.16) USB-MC-INT and USB-MC use the same Mach3 plugin.

NOTE: USB-MC-INT motion controller can be powered from computer USB port, but in that case some function of the motion controller won't be available. In order to use all available USB-MC-INT motion controller functions it is necessary to use external power supply 15-28 VDC / 500 mA.

1.1 Supported Mach3 functions

- all jogging modes
- spindle PWM out, adjustable frequency 10 Hz – 200 kHz
- spindle index input, adjustable divider
- spindle step/dir axis
- spindle relays (M3, M4 and M5)
- coolant relays (M7, M8 and M9)
- ESTOP input
- MPG (encoder) inputs, all Mach3 MPG modes + hardware mode
- freely assignable functions to any of inputs and outputs
- adjustable active signal state (low/high) for all inputs and outputs
- homing/referencing (single axis and multiaxis)
- hardware limit switches
- softlimits with deceleration for smooth stop
- limits override, auto/manual/external
- charge pump outputs, adjustable frequency (12.5 kHz and 5 kHz)
- slave axes
- probing function (G31)
- laser M10p1/M11p1, e5p1/e5p0 fast outputs (#1-6)
- laser PWM, power compensation (PWM duty cycle can change in relation to velocity of movement), adjustable arbitrary relation curve
- laser PWM, gate by M10/M11
- laser gray scale (8-bit) engraving
- shuttle mode, adjustable acceleration time
- detailed adjustment for debouncing of all input signals
- FRO, SRO or any DRO/Variable control using potentiometer or rotary encoder
- offline mode
- threading on lathe using Mach3turn, G32, G76
- THC function (integrated and external controller support)
- THC advanced options (kerf detect, THC lock, low pass filter...)

1.2 Not supported

- Backlash compensation

1.3 Other functions

With softlimits, slow zones are not adjustable, but the width of these zones is automatically determined so that the given criteria for maximum motor velocity and acceleration are obeyed for every axis separately.

AUDIOMS AUTOMATIKA

| Audioms Automatika doo | web: www.audiohms.com | Page 5 of 31 |
| Kragujevac, Serbia | e-mail: office@audiohms.com | |

USB-MC-INT v.3 Motion controller user's manual, July 2023

2 Technical specifications

Function	Description
Communication with PC	USB port with build-in CMC filter and TVS protection Data buffer of about 1 s for stable communication
Number of supported axes	6
Digital outputs	- 12 general purpose digital outputs - 1 PNP open collector output (for Enable line) - 1 digital output reserved for analog signal generation
Maximum current on general purpose digital outputs	32 mA
Relay outputs	2 NO relay outputs with capacity 250 VAC / 8 A max. or 30 VDC / 8A max
Digital inputs	- 8 opto-isolated inputs for 24V signal levels - 6 Schmitt trigger general purpose digital inputs for TTL levels and with 4.7 kΩ pull-up resistors
Maximum STEP signal frequency	250 kHz (optional 125 kHz)
STEP pulse width	2 µs (optional 4 µs)
PWM output frequency	10 Hz – 200 kHz *
PWM duty cycle resolution	16-9 bits, depending on frequency; 16 bit for f ≤ 2kHz
Frequency of signal on Index input	≤ 10 kHz
Pulse width on Index input	≥ 100 ns
MPG/enkoder input (x4) frequency	≤ 10k steps/sec
Number of analog outputs	1
Analog output range	0–5 V or 0–10 V
Number of analog inputs	1
Analog input range	0–5 V
Number of charge pump outputs	2
Charge pump frequency	12.5 kHz or 5 kHz
Power supply	15–28 VDC / 250 mA minimum
Dimensions	120 mm x 92 mm x 34 mm
Weight	~ 125 g

NOTE: Shown specifications are subject to change without prior notice

* PWM output signal can be assigned to the output pins 1-14 (O1-O14)

3 INSTALLATION

3.1 Driver installation

Connect the USB-MC-INT motion controller to a free USB port on personal computer. In most cases, if Windows 7 or newer operating system is used, Windows will automatically find and install required drivers so that manual installation should not be needed. Otherwise, if Windows does not find drivers for motion controller, it will ask for location on local computer to read it from. Drivers can be downloaded from www.audiohms.com site.

Note: USB-MC-INT motion controller does not require Mach3 LPT driver to be installed nor does it use this driver.

3.2 Plugin installation

Mach3 plugin contains integrated the latest compatible version of firmware so in case that firmware has to be updated, this process is automatic and easy for user. Plugin can be downloaded from www.audiohms.com.

Note: Since June 2019, the firmware version of motion controllers (Firmware v01.19 & Plugin v01.16) USB-MC-INT and USB-MC use the same Mach3 plugin.

To install USB-MC-INT Mach3 plugin, copy supplied file **usbmc_drv.dll** to Mach3 plugins folder (usually "**c:\mach3\plugins**"). Then, start Mach3 and new plugin should be detected (Figure 3.1). Now choose **USB-MC-plugin** in displayed list of options. Also, optionally turn on option **Dont ask me this again** so that this choice is remembered and not displayed again on next Mach3 startup.

In case that this dialog for plugin selection is not shown, it is possible to initiate it using menu option **Function Cfg's\Reset Device Sel…**
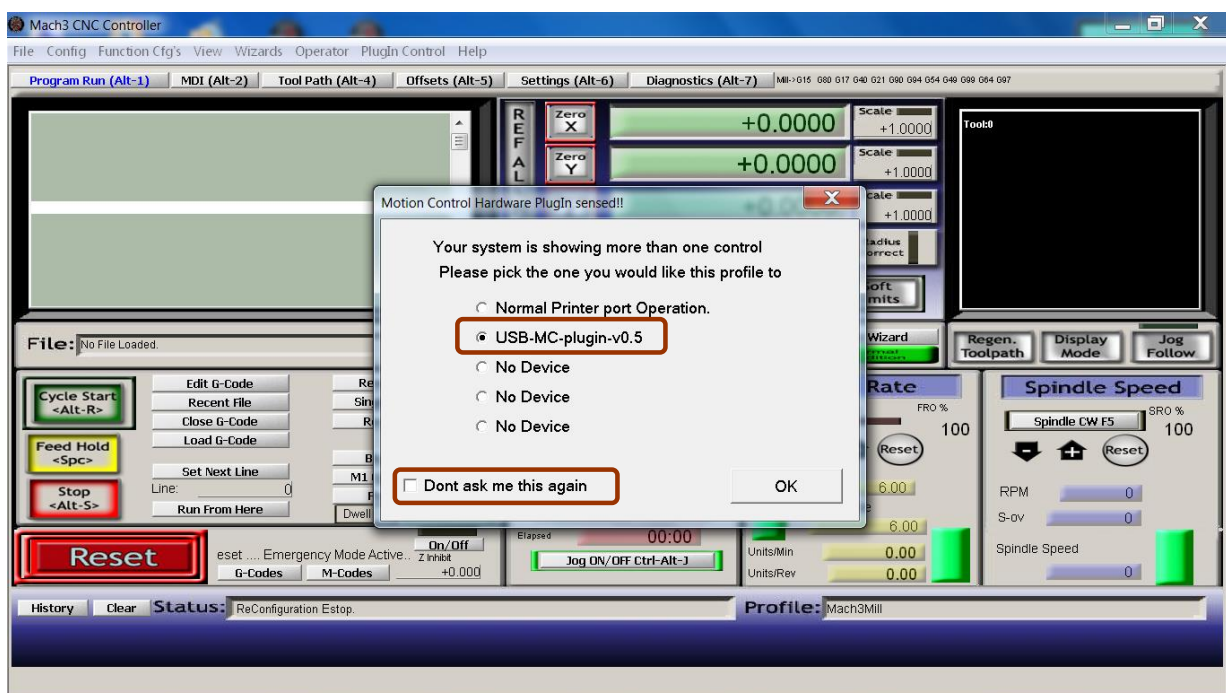

Figure 3.1 Plugin selection

Figure 3.2

On power-up, controller is in safe mode, that is, all outputs are in high impedance state (unconnected). Mode indicator LED on controller board is blinking slowly.

After clicking **RESET** button in Mach3, connection with controller is established and status like shown on (Figure 3.2) is reported. Controller then enters normal operation mode, LED indicator on board stops blinking and glows continuously.

If USB connection is lost for any reason, controller instantly enters safe mode. Then it is needed to investigate and eliminate cause of error and click **RESET** button to establish communication again.

Also, controller enters safe mode on all configuration changes and also on exiting Mach3 application.

	Audioms Automatika doo	web: www.audiohms.com	Page 7 of 31
AUDIOMS AUTOMATIKA	Kragujevac, Serbia	e-mail: office@audiohms.com	

USB-MC-INT v.3 Motion controller user's manual, July 2023

3.3 Automatic firmware update

USB-MC-INT motion controller plugin also contains feqiured firmware for the controller. Thus, upon establishing connection, if it is determined that firmware update is required, message like on Figure 3.3 will be shown. It is necessary to click **Yes** and wait for the process to be completed (Figure 3.4). Finally, result like on Figure 3.5 should be presented.

Current versions of plugin and firmware can be found on **About** window of USB-MC configuration dialog.
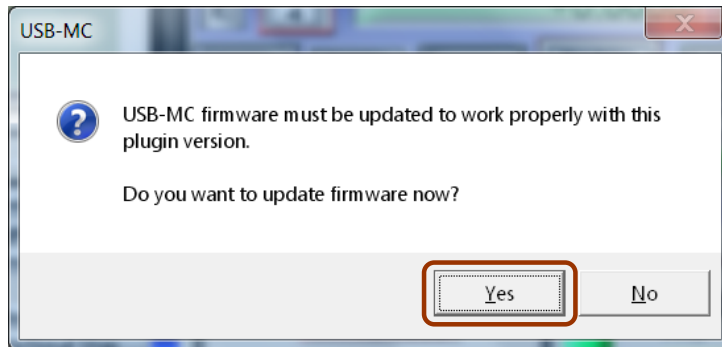
Figure 3.3
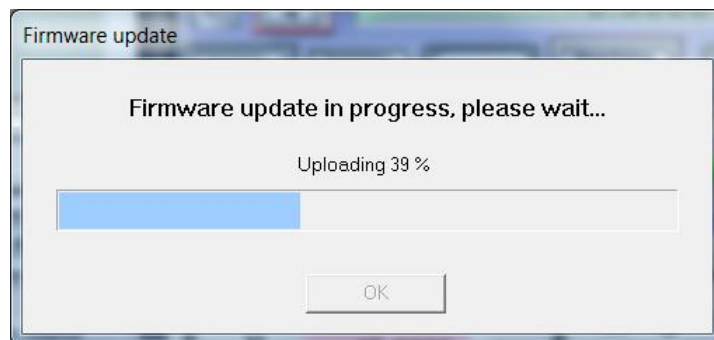
Figure 3.4
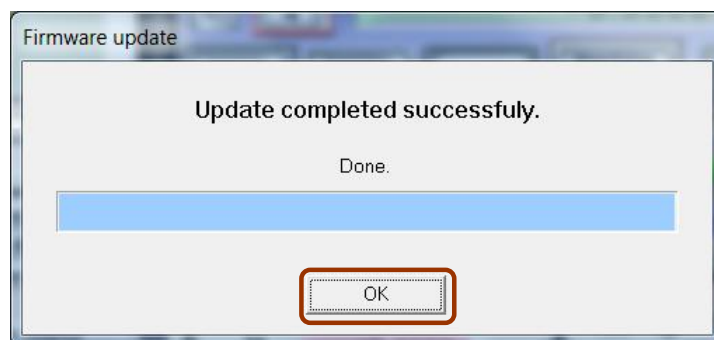
Figure 3.5

4 Configuration

Most of configuration is done using existing dialogs for adjustments in Mach3 application, like **Ports and pins**, **General config** etc. just like when LPT driver is used. Some additional options, which are offered by USB-MC-INT motion controller, can be adjusted via dialog box that is opened using menu option **Plugin Control/USB-MC Config…** The status window that can be opened via **Plugin Control/USB-MC Status…**

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 8 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

4.1 Adjusting ports and pins in the Ports & pins window

USB-MC-INT motion controller provides one digital input port with 14 pins and one digital output port with 16 pins. These pins can be remapped as desired, that is, can be assigned different functions that are needed for specific application (Figure 4.1).

Figure 4.1 Ports and pins configuration

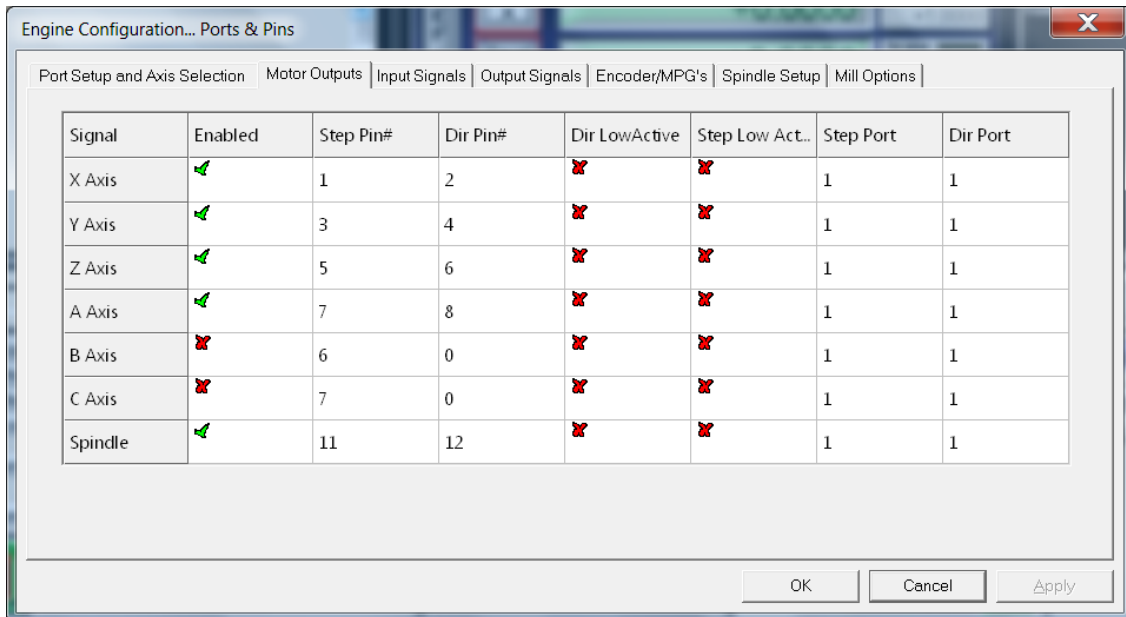When using configuration dialogs like **Motor Outputs**, **Input Signals**, **Output Signals** etc. number 1 is always used for port number. Available pins on input port are numerated from 1 to 14. Similarly, output port pins are numerated from 1 to 16. USB-MC-INT motion controller will ignore any port number different from 1 and any pin number that is out of available range.

5 USB-MC-INT configuration dialog

USB-MC-INT motion controller uses the same configuration dialog as USB-MC motion controller. This dialog can be opened using menu option **Plugin Control/USB-MC Config…** (Figure 5.1).

5.1 General setup tab (Figure 5.1)

5.1.1 Spindle/laser PWM frequency

The frequency of PWM output signal that is used for spindle rpm control or for laser power control, can be adjusted in range 10 Hz – 200000 Hz (Figure 5.1). Output pin for this purpose is selected via **Spindle axis** line in **Motor Outputs** window (Figure 4.1). Only adjustments for **Step** signal are used (**pin/low act/port),** and **Dir** field is not used for PWM output.

IMPORTANT NOTE: Only output pins 1-14 can be used for PWM output (and not pins 15 and 16).

Also, in **Ports&pins/Spindle setup** window, in **Motor control** group, options **Use spindle motor** and **PWM control** should be turned on**. PWMBase Freq** in the same group, is not used.

AUDIOMS AUTOMATIKA

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 9 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

5.1.2 Home retract speed

This is the speed of retraction from a home switch given as a percentage of homing speed (Figure 5.1). In first phase of homing (referencing) operation for an axis, movement toward home switch is performed until the switch is activated. Then, movement is performed in the opposite direction (retracting) until the switch deactivates and that position is used as a reference. Home retract speed should be low enough so that good referencing precision is achieved.
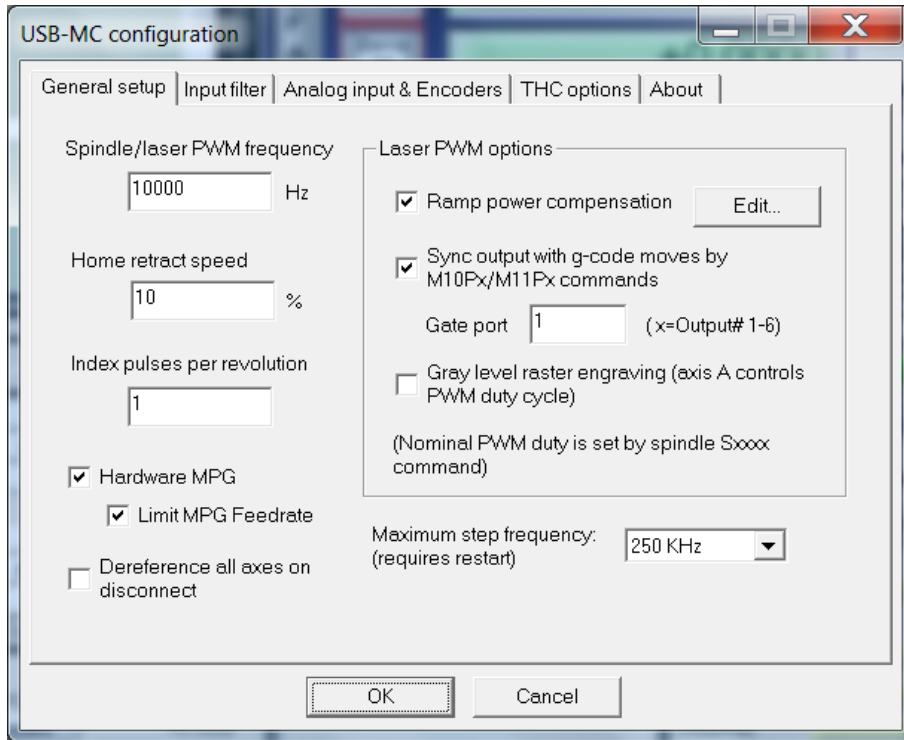

Figure 5.1 General setup

5.1.3 Index pulses per revolution

Index input is used for detection of spindle rotational speed. It is common to use one pulse per revolution, but more than one can also be used (Figure 5.1).

5.1.4 Dereference all axes on disconnect

This option should be turned on if it is desired to dereference all axes in case of an error or a break of connection with the controller (Figure 5.1).

5.1.5 Maximum step frequency

Enables setting the maximum frequency of the generated step signals (Figure 5.1). Lower speed (125 kHz, 4μs pulse width) is used in case when drivers/controllers that are being controlled are not fast enough for impulse width of 2 μs that is required when using full speed (250 kHz).
After changing this parameter it is necessary to restart Mach3 for the new setting to take effect. Also, after the restart, it is needed to check in **MotorTuning** screen whether the speed for any axis is set to a value greater than the current maximum frequency permits and correct settings if needed.

5.1.6 Hardware MPG

If this option is turned on (Figure 5.1) USB-MC-INT motion controller will use hardware MPG mode, that is, reading MPG inputs and generation of STEP/DIR output signals is done completely in hardware without

AUDIOMS AUTOMATIKA | Audioms Automatika doo
Kragujevac, Serbia | web: www.audiohms.com
e-mail: office@audiohms.com | Page 10 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

need for communication with PC. This enables very fast response (low latency) and at the same time precise motor control. Configured motor parameters (maximum velocity, acceleration) are obeyed.

If this option is turned off, standard Mach3 modes are used for MPG operation. These options can be shown by pressing TAB key in Mach3. In this case USB-MC-INT motion controller reads MPG input, sends current position to Mach3, and Mach3 then, according to the selected MPG mode (Velocity only, Multi-Step...), generates appropriate commands for movements. These commands are then sent to USB-MC-INT motion controller and executed.

In hardware mode just like in standard mode, **CycleJogStep** is used for setting movement step, and also the majority of settings (MPG axis, detent...) are the same.

5.1.6.1 Limit MPG federate

If this option is turned on (Figure 5.1), speed limit given with parameter **MPG Feedrate** is obeyed in hardware MPG mode. This parameter is located on MPG/Jog window (Figure 6.1).

5.1.7 Laser PWM options

5.1.7.1 Ramp power compensation

Laser power compensation (Figure 5.1) is used to overcome typical problem during laser engraving, and that is that depth/intensity of engraving depends on movement speed of the laser head. This is particularly visible at the start and at the end of one engraving segment, where laser head slows down and stops, so unwanted black dots appear. To eliminate this phenomenon, laser power can be controlled using PWM so that PWM duty cycle is directly dependent on velocity of the laser head. Thus, for example, if velocity is zero, PWM duty cycle will also be zero. As velocity increases, the duty cycle that controls the laser power is also increased. It is possible to configure an arbitrary relation curve.

5.1.7.2 Sync output with g-code moves, M10px, M11px

This option (Figure 5.1) enables that fast commands M10px and M11px, in addition to their primary function of setting state on output x (Output#1-6), at the same time can turn on/off PWM output. **Gate port** determines which output x controls PWM output in this way. So, for example, if command M11p3 is given and **gate port**=3, PWM output will be turned on.

Laser engraving requires much faster turn on/off of laser then it is possible to achieve using spindle commands (M3, M4, and M5). By using M10/M11 commands, laser turn on/off is also ideally synchronized with g-code execution. This is done in the following way: when, for example, command M11p1 (turn on output 1) is executed in g-code program, initially nothing happens, but this "turn on output x" command is remembered as armed for execution. When next command for positioning (like G01 probably at the very next program line) is executed, then at the same moment when commanded movement begins, the given output is also activated. The same logic applies for M11px (turn of output) command.

5.1.7.3 Gray level raster engraving

This option is used for laser engraving of raster images and 8-bit pallet is supported (256 shades of gray) (Figure 5.1). When this option is turned on A axis is used to control laser power i.e. given "movement" of A axis is directly translated to duty cycle of PWM output.

G-code should be generated from a bitmap image using one of the programs for that purpose. More details about this option and required settings in Mach3 for raster image engraving can be found in the separate document (USB motion controller laser raster engraving).

| AUDIΩMS AUTOMATIKA | Audioms Automatika doo
Kragujevac, Serbia | web: www.audiohms.com
e-mail: office@audiohms.com | Page 11 of 31 |

USB-MC-INT v.3 Motion controller user's manual, July 2023

5.2 Input Filter tab

Digital filtering (debouncing) is available for all inputs. **Input filter** window enables detailed debouncing adjustments (Figure 5.2). Debouncing time is specified in increments of 100 µS. For example, if value 30 is given, that means that 3ms of stable state is needed on input for state to change from active to inactive or vice versa. If debounce time of 0 is given for an input, debouncing is turned off for that input. This is recommended in case we want maximum reading speed and we are sure that signal is clean (e.g. optical encoder). Debounce time can be adjusted for group of pins by function or for every pin separately (Figure 5.2).
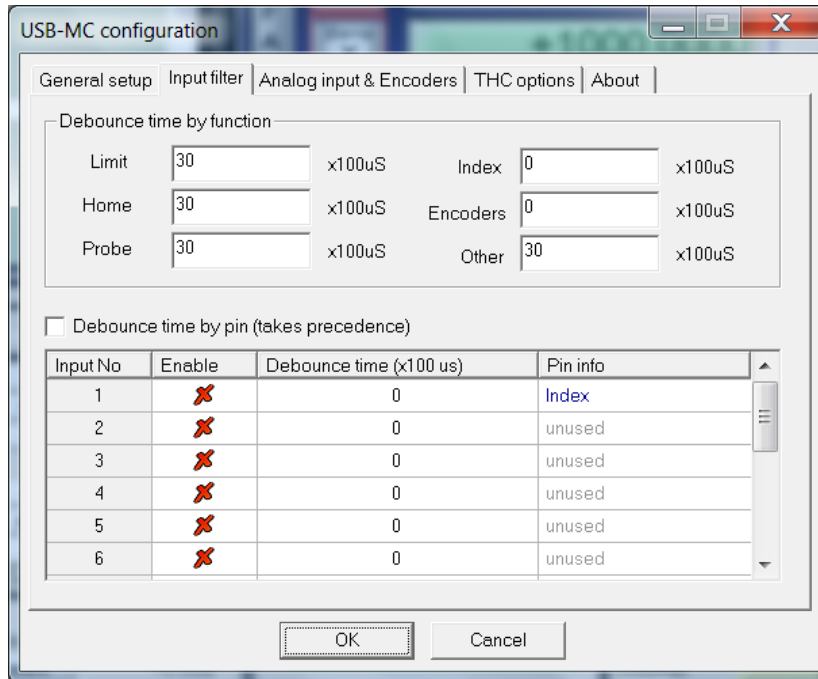

Figure 5.2 Input filter

5.3 Analog input & Encoders tab

USB-MC-INT motion controller offers one analog input, and in addition, enables simultaneous reading of two incremental encoders. Their functionality can be adjusted using this dialog (Figure 5.3).

5.3.1 Special function group

In the field on the left, available input signal sources are shown and in parentheses assigned function (if there is one). For the selected signal source, on the right side are shown parameters that can be adjusted.

For **Special function**, available options are:
- **None** – signal is not used for any special function,
- **FRO 0–250%** - feedrate override control,
- **SRO 0–250%** - spindle rate override control,
- **Set user variable** – read value is put in Mach3 internal variable so that it can be used, for example, from macro script or similar. **ID** represents identifier (address) of the variable. Type of output can be chosen to be 16-bit value (0–65535) or percentage (0-100%). Values of these variables can be monitored using Mach3 function **Operator/Geode Vary Monitor**
- **Set user DROP** – similar to previous option, only in this case **ID** represents DROP field indicator.

When encoder is used, step increment for a variable is adjusted by setting detent value for the encoder used (see description in further text).

AUDIOMS AUTOMATIKA	Audioms Automatika doo	web: www.audiohms.com	Page 12 of 31
	Kragujevac, Serbia	e-mail: office@audiohms.com	

USB-MC-INT v.3 Motion controller user's manual, July 2023

5.3.2 Zero threshold voltage

Voltage threshold adjustment for analog input, given in mV. Read value that is less than or equal to this is considered to be zero (Figure 5.3).
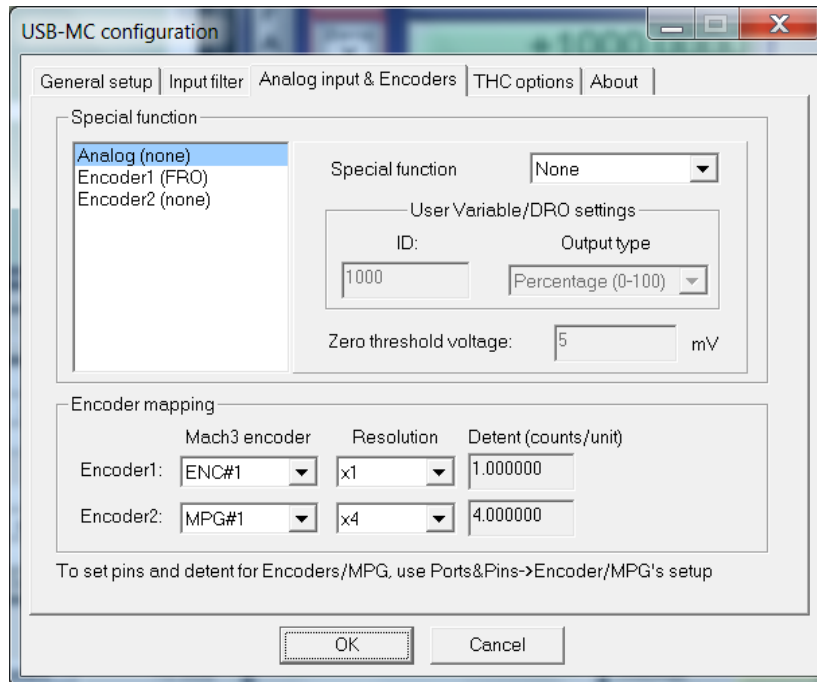

Figure 5.3 Analog input & encoders

5.3.3 Encoder mapping

USB-MC-INT motion controller supports simultaneous reading of two incremental encoders, including one from MPG device (Figure 5.3). Since Mach3 offers adjustments for total of seven encoder inputs, it is needed to map these two encoders to desired positions.

5.3.3.1 Encoder/MPG resolution

It is used to adjust incremental encoder resolution (Figure 5.3). Available options are x1 and x4. Option x4 gives the best resolution and is appropriate e.g. for optical encoders. Option x1 gives basic encoder resolution, that is, one increment for one full cycle of state change on A and B lines. This option is appropriate for e.g. little mechanical, rotational encoders, for which we want for one detent to correspond to position change of 1 and not 4. Also, with mechanical encoders, there is possible effect of contacts bouncing which induces errors in position reading thus it is needed to set debouncing for encoder to an optimal value. The algorithm that is used for x1 reading option is fairly resistant to these problems so it is possible to set debouncing to zero when this option is used.

5.3.3.2 Detent (counts/unit)

Detent is number of pulses (increments) from encoder/MPG for one full movement step in Mach3. For MPG, this step is defined on MPG/Jog screen (Figure 6.1).

Detent value is, for better clarity, shown on this dialog, but can be adjusted via Mach3 window **Config/Ports&Pins/Encoders/Mpg's** together with input ports and pins for encoders.

Detent does not have to be a whole number, and also can be negative if it is needed to change direction of rotation.

Usually MPG is set to have detent value of 4 if encoder resolution x4 is chosen.

5.3.4 THC options tab

THC (torch height control) function is used with plasma cutters for continuous regulation of plasma head vertical position above the material. In addition to support for external regulators, USB-MC-INT motion controller also contains internal THC regulator that is possible to utilize by connecting appropriate voltage sensor to the analog input of the USB-MC-INT motion controller.

More details about THC operation and Mach3 adjustments related to this mode can be found in the separate document (THC operation with Audioms Automatika doo USB motion controllers).

6 Shuttle mode

Figure 6.1

It is possible to use MPG also for Mach3 shuttle mode, that is, fine real-time control of execution speed of G-Code program (Figure 6.1).

This function is performed completely in hardware and in this mode speed of turning MPG directly affects G-Code program execution speed.

Shuttle mode button can also be used as fast FeedHold, even if MPG is not connected or configured in the system. In this case, if shuttle mode is activated during G-code execution, movement on all axes slows down to complete stop.

By deactivating shuttle mode, movement on all axes is accelerated to reach the normal speed. This acceleration/deceleration can be adjusted using field **Shuttle Accel.** which can be found on Mach3 **General Config** dialog.

7 Status window

Status window (Figure 7.1) displays current state of all input and output pins on USB-MC-INT motion controller. Also, on the left side, current position of all 6 axes is shown, and on the right side, various status information for the controller.

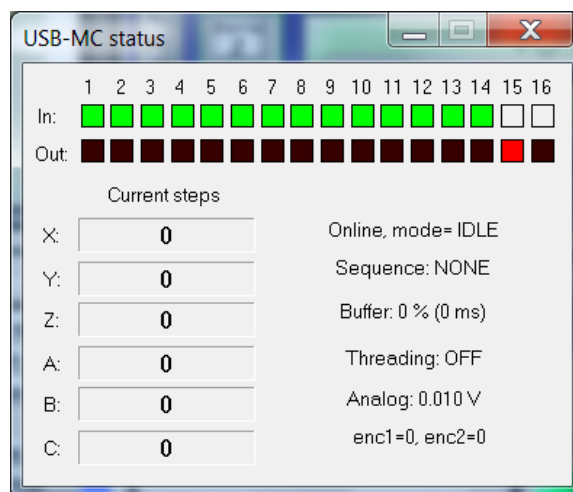This window is floating above other windows and does not prevent normal usage of Mach3 controls.

Figure 7.1 USB-MC-INT status window

8 Connecting USB-MC-INT motion controller into CNC system

The following is a description of wiring USB-MC-INT motion controller into CNC control system.

8.1 Connection with computer and power supply for the USB-MC-INT motion controller

For powering USB-MC-INT motion controller it is required to provide external power supply 15-28 VDC / 500 mA (Figure 8.1).
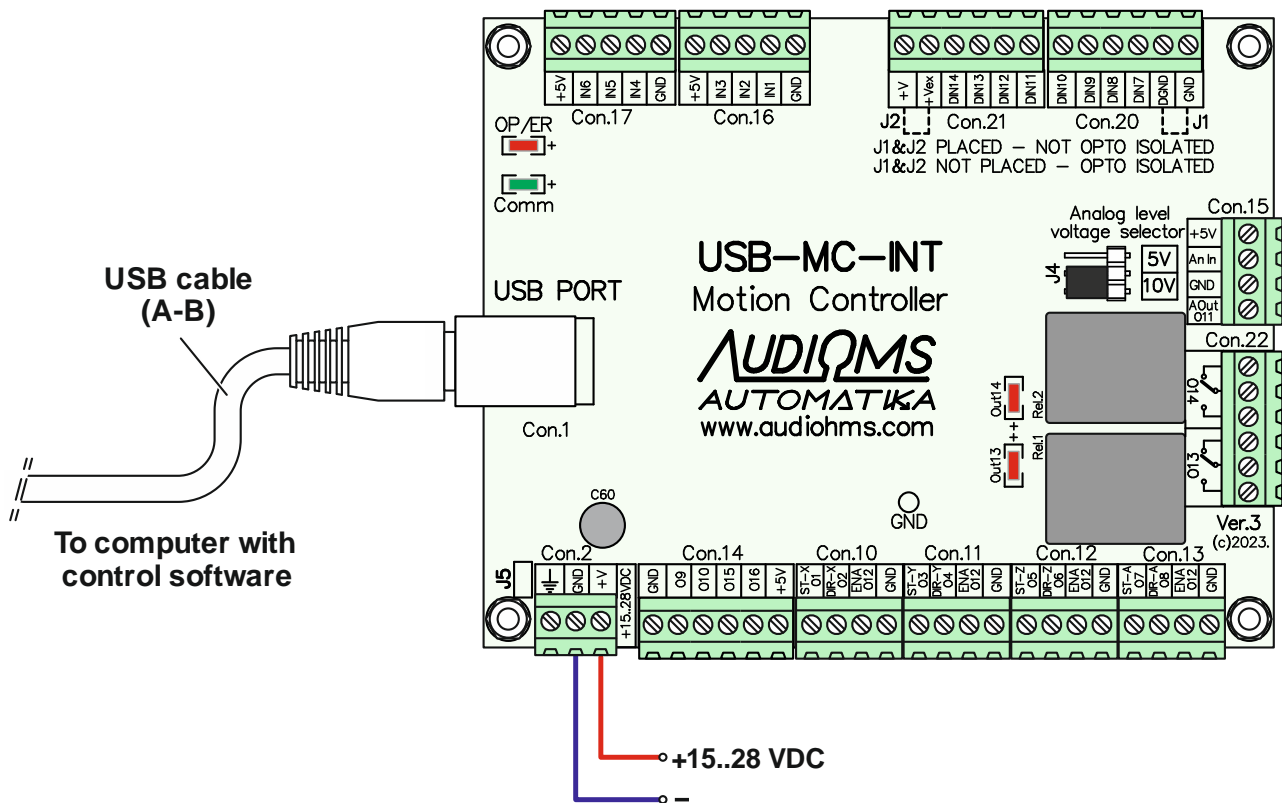

Figure 8.1 Connection with computer and connecting power supply to USB-MC-INT motion controller

For connecting USB-MC-INT motion controller to a computer type A-B USB cable is used (Figure 8.1). The motion controller is supplied with a high-quality 1m long USB cable with two ferrite cores.

If necessary, it is possible to use other USB cables. In that case, use quality USB cables, preferably no longer than 2 m. It is recommended to use a USB cable with ferrite cores (Figure 8.2).

Figure 8.2 Type A-B USB cable with ferrite cores

| | Audioms Automatika doo | web: www.audiohms.com | Page 15 of 31 |
| | Kragujevac, Serbia | e-mail: office@audiohms.com | |

USB-MC-INT v.3 Motion controller user's manual, July 2023

8.2 Connecting stepper motor drives to USB-MC-INT motion controller

USB-MC-INT motion controller can accept connection of up to 6 step motor drives. Figure 8.3 shows recommended wiring principle for STEP/DIR/ENABLE command lines to four microstep stepper motor drivers MST-107 or MST-109.

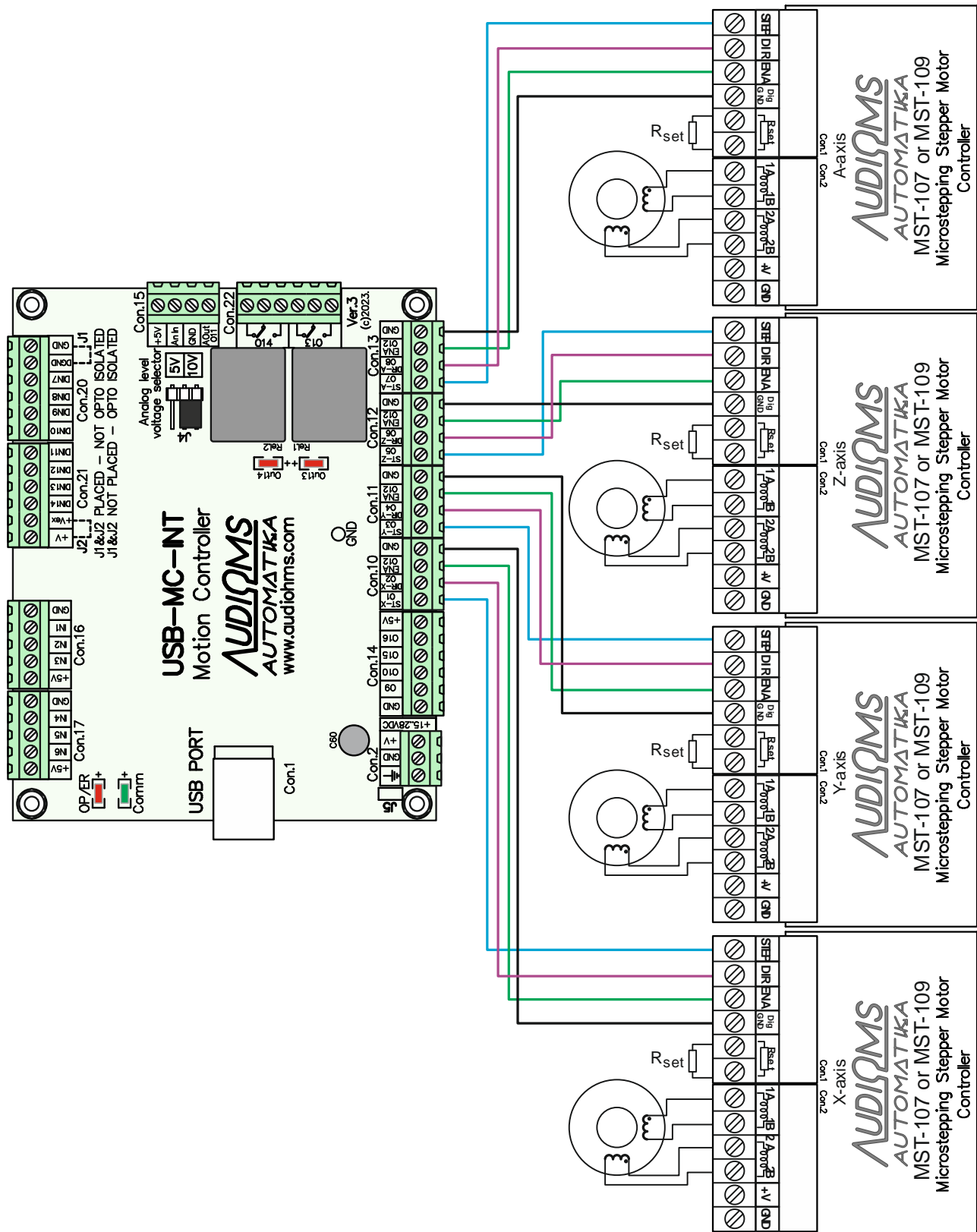Figure 8.3 Connecting 4 microstep drivers MST-107 or MST-109 to USB-MC-INT motion controller

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 16 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

Optionally, USB-MC-INT motion controller can accept two additional axes, that is, two more microstep motor drives MST-107 or MST-109 (Figure 8.4).
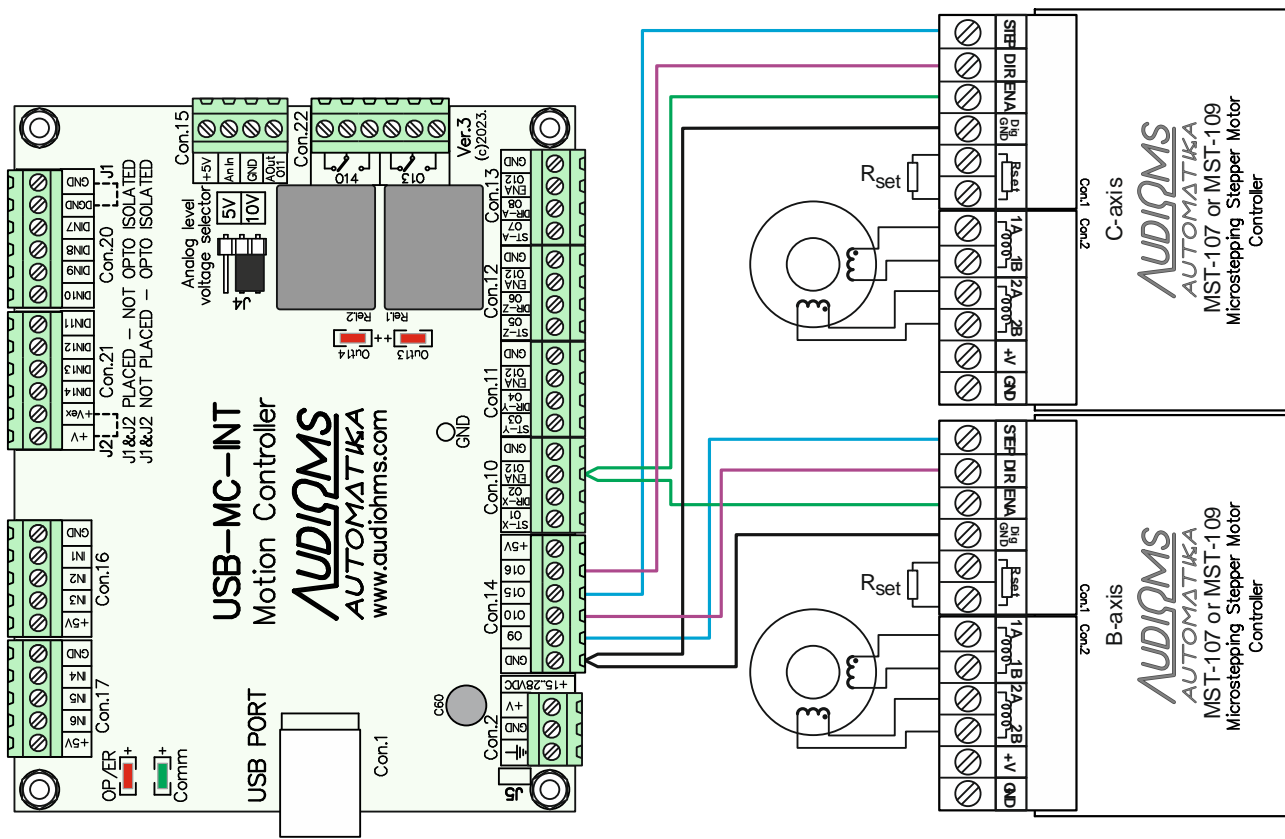

Figure 8.4 Optional connection of fifth and sixth axis

Common Enable output is available on connectors Con.10, Con.11, Con.12 and Con.13 and is labeled ENA O12. Enable output is realized using PNP transistor wired in open collector configuration and is activated by output O12. Maximum current for Enable output is 150 mA.

Table 8.1 gives list of recommended outputs for generation of STEP and DIR signals for controlling up to 6 axes. Output O12 is reserved for Enable signal.

Table 8.1 List of recommended outputs for controlling 6 axis

Axis	STEP (Output)	DIR (Output)	ENA (Output)
X	O1	O2	O12
Y	O3	O4	
Z	O5	O6	
A	O7	O8	
B	O9	O10	
C	O15	O16	

For powering USB-MC-INT motion controller and up to 4 microstep drivers MST-107 or MST-109 it is recommended to use power supply module with integrated motor break PSB-1 (Figure 8.5). More details about power supply module PSB-1 and wiring instructions can be found in the manual for this module.

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 17 of 31

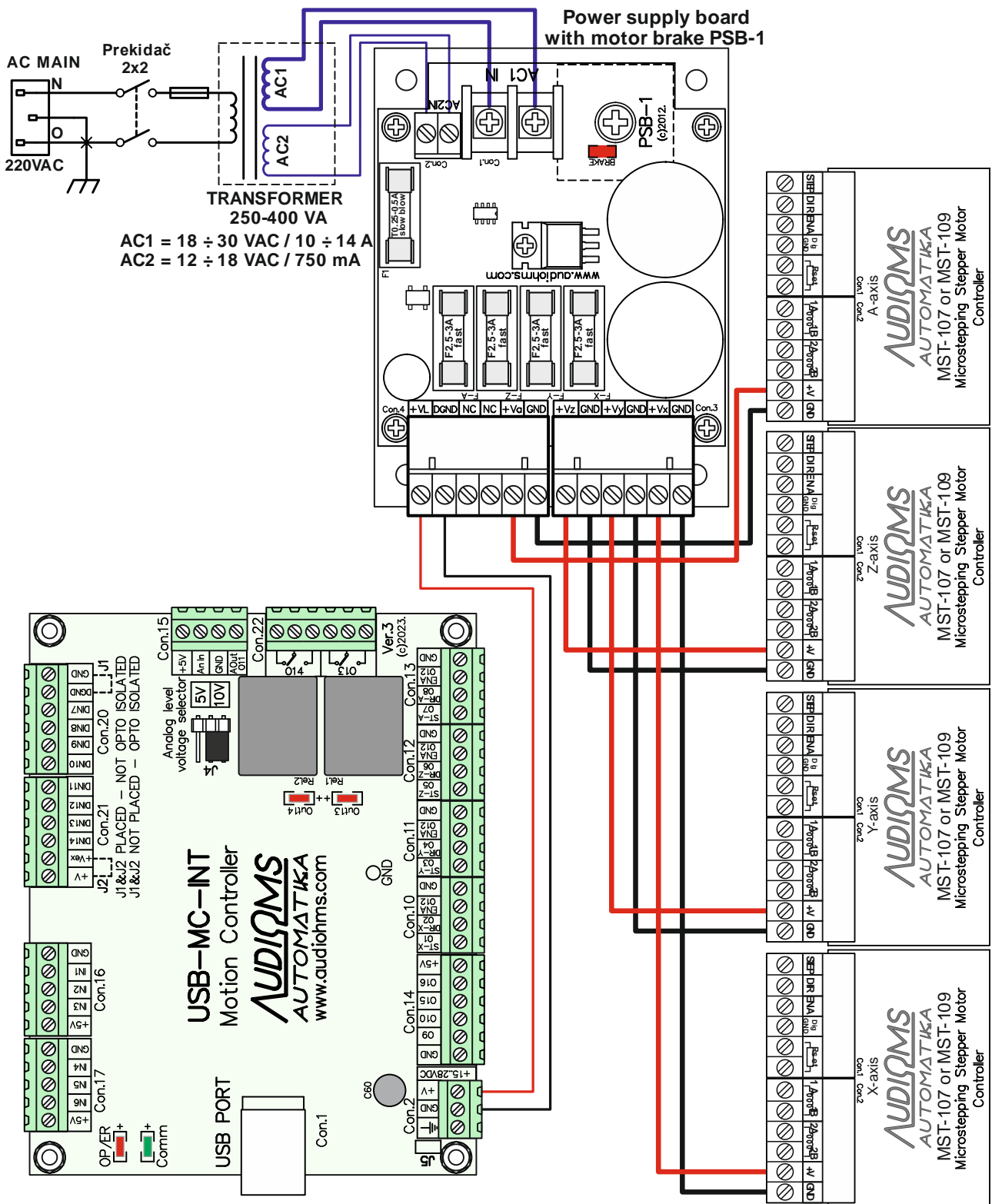USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.5

User can also provide his own power supply. In that case Figure 8.6 shows recommended scheme for connecting power supply for USB-MC-INT motion controller and up to 4 drivers MST-107. Power supply must provide two independent sources, one for powering USB-MC-INT controller (15–24 VDC / 350 – 500 mA) and the other for powering drivers MST-107 (20-40 VDC, current for this power source depends on stepper motors used – review manual for microstep driver MST-107).

On each +V power supply line, for each driver MST-107, it is recommended to use fast melting fuses that protect drivers in case of overload situation.
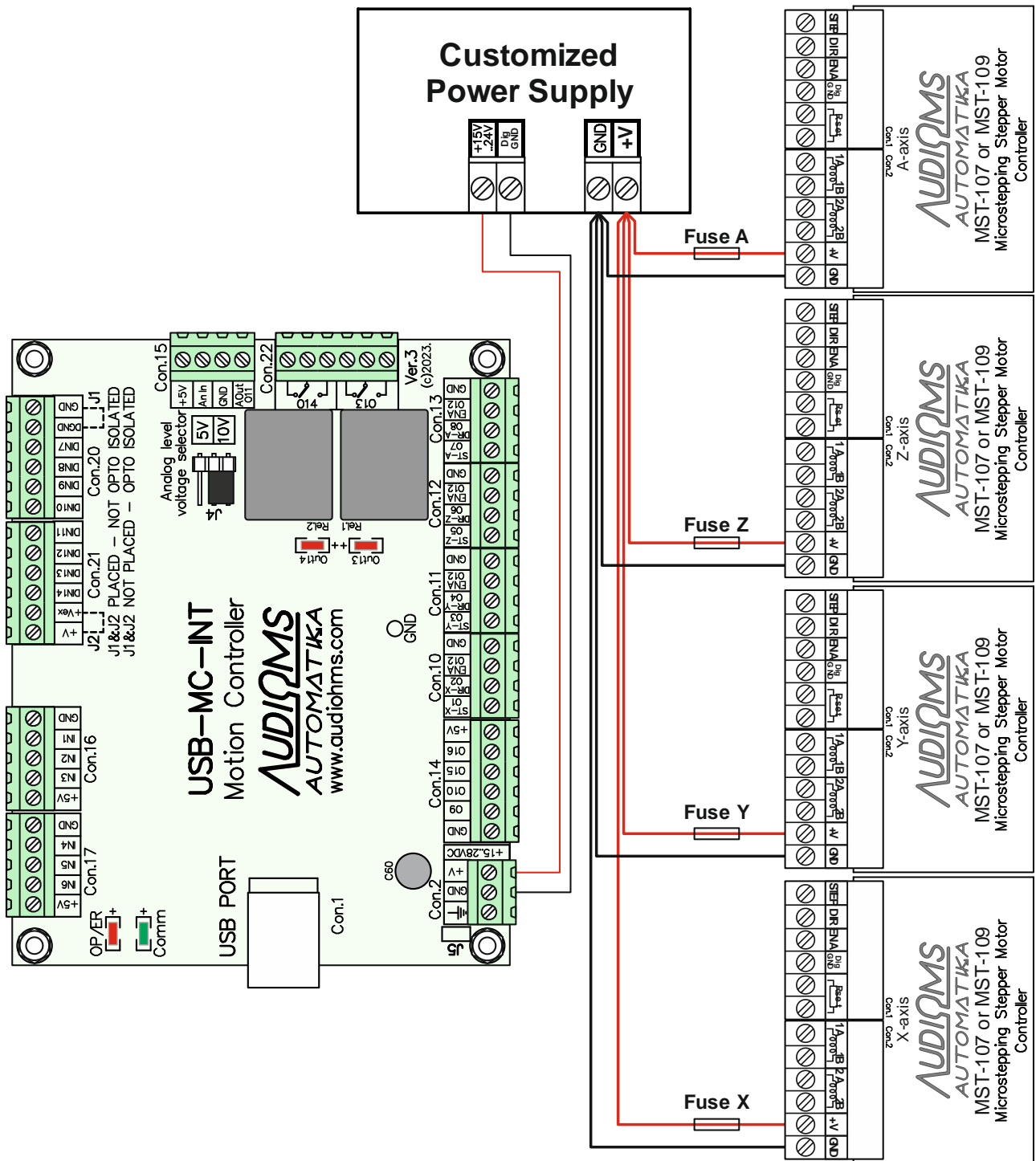
| Audioms Automatika doo | web: www.audiohms.com | Page 18 of 31 |
| Kragujevac, Serbia | e-mail: office@audiohms.com | |

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.6

8.3 Connecting drives from other manufacturers to USB-MC-INT motion controller

Figure 8.7 shows recommended wiring scheme for connecting 4 drives from other manufacturers to USB-MC-INT motion controller. Used digital outputs on USB-MC-INT motion controllers are of TTL type. Drives from other manufacturers, regardless whether they are intended for stepper, DC servo or AC servo motors, usually have same or very similar input interface.
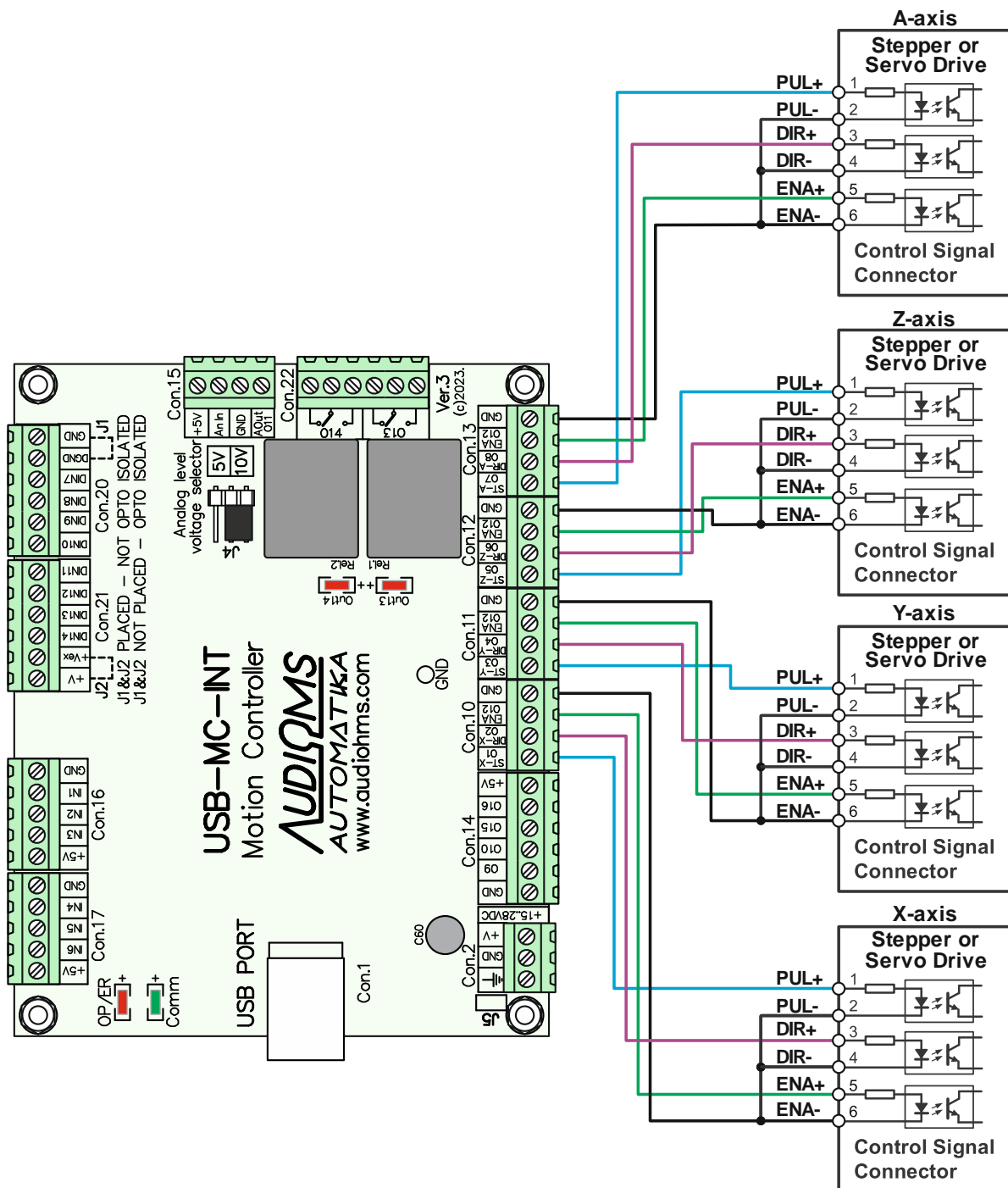
	Audioms Automatika doo	web: www.audiohms.com	Page 19 of 31
	Kragujevac, Serbia	e-mail: office@audiohms.com	

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.7

Possible problems when connecting drivers from other manufacturers and suggested solutions.

- Drivers from other manufacturers often have pretty strong filters on PUL (STEP) and DIR lines. In the case of maximum frequency (250 kHz, while the signal width is 2 μs) of STEP signal on the USB-MC-INT motion controller the driver may skip steps or even not detect them at all. When that happens, the maximum frequency should be lowered to 125 kHz (4 μs signal width) in the plugin of USB-MC-INT motion controller (Figure 5.1 General setup). **After changing the parameters the control software must be restarted in order for the setting to be activated.**
- Check whether the driver from other manufacturers requires falling or rising edge of the STEP signal. If needed, activate or deactivate the option "**Step low active**" in the control software.
- Some drivers from other manufacturers have inverted ENABLE pin logic. USB-MC-INT motion controller can't support this and in that case **don't connect** ENA+ and ENA- lines (Figure 8.8). That way the driver will always be active.

| AUDIOMS AUTOMATIKA | Audioms Automatika doo
Kragujevac, Serbia | web: www.audiohms.com
e-mail: office@audiohms.com | Page 20 of 31 |

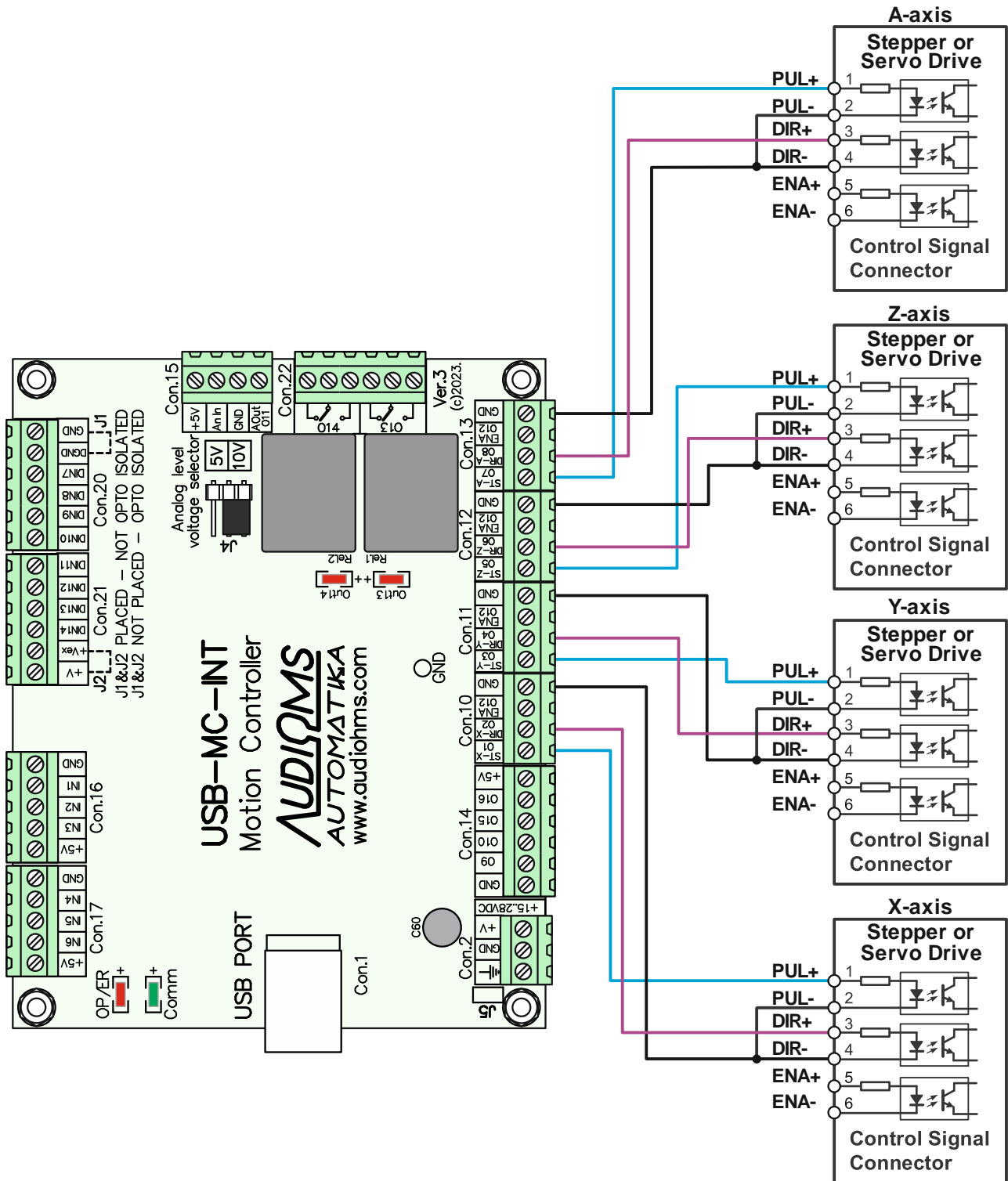USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.8 Connecting drivers from other manufacturers in the case of inverted logic on ENABLE input

Optionally, it is possible to connect additional two axes i.e. additional two drives from other manufacturers to the USB-MC-INT motion controller (Figure 8.9).
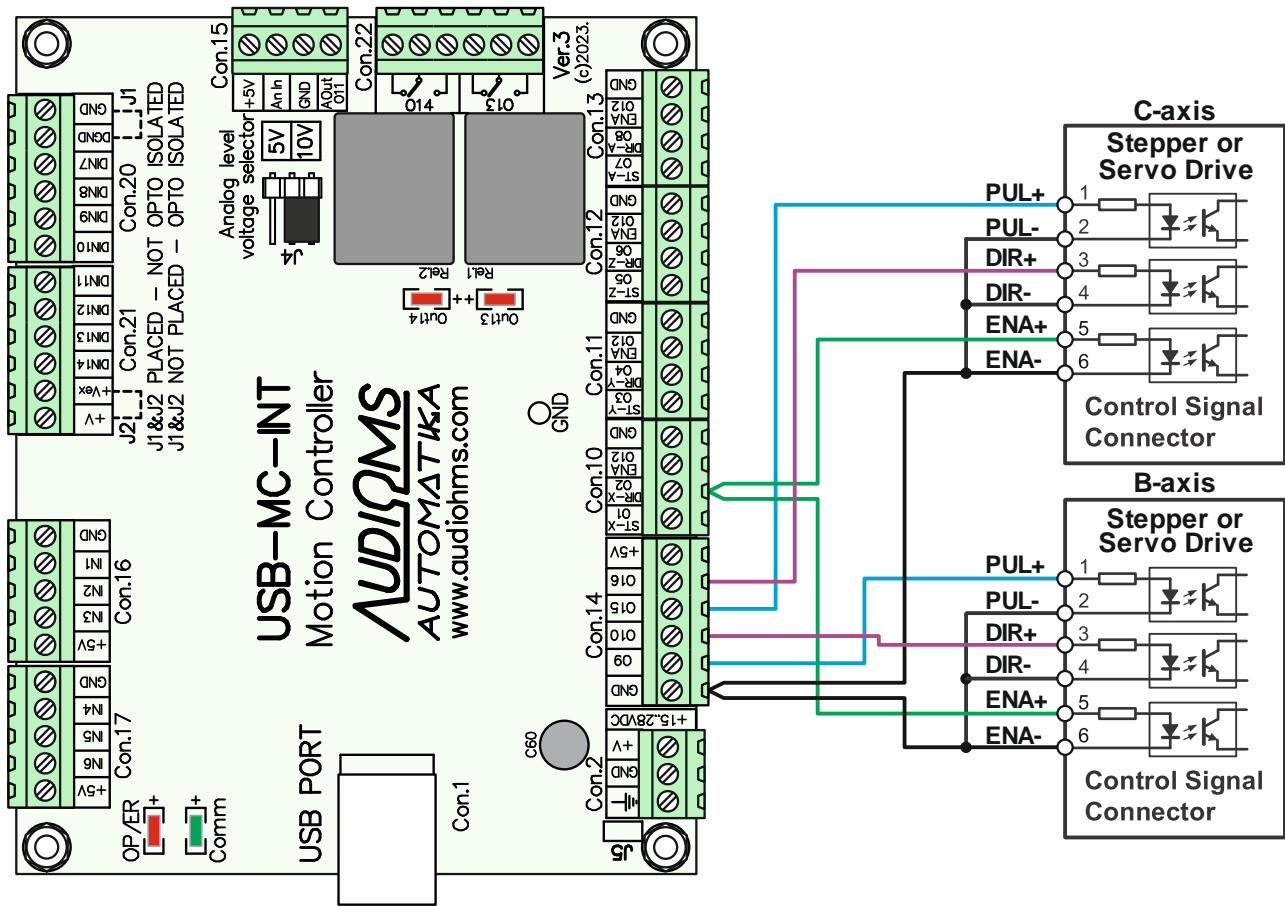
Figure 8.9

Table 8.1 gives list of recommended outputs for generation of STEP and DIR signals for controlling up to 6 axes. Output O12 is reserved for Enable signal.

8.4 Connecting relays outputs

USB-MC-INT motion controller has integrated two relays with SPDT type contacts. Capacity for each relay is 250 VAC / 8 A max or 30 VDC / 8A max.

Figure 8.10 shows possible wiring scheme of relay outputs on USB-MC-INT motion controller. For currents that exceed 3A it is recommended to use external relays with higher nominal current or contactors and in that case these can be activated by relays on USB-MC-INT motion controller.

For activation of relay outputs digital outputs O13 and O14 are used and on USB-MC-INT motion controller there are indicators that show state of relay outputs.
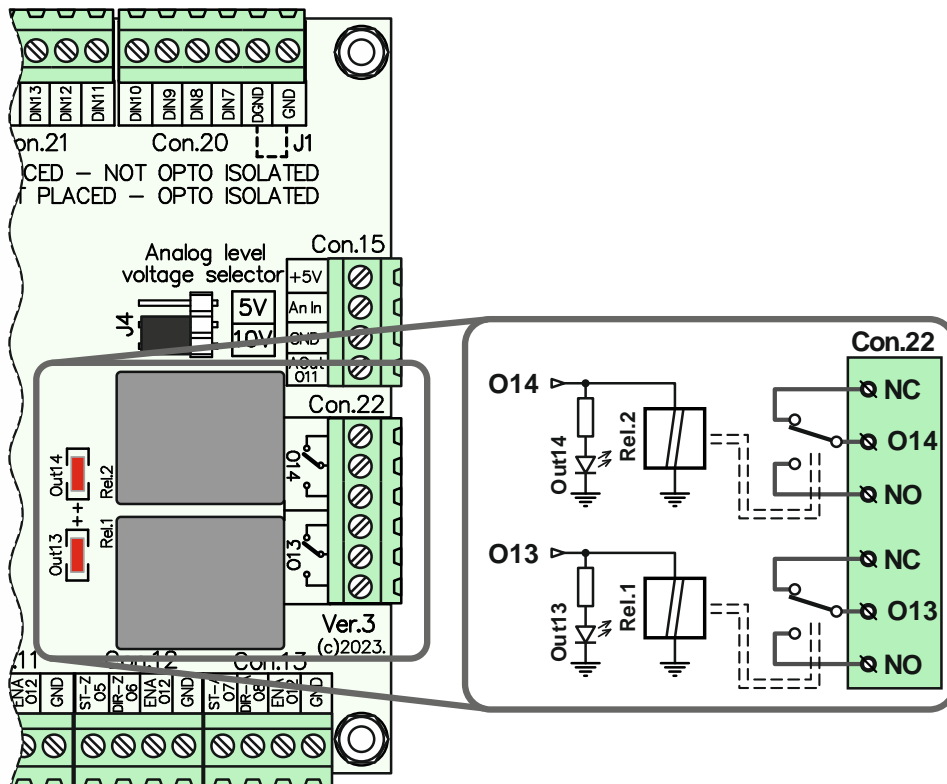
Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 22 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.10 Possible connection of relay outputs

8.5 Analog output on USB-MC-INT motion controller

Mach3 has the ability to generate a PWM (Pulse-width modulation) signal. PWM or pulse width modulation is a method of control where the frequency of the control signal does not change. What is changing is the signal / pause ratio, i.e. the signal width changes.

If an appropriate filter is placed on the TTL output on which the PWM signal is received, then the analog signal will be output at this filter. The voltage level of the analog signal depends on the signal / pause ratio. For example, if the signal width is 10% and the pause width is 90%, the analog output voltage will be 10% of the maximum voltage. This analog signal can be used as a control signal for regulating the spindle speed or for controlling one of the other peripherals on the machine.

USB-MC-INT motion controller has one analog output. Analog output Aout is available on connector Con. 15 (Figure 8.11). The control of the analog output Aout is done by generating a PWM signal on digital output O11.

Voltage level for analog output is factory preset to range 0-10 V. Optionally it is possible to set voltage level to range 0-5V (on special request).

> **NOTE: Negative output of analog output Aout (O11) is galvanically connected to the power supply ground of USB-MC-INT motion controller.**

| Audioms Automatika doo | web: www.audiohms.com | Page 23 of 31 |
| Kragujevac, Serbia | e-mail: office@audiohms.com | |

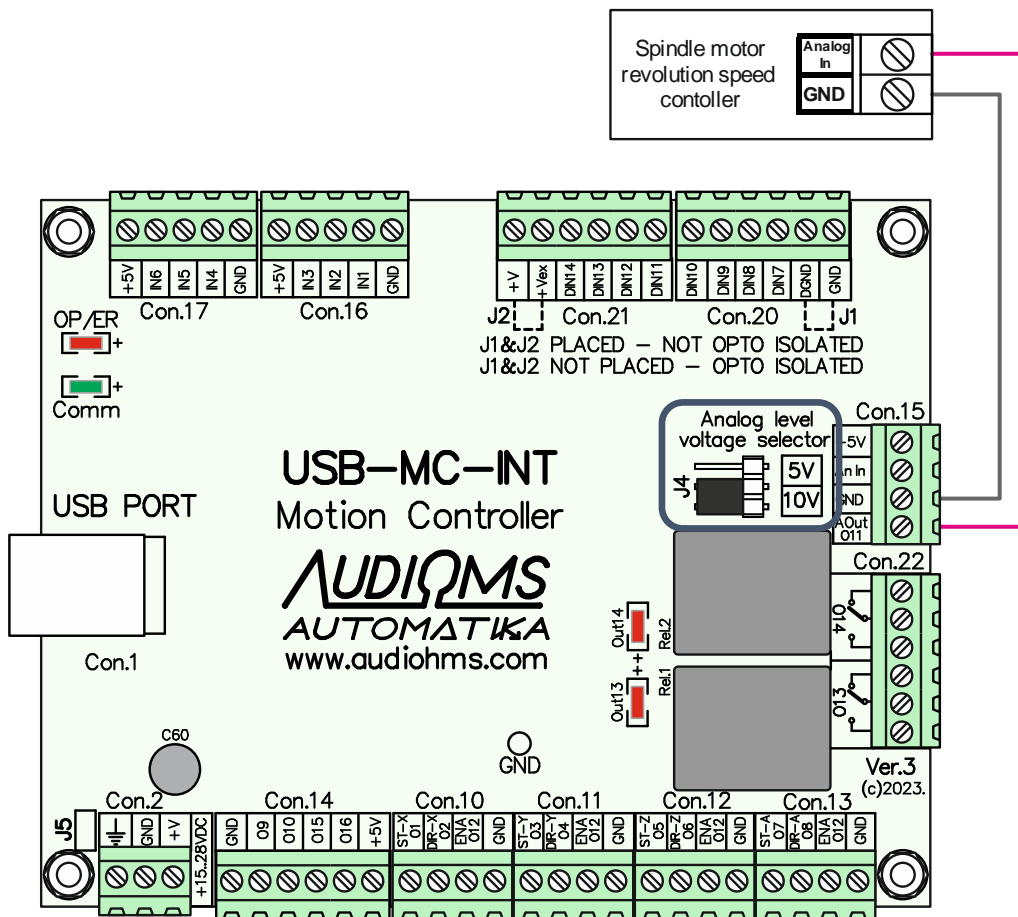USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.11 Analog output for controlling spindle motor revolution rate

The analog output can be configured to be either in range 0-5V or 0-10V. The range is chosen by the jumper J4 – Analog output voltage selector (Figure 8.12).
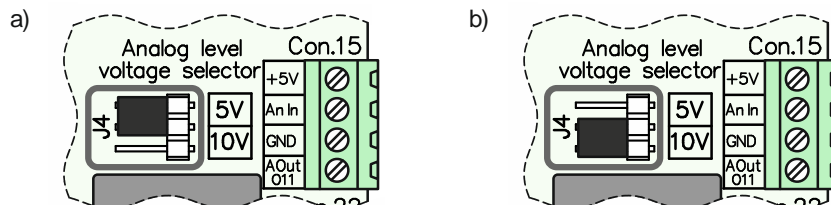

Figure 8.12 Jumper for analog output range selection, a) position for range 0-5V and b) position for range 0-10V

8.6 Analog input USB-MC-INT motion controller

USB-MC-INT motion controller has one analog input (An in) with range 0-5 V and it is available on the connector Con.15 (Figure 8.13).

Analog input offers the possibility of connecting potentiometers, THC sensors and other sensors with analog outputs in order to realize some of the special functions (FRO, SRO, THC control, etc.).

Figure 8.13.a shows the recommended method for connecting potentiometer to the analog input An In, and Figure 8.13.b shows recommended way for connecting THC Sensor analog output to analog input An In. A detailed description of the Torch Height Control (THC) using USB-MC-INT is given in separate instruction manual.
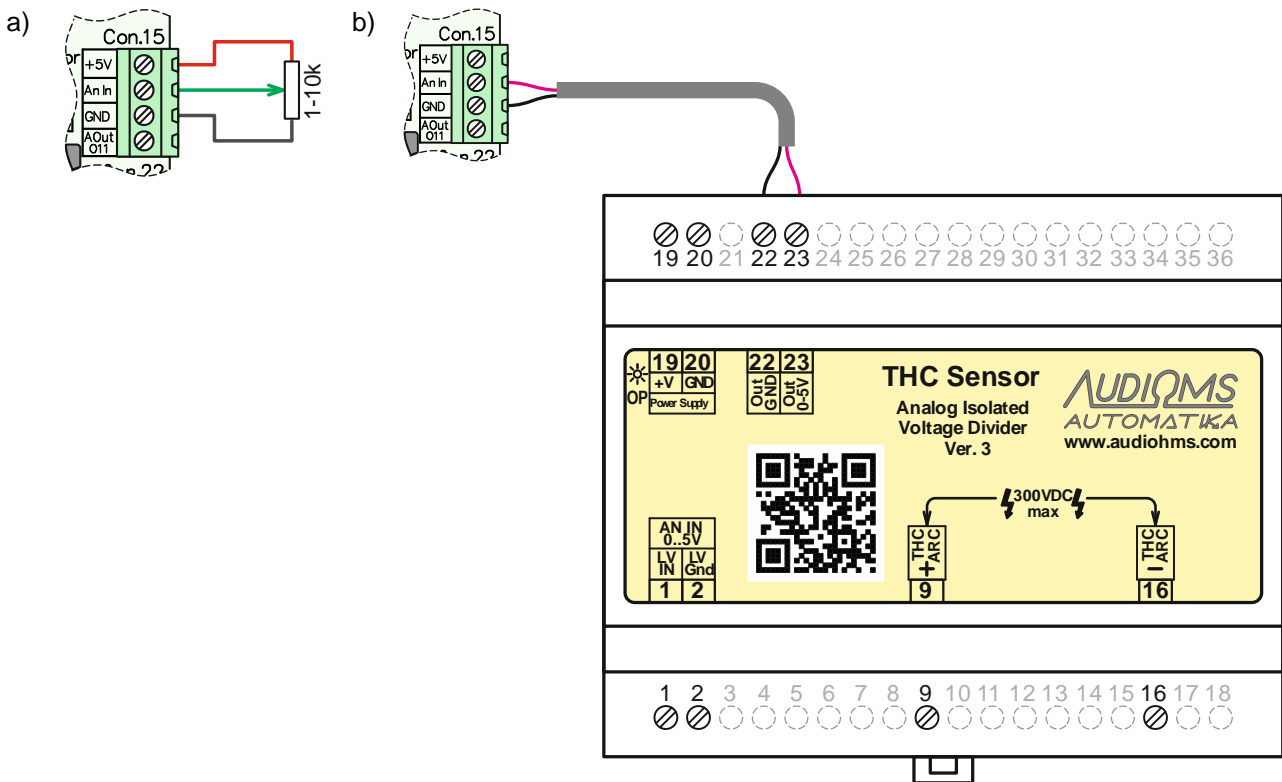
Audioms Automatika doo	web: www.audiohms.com	Page 24 of 31
Kragujevac, Serbia	e-mail: office@audiohms.com	

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.13 Connecting the source of analog signal to the analog input, a) using potentiometer and b) from THC sensor

8.7 Opto-isolated digital inputs

USB-MC-INT motion controller offers connection of signals to up to 8 digital inputs (DIN7-DIN14) of voltage level 24 VDC. These digital inputs are connected to connectors Con.20 and Con.21 (Figure 8.14). For level shifting the voltage levels from 24 VDC to 5 VDC optocouplers on-board are used.

NOTE: For the activation of digital inputs, for safety reasons it is recommended to use NC type of switches (Normally Closed).

There are two modes for wiring limit switches:

- non-isolated mode and
- opto-isolated mode.

In addition, Figure 8.14 shows the simplified electric schematic of the input circuit for digital inputs DIN7-DIN14, as well as two modes for wiring limit switches (non-isolated mode and opto-isolated mode). Digital inputs DIN7-DIN14 have passive low-pass filter with 3.4 kHz cutoff frequency implemented.

Digital inputs DIN7-DIN14 have common negative supply line (DGnd).

In the following text there is a detailed explanation of limit switches wiring.
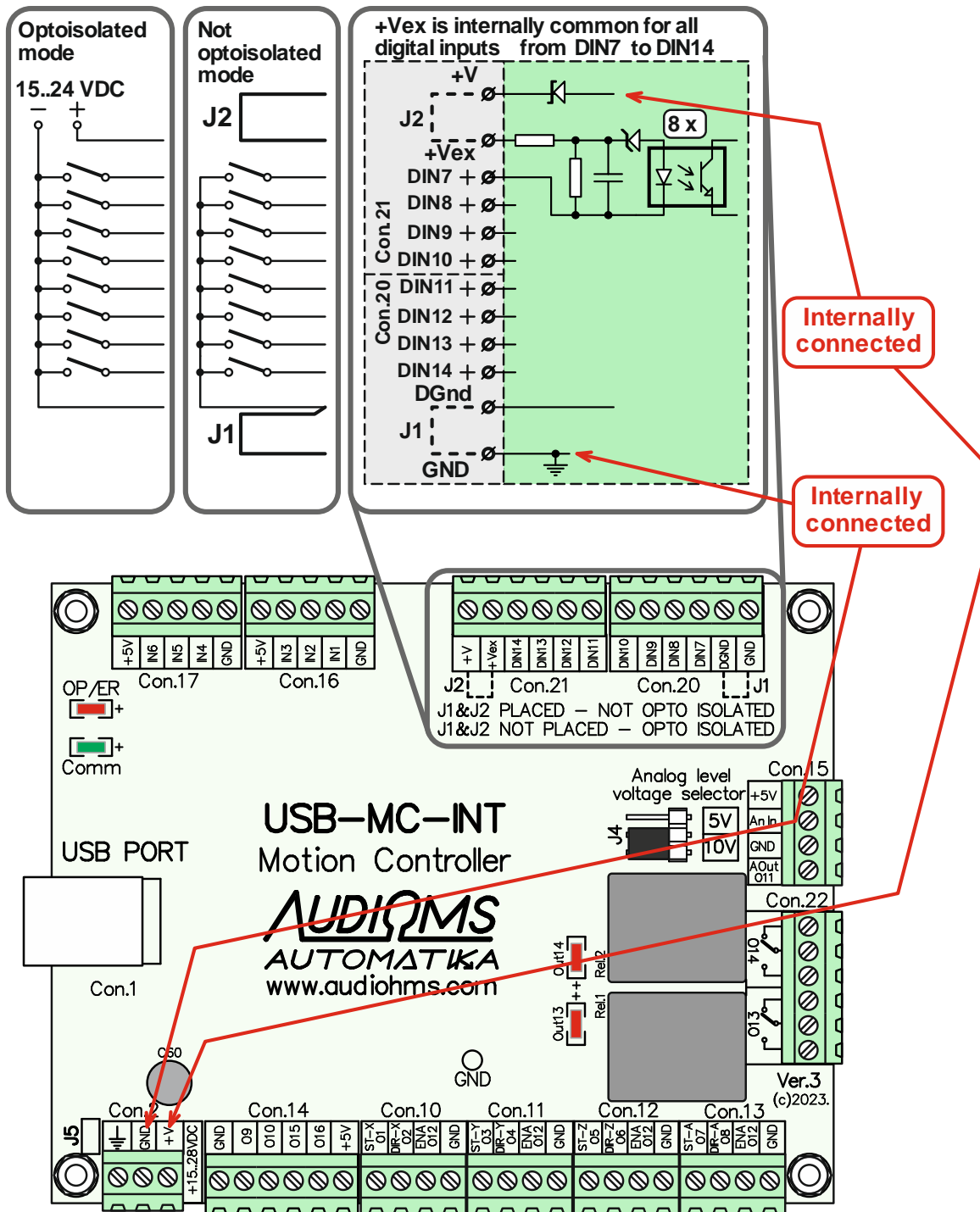
Figure 8.14 Location of opto-isolated digital inputs on the USB-MC-INT motion controller

8.7.1 Isolated mode for wiring limit switches to the opto-isolated inputs

Isolated mode for wiring limit switches to digital inputs DIN7-DIN14 implies using **additional power supply** with voltage in range of 15-25 VDC. Figure 8.15 shows connection of electro-mechanical switches, while Figure 8.16 shows a possible way of connecting inductive switches to digital inputs DIN7-DIN14 in **isolated wiring mode**. Inductive switch with NPN type of output should be used (Figure 8.16).

> **IMPORTANT NOTE**: When connecting limit switches in **isolated mode** (Figure 8.16 and Figure 8.17) it is required to **remove jumpers from locations J1 and J2**.

AUDIOMS AUTOMATIKA

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 26 of 31

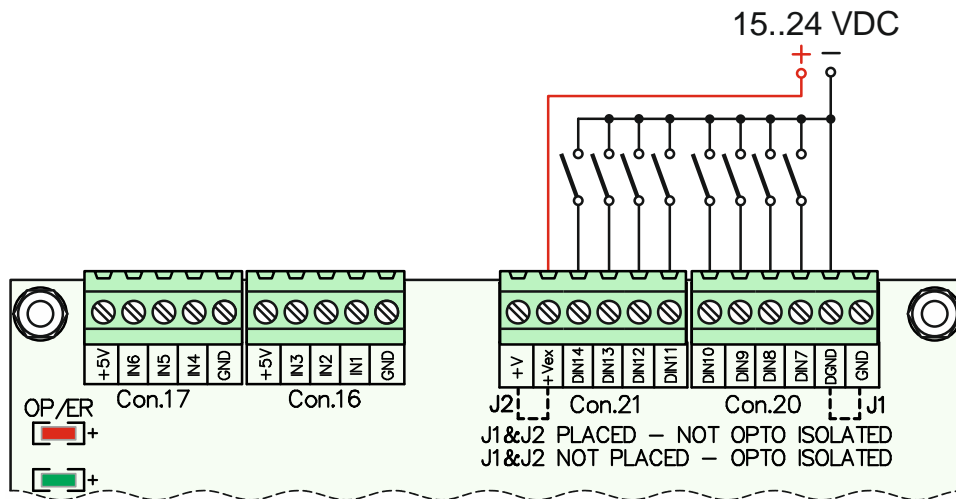USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.15 Isolated mode for wiring electro-mechanical type of limit switches
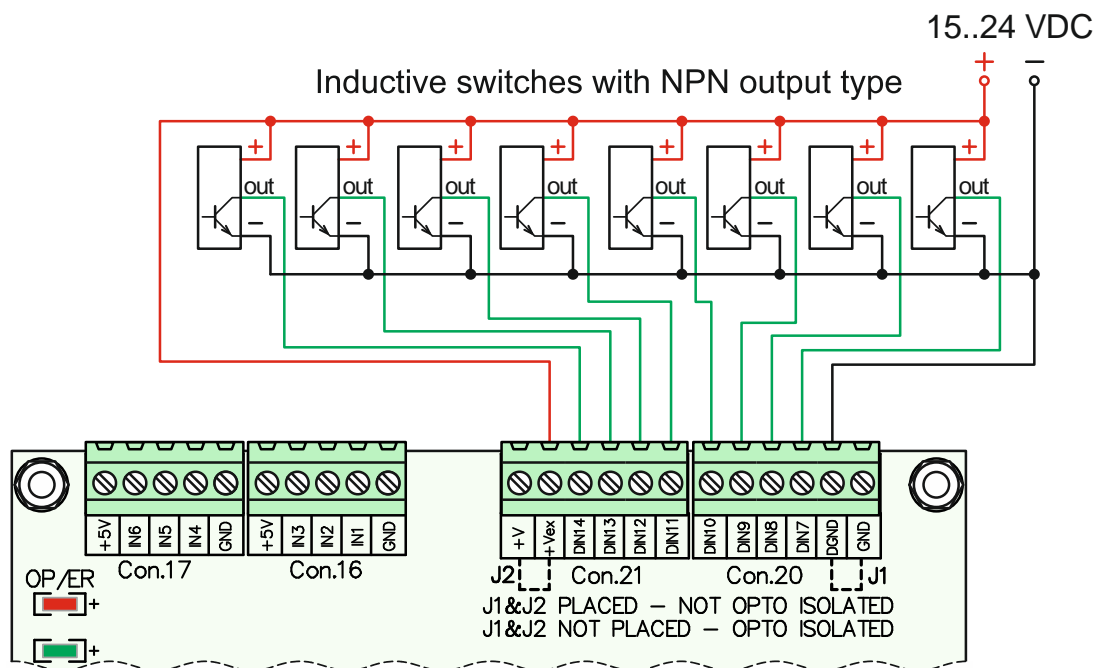

Figure 8.16 Isolated mode for wiring inductive type of limit switches

8.7.2 Non-isolated mode for wiring limit switches to the opto-isolated inputs

This mode implies usage of power supply of USB-MC-INT motion controller for activation of digital inputs DIN7-DIN14. In that case it is necessary for supply voltage of USB-MC-INT motion controller to be in the recommended range (15-28 VDC). Figure 8.17 shows wiring of electro-mechanical switches, while Figure 8.18 shows a possible connection of inductive switches to digital inputs DIN7-DIN14 in non-isolated wiring mode.

IMPORTANT NOTE: When connecting limit switches in **non-isolated mode** (Figure 8.17 i Figure 8.18) it is required to **set jumpers into positions J1 and J2**.
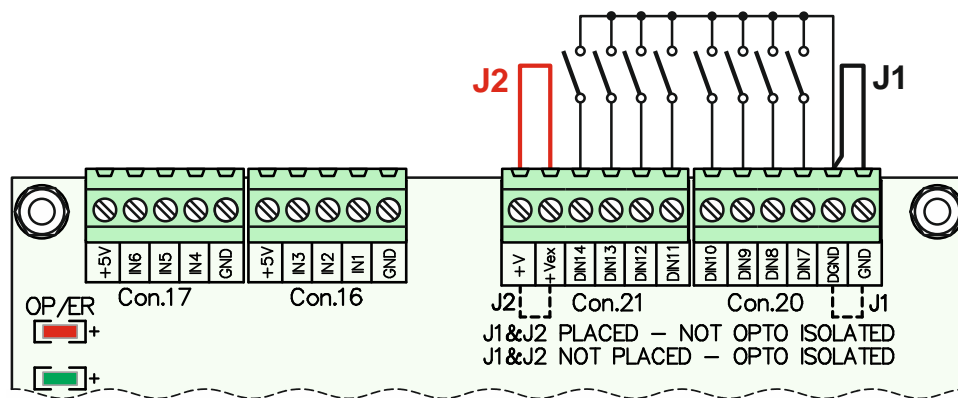
Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 27 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.17 Non-isolated mode for wiring limit switches of electro-mechanical type
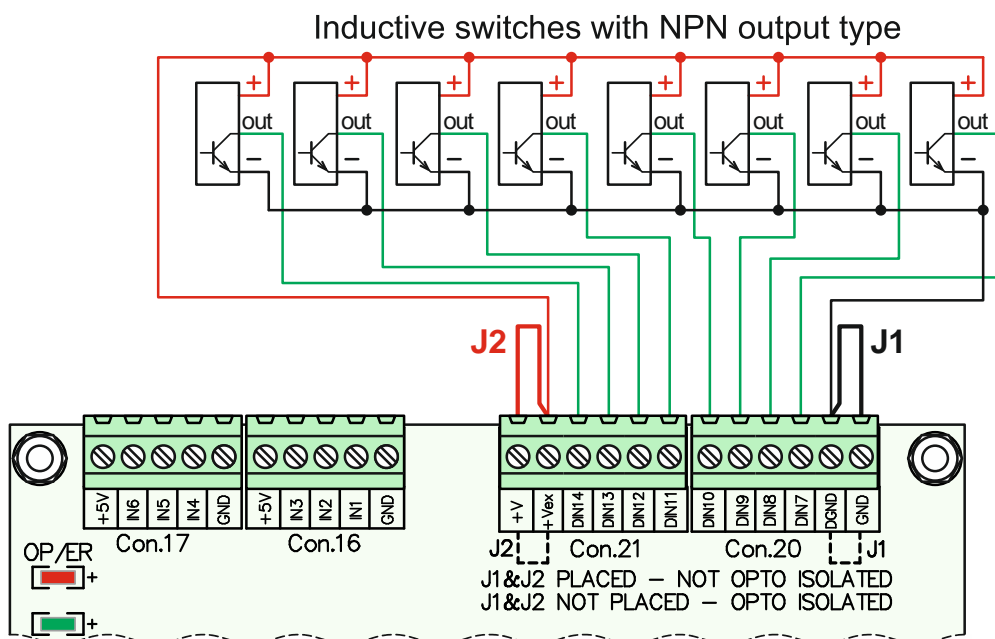
Inductive switches with NPN output type

Figure 8.18 Non-isolated mode for wiring limit switches of inductive type

8.7.3 Connecting the cutting tool height measuring system

One useful option with modern CNC control systems is to measure cutting tool height across the Z axis (Auto Tool Height). This is done with the G31 function (Probe function). Measuring cutting tool height can be done in different ways. The following are the two most common ways of measuring it.

First way: Measuring with a special measuring tool that gets placed between the cutting tool and workpiece (Figure 8.19). When the cutting tool touches the top of the measuring tool, a switch inside measuring tool is activated that tells the control system a contact occurred. This way the switch wires aren't in electrical contact with the metal parts of the machine. This is the recommended way of measuring Z axis height.

Second way: Using a metal sheet or block of known width or some simple measuring tool (Figure 8.20). There is an electrical isolator under the sheet or the measuring tool in order for it to be electrically isolated from the machine. In this case the sheet (or the measuring tool) and the cutting tool that is placed in machine clamping tool act as a switch. That way the metal parts of the machine are in direct electrical contact with control electronics. When measuring this way, it is very important to check the wiring of the system so that the control electronics don't get damaged.

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 28 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.19

Figure 8.20

USB-MC-INT motion controller offers the possibility of connecting opto isolated digital inputs of 24V. The digital inputs have a common negative supply line (DGnd), so Figure 8.21 shows the recommended way of connecting the cutting tool Z height measuring system. In the given example, the measuring is done over a digital input DIN7. An additional power source of 24VDC is needed in order to ensure opto isolated regime.
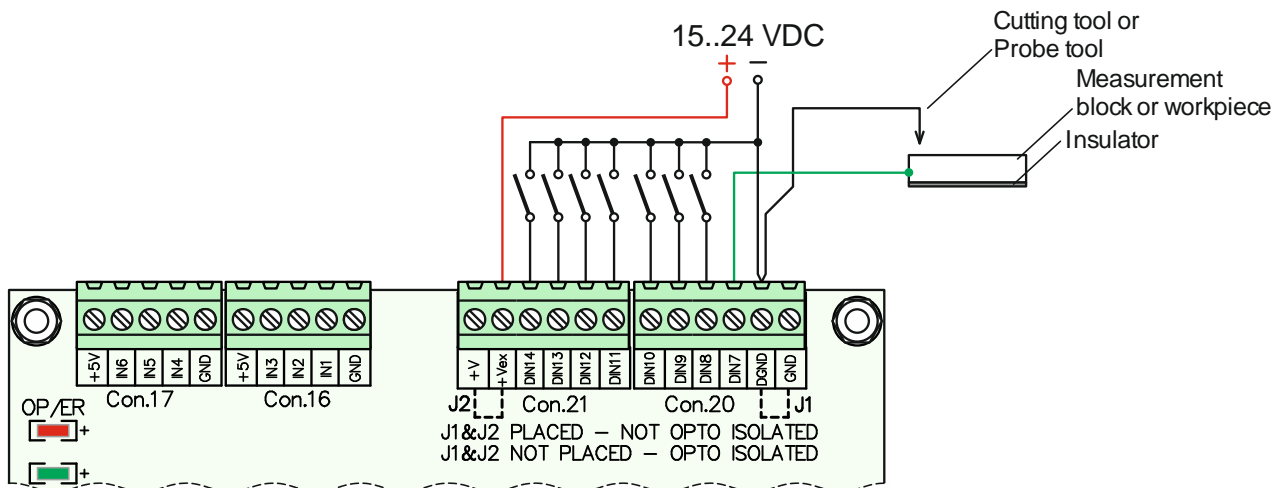

Figure 8.21

8.8 General purpose digital inputs

USB-MC-INT motion controller offers six general purpose TTL digital inputs which are accessible via connectors Con.16 and Con.17. These are labeled as IN1 to IN6 (Figure 8.22) and have integrated 4.7 kΩ pull-up resistors. Digital input IN5 is used for **Error** signal from connectors for controlling DC servo drivers (connectors labeled as X-Axis, Y-Axis, Z-Axis and A-Axis).
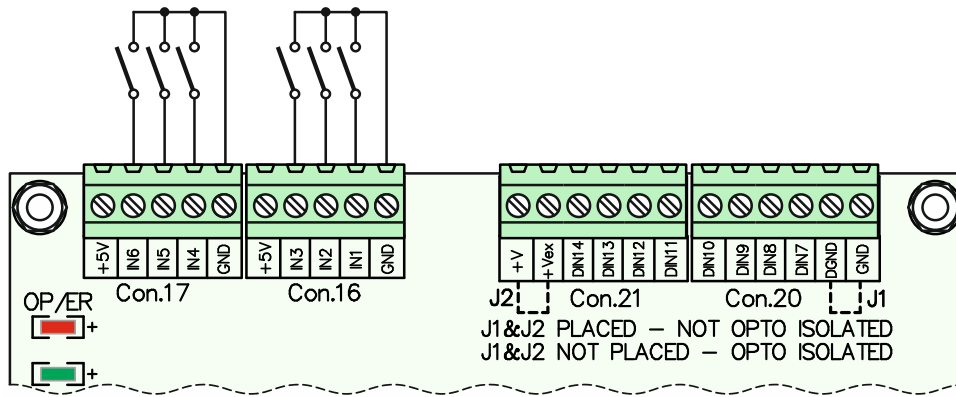
Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 29 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

Figure 8.22 Wiring general purpose digital inputs

8.9 General purpose digital outputs

USB-MC-INT motion controller also has 4 TTL digital outputs for general purpose. These are marked as O9, O10, O15 and O16 and are available on connector Con.14 (Figure 8.23).

General purpose digital outputs can be used for generation of STEP/DIR signals for additional axes (fifth and sixth axis) (Figure 8.4 and Figure 8.9), for activation of external relays etc.

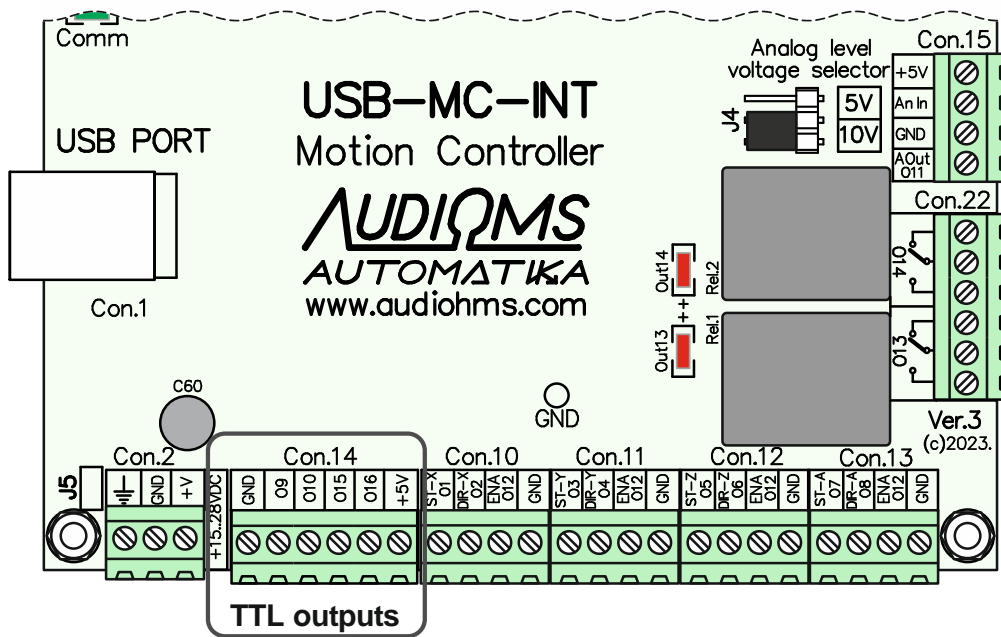| NOTE: PWM signal cannot be configured to outputs O15 and O16. |
| --- |

Figure 8.23 Location of general purpose digital outputs

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 30 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023

9 LED indicators

9.1 OP/ER – Status LED

Does not light up	Controller is not powered
Blinking slow	Controller is in safe mode (outputs are in high impedance state)
Constantly lights	Established connection with computer, controller is in idle mode (ready for work)
Blinking fast	A command (jog, G-code) is currently being executed
1 short blink	An error is detected (e.g. limit switch activated, ESTOP or similar). For error type look at Mach3 status line

9.2 Comm LED

Lights when there is a communication with computer.

10 Safety recommendations

- It is highly recommended to enforce galvanic isolation between work environment and PC (using opto-isolators and similar).
- All Audioms Automatika doo drives for stepper and DC servo motors have built-in opto-couplers on STEP and DIR inputs thus for these lines additional isolation is not needed. For other inputs and outputs, and depending on used equipment, it may be needed to use additional opto-isolators.
- Usage of USB-MC-INT motion controller requires knowledge and understanding of operation of complete work system, also awareness of possible risks of working with machines and tools.
- It is advisable to place USB-MC-INT motion controller in metal enclosure so that it is protected from external influences in presence of strong electromagnetic field, very high temperature, moisture, and similar.
- It is necessary to comply with safety standards like installation of EStop button, limit switches and similar.

DOCUMENT REVISION:
- Ver. 1.0, July 2023, Initial version

Audioms Automatika doo
Kragujevac, Serbia

web: www.audiohms.com
e-mail: office@audiohms.com

Page 31 of 31

USB-MC-INT v.3 Motion controller user's manual, July 2023