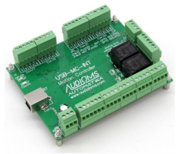
AUDIOMS AUTOMATIKA USB-MC-INT-v3 Motion Controller



AUDIOMS AUTOMATIKA USB-MC-INT-v3 Motion Controller User Manual

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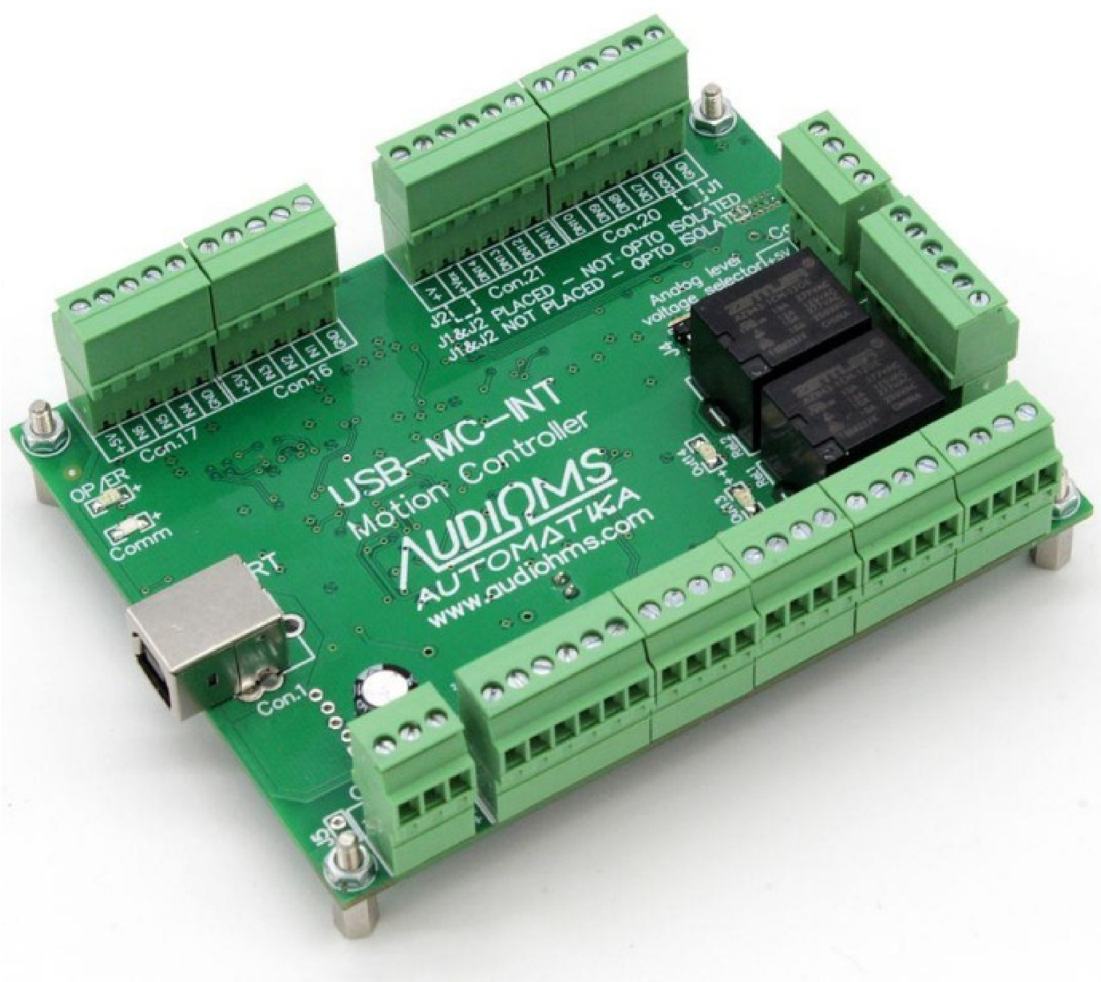


Technical Specifications

- Supported Mach3 functions
- Not supported functions
- Other functions

Description

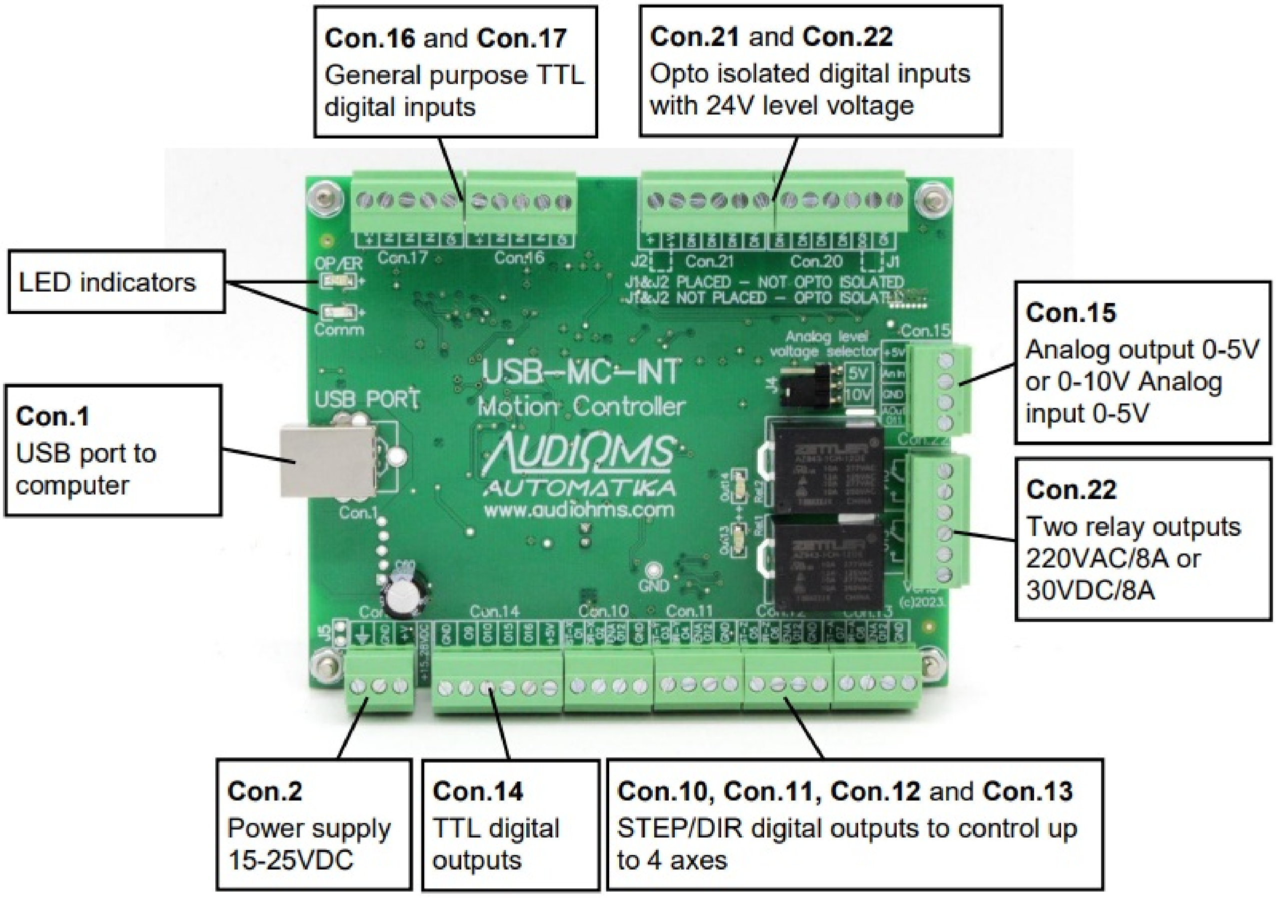


Figure 1.1 USB-MC-INT v.3 motion controller

USB-MC-INT v.3 is a 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 the computer, a 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, the 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 which are relay outputs,
- 14 digital outputs, while 8 of them are optoisolated 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.

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

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

Mach3 plugin contains the integrated latest compatible version of firmware so in case the firmware has to be updated, this process is automatic and easy for the 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 a computer USB port, but in that case, some functions of the motion controller won't be available. To use all available USB-MC-INT motion controller functions it is necessary to use an external power supply 15-28 VDC / 500 mA.

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 the inputs and outputs
- adjustable active signal state (low/high) for all inputs and outputs
- homing/referencing (single axis and multi axis)
- hardware limit switches
- limits with deceleration for a 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 about velocity of movement), adjustable arbitrary relation curve
- laser PWM, gate by M10/M11
- laser grayscale (8-bit) engraving
- shuttle mode, adjustable acceleration time
- detailed adjustment for debouncing of all input signals
- FRO, SRO or any DRO/Variable control using a 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…)

Not supported

- Backlash compensation

Other functions
With limits, 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.

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 digit al outputs	32 mA
Relay outputs	2 NO relay outputs with capacity 250 VAC / 8 A max. or 30 VDC / 8 A max
Digital inputs	– 8 opto-isolated inputs for 24V signal levels – 6 Schmitt trigger general purpose digital inputs for TTL levels a nd 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)

INSTALLATION

Driver installation

Connect the USB-MC-INT motion controller to a free USB port on a 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 the motion controller, it will ask for the location on the local computer to read it from. Drivers can be downloaded from www.audiohms.com site.

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

Plugin installation

Mach3 plugin contains integrated the latest compatible version of firmware so in case firmware has to be updated, this process is automatic and easy for the user. The 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 the USB-MC-INT Mach3 plugin, copy supplied file usbmc_drv.dll to the Mach3 plugins folder (usually "c:\mach3\plugins"). Then, start Mach3 and a new plugin should be detected (Figure 3.1). Now choose the USB-MC-plugin in the displayed list of options. Also, optionally turn on the option Don't ask me this again so that this choice is remembered and not displayed again on the next Mach3 startup.

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

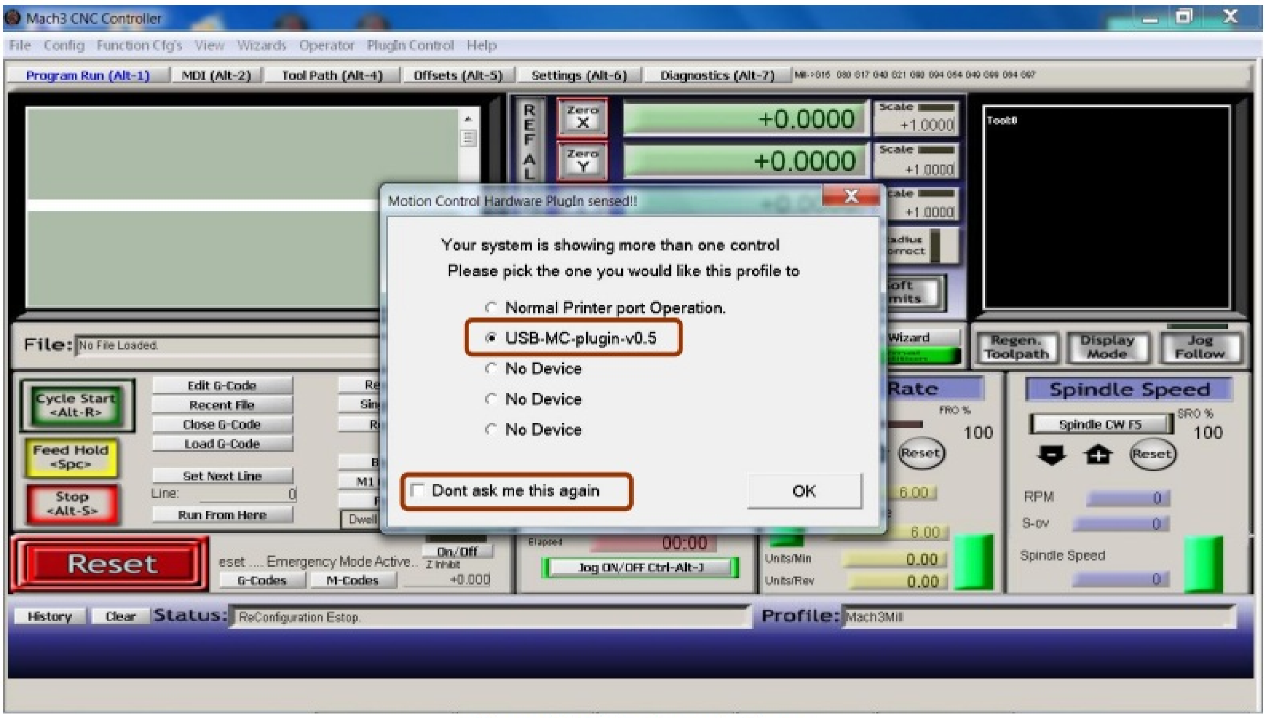


Figure 3.1 Plugin selection

On power-up, the controller is in safe mode, that is, all outputs are in a high impedance state (unconnected). The mode indicator LED on the controller board is blinking slowly.
After clicking the RESET button in Mach3, the connection with the controller is established and the status shown in (Figure 3.2) is reported. The controller then enters normal operation mode, the LED indicator on the board stops blinking and glows continuously.

Figure 3.2

If the USB connection is lost for any reason, the controller instantly enters safe mode. Then it is needed to investigate and eliminate the cause of the error and click the RESET button to establish communication again. Also, the controller enters safe mode on all configuration changes and also on exiting the Mach3 application.

Automatic firmware update
USB-MC-INT motion controller plugin also contains the required firmware for the controller. Thus, upon establishing a connection, if it is determined that a firmware update is required, a 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, results like in Figure 3.5 should be presented.

Current versions of the plugin and firmware can be found on the About window of the USB-MC configuration dialog.

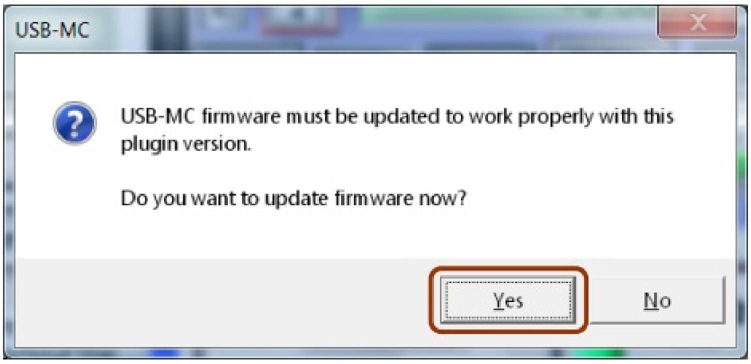


Figure 3.3

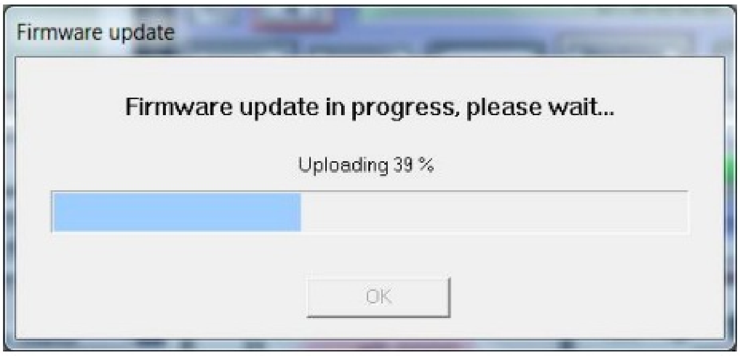


Figure 3.4

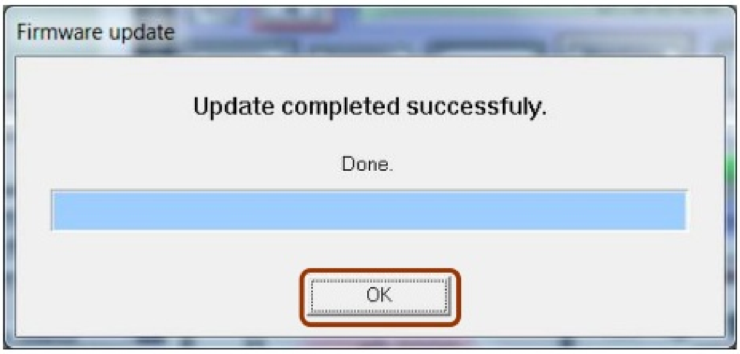
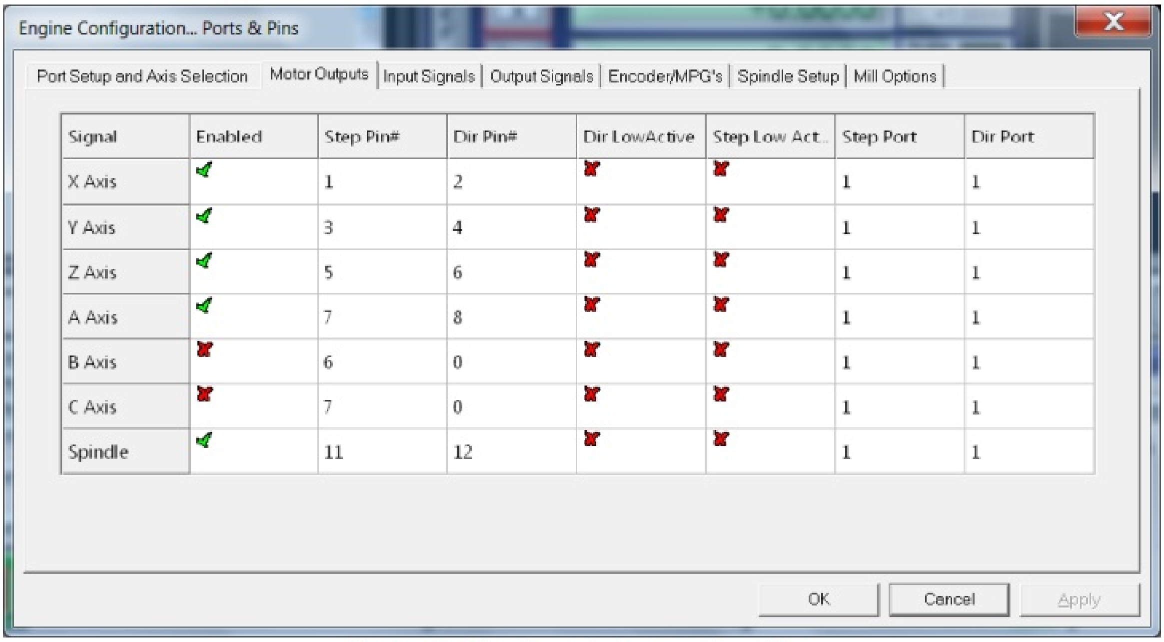


Figure 3.5

Configuration

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

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 applications (Figure 4.1).



Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Act..	Step Port	Dir Port
X Axis	✔	1	2	✘	✘	1	1
Y Axis	✔	3	4	✘	✘	1	1
Z Axis	✔	5	6	✘	✘	1	1
A Axis	✔	7	8	✘	✘	1	1
B Axis	✘	6	0	✘	✘	1	1
C Axis	✘	7	0	✘	✘	1	1
Spindle	✔	11	12	✘	✘	1	1

Figure 4.1 Ports and pins configuration

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 the 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 that is out of the available range.

USB-MC-INT configuration dialog

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

Spindle/laser PWM frequency
The frequency of the PWM output signal that is used for spindle rpm control or laser power control, can be adjusted in the range of 10 Hz – 200000 Hz (Figure 5.1). The output pin for this purpose is selected via the Spindle axis line in the Motor Outputs window (Figure 4.1). Only adjustments for the Step signal are used (pin/low act/port), and the 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 the Ports&pins/Spindle setup window, in the Motor control group, options Use spindle motor and PWM control should be turned on. PWMBase Freq in the same group, is not used.

Home retract speed

This is the speed of retraction from a home switch given as a percentage of homing speed (Figure 5.1). In the first phase of the homing (referencing) operation for an axis, movement toward the 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.

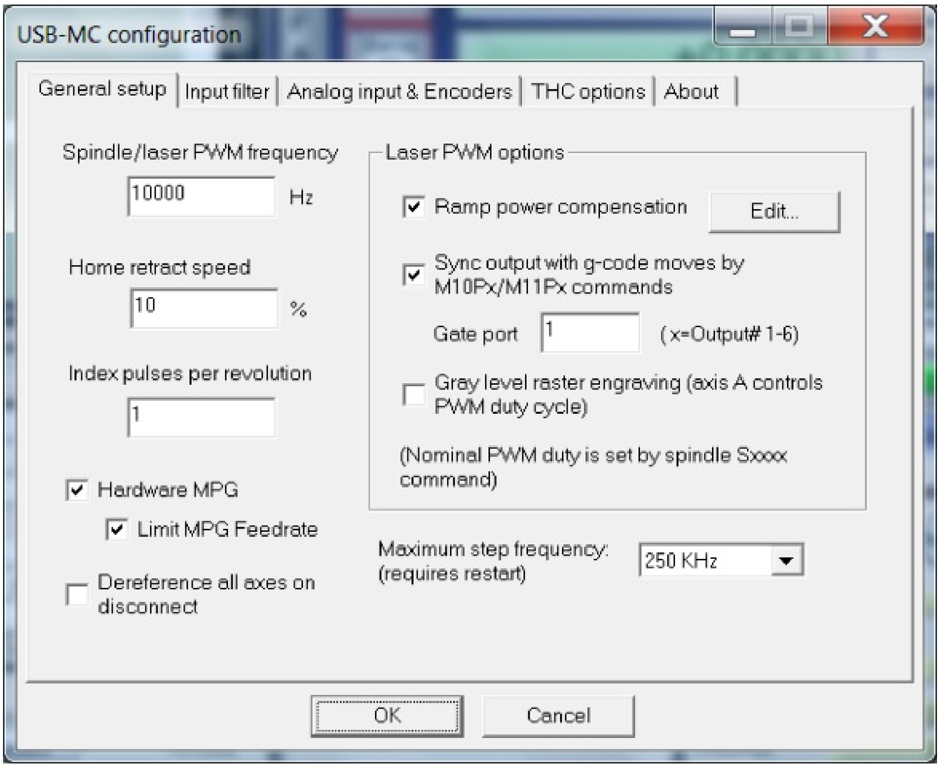


Figure 5.1 General setup

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).

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).

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 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 the 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.

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 the need for communication with the 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 the TAB key in Mach3. In this case, the USB-MC-INT motion controller reads MPG input, sends the 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 the USB-MC-INT motion controller and executed.
- In hardware mode just like in standard mode, CycleJogStep is used for setting the movement step, and also the majority of settings (MPG axis, detent…) are the same.

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

Laser PWM Options

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

Sync output with g-code moves, M10px, M11px
This option (Figure 5.1) enables fast commands M10px and M11px, in addition to their primary function of setting the state on output x (Output#1-6), at the same time can turn on/off PWM output. The 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 a much faster turn on/off of laser than 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 the g-code program, initially nothing happens, but this “turn on output x” command is remembered as armed for execution. When the next command for positioning (like G01 probably at the very next program line) is executed, then at the same moment when the commanded movement begins, the given output is also activated. The same logic applies to the M11px (turn of output) command.

Gray-level raster engraving

- This option is used for laser engraving of raster images and an 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 the A axis is directly translated to the 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).

Input Filter tab
Digital filtering (debouncing) is available for all inputs. The 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 the state to change from active to inactive or vice versa. If a 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 the signal is clean (e.g. optical encoder). Debounce time can be adjusted for a group of pins by function or for every pin separately (Figure 5.2).

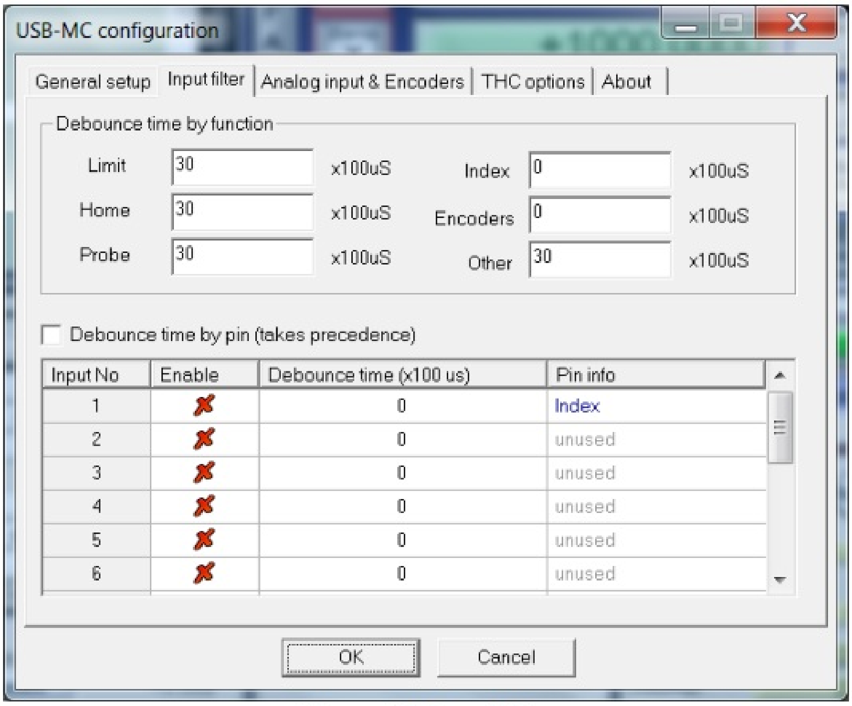


Figure 5.2 Input filter

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).

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 functions, available options are:

- None – signal is not used for any special function,
- FRO 0–250% – feed rate 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 a macro script or similar. ID represents the identifier (address) of the variable. The type of output can be chosen to be a 16-bit value (0–65535) or percentage (0-100%). Values of these variables can be monitored using the Mach3 function Operator/Geode Vary Monitor
- Set user DROP – similar to the previous option, only in this case ID represents the DROP field indicator.

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

Zero threshold voltage

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

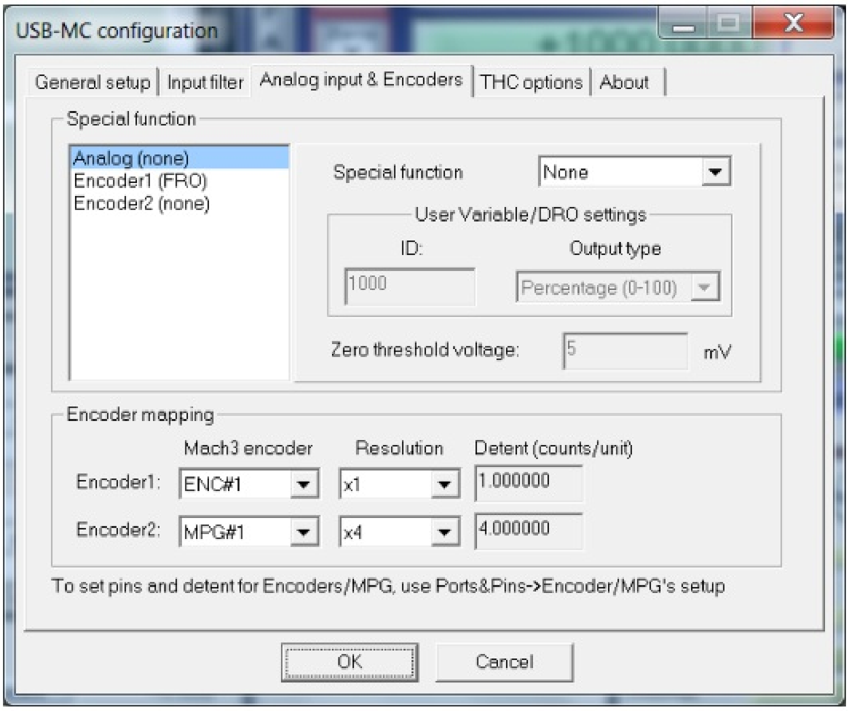


Figure 5.3 Analog input & encoders

Encoder mapping
USB-MC-INT motion controller supports simultaneous reading of two incremental encoders, including one from an MPG device (Figure 5.3). Since Mach3 offers adjustments for a total of seven encoder inputs, it is needed to map these two encoders to desired positions.
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 e.g. little mechanical, rotational encoders, for which we want for one detent to correspond to a position change of 1 and not 4. Also, with mechanical encoders, there is a possible effect of contacts bouncing which induces errors in position reading thus it is needed to set debouncing for the encoder to an optimal value. The algorithm that is used for the x1 reading option is fairly resistant to these problems so it is possible to set debouncing to zero when this option is used.

The detent (counts/unit)

- The detent is several pulses (increments) from the encoder/MPG for one full movement step in Mach3. For MPG, this step is defined on the 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 the direction of rotation.
- Usually, MPG is set to have a detent value of 4 if encoder resolution x4 is chosen.

THC options tab
THC (torch height control) function is used with plasma cutters for continuous regulation of the plasma head’s vertical position above the material. In addition, to support external regulators, the USB-MC-INT motion controller also contains an internal THC regulator that is possible to utilize by connecting an 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 a separate document (THC operation with Audioms Automatika doo USB motion controllers).

Shuttle mode

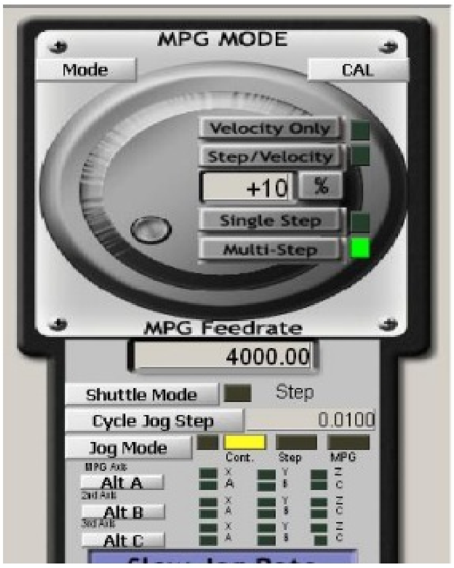


Figure 6.1

- It is possible to use MPG also for Mach3 shuttle mode, that is, fine real-time control of the execution speed of the 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 a complete stop.
- By deactivating the shuttle mode, movement on all axes is accelerated to reach the normal speed. This acceleration/deceleration can be adjusted using the field Shuttle Accel. which can be found on the Mach3 General Config dialog.

Status window

The status window (Figure 7.1) displays the current state of all input and output pins on the USB-MC-INT motion controller. Also, on the left side, the 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.

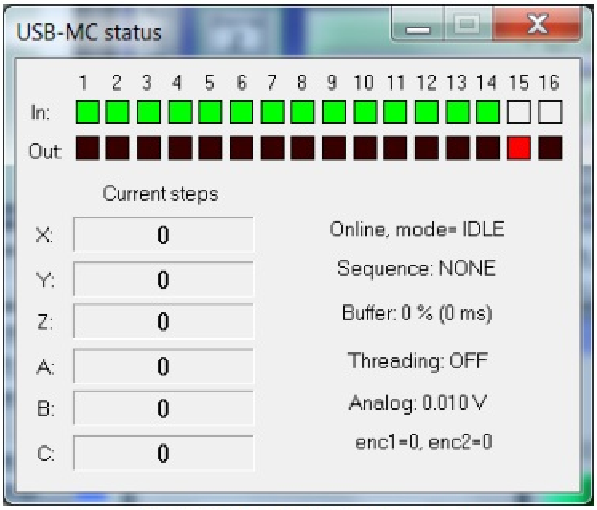


Figure 7.1 USB-MC-INT status window

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

Connection with computer and power supply for the USB-MC-INT motion controller
For powering the USB-MC-INT motion controller it is required to provide an external power supply 15-28 VDC / 500 mA (Figure 8.1).

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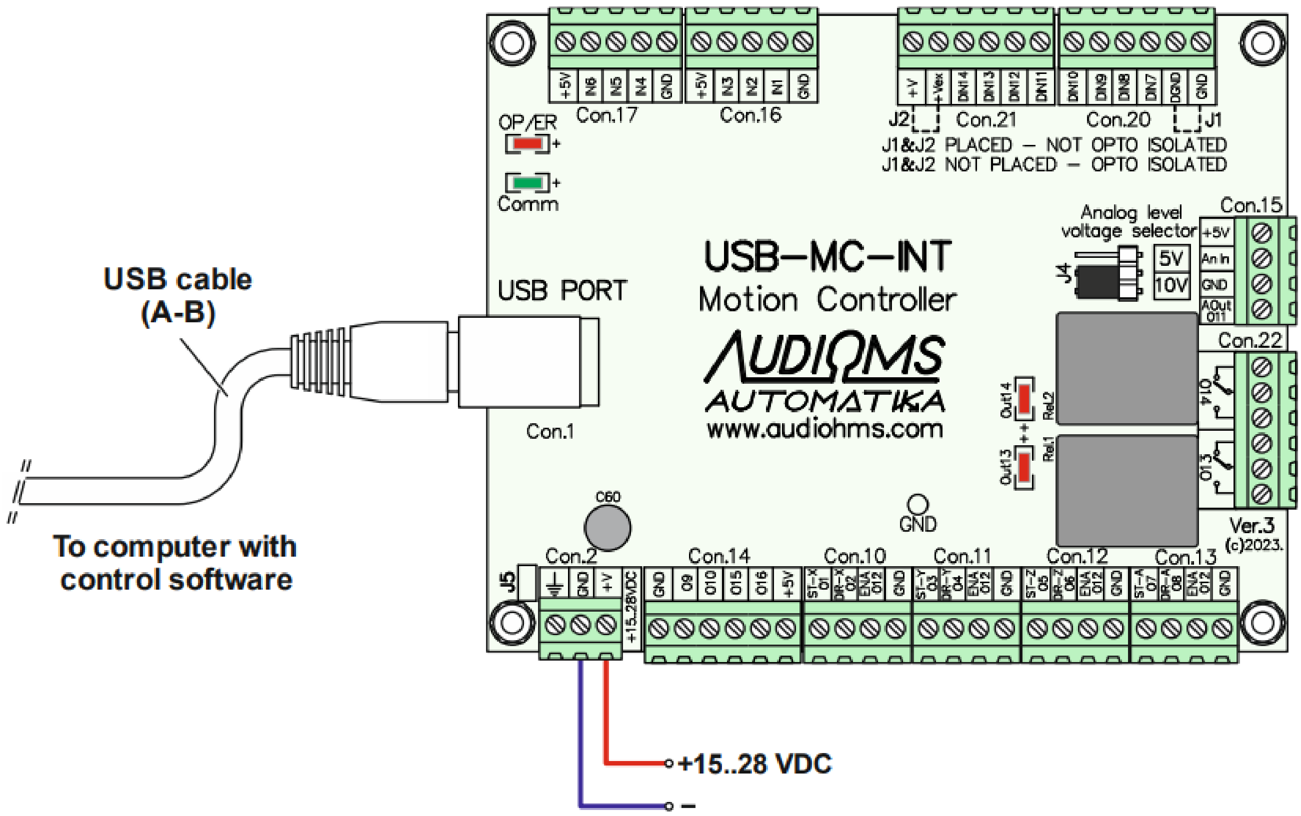


Figure 8.1 Connection with computer and connecting power supply to USB-MC-INT motion controller

For connecting the 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

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

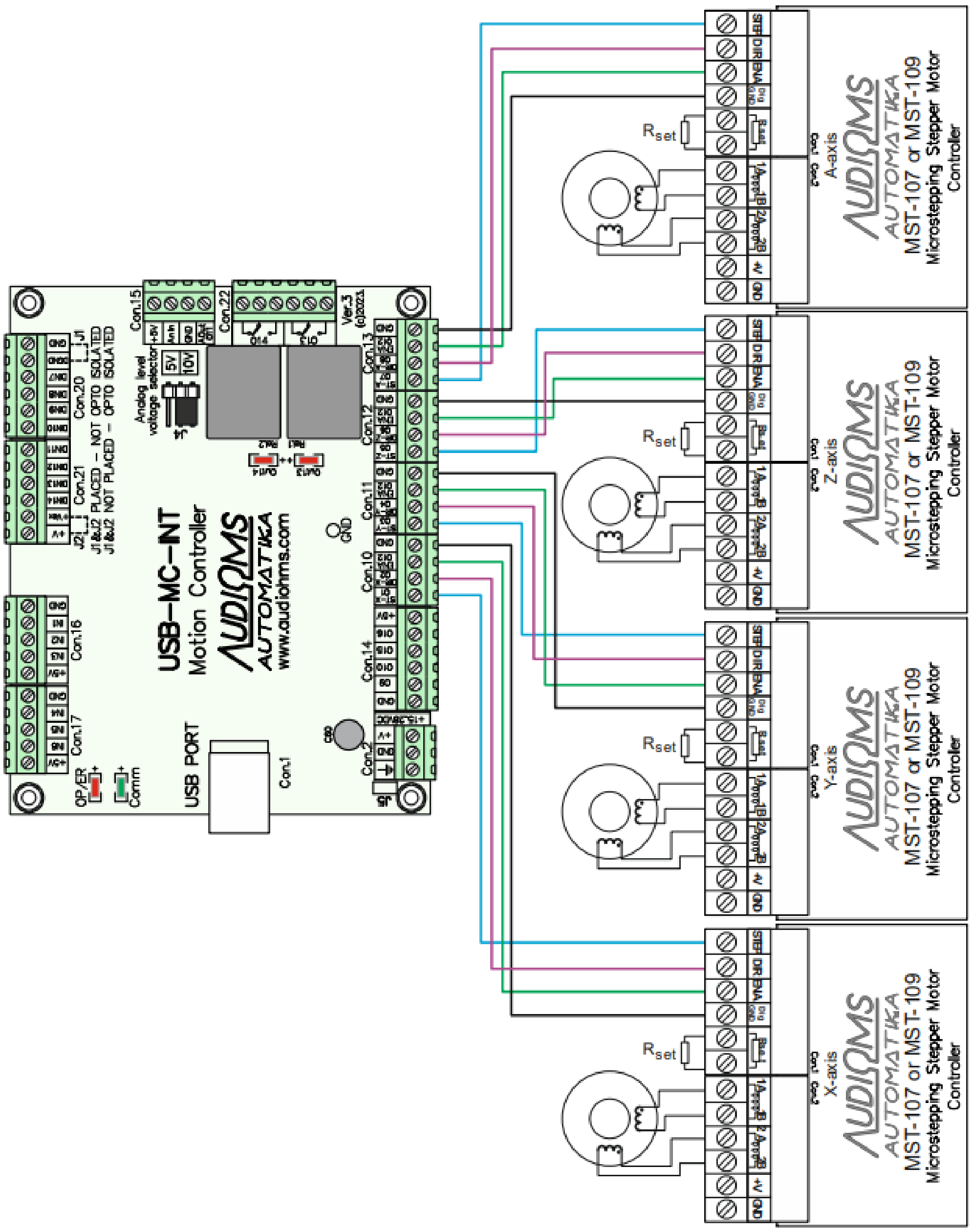


Figure 8.3 Connecting 4 microstep drivers MST-107 or MST-109 to USB-MC-INT motion controller

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).

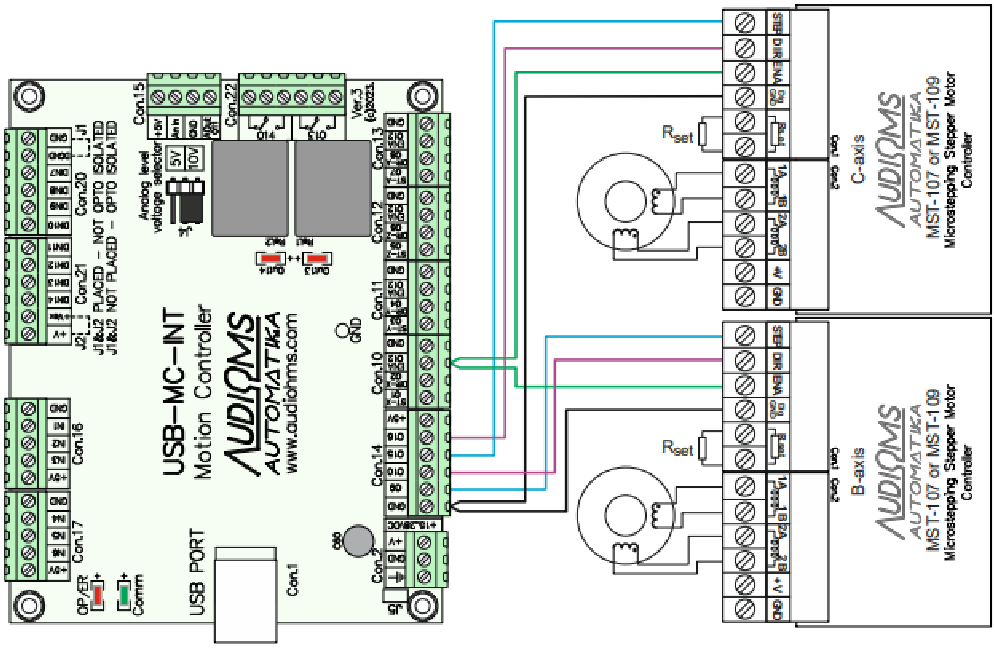


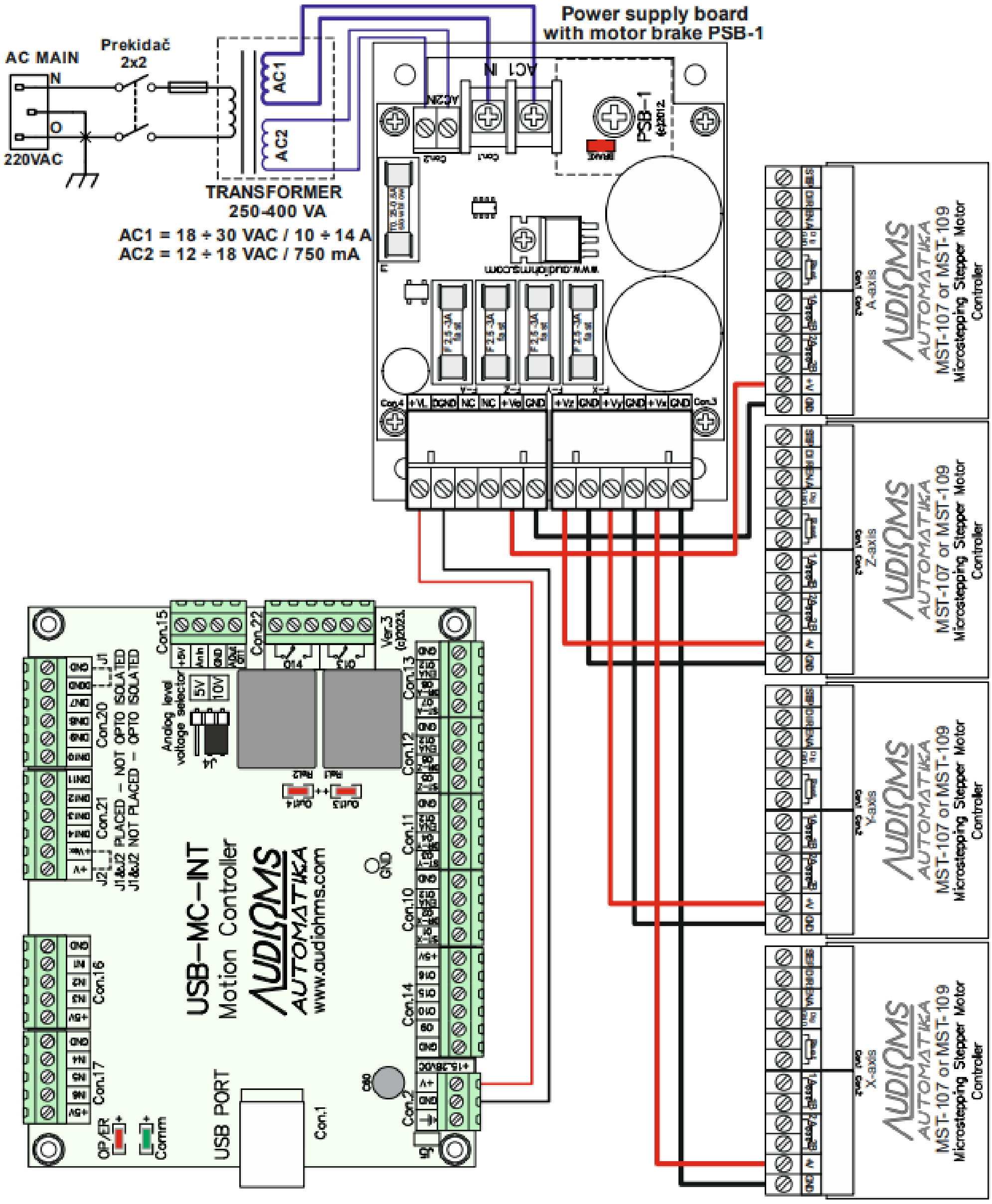
Figure 8.4 Optional connection of fifth and sixth axis

- 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 a PNP transistor wired in an open collector configuration and is activated by output O12. The maximum current for Enable output is 150 mA.
- Table 8.1 gives a list of recommended outputs for the 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 the USB-MC-INT motion controller and up to 4 micro-step drivers MST-107 or MST-109 it is recommended to use a power supply module with integrated motor break PSB-1 (Figure 8.5). More details about the power supply module PSB-1 and wiring instructions can be found in the manual for this module.



The user can also provide his power supply. In that case, Figure 8.6 shows a recommended scheme for connecting the power supply for the USB-MC-INT motion controller and up to 4 drivers MST-107. The power supply must provide two independent sources, one for powering the 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 situations.

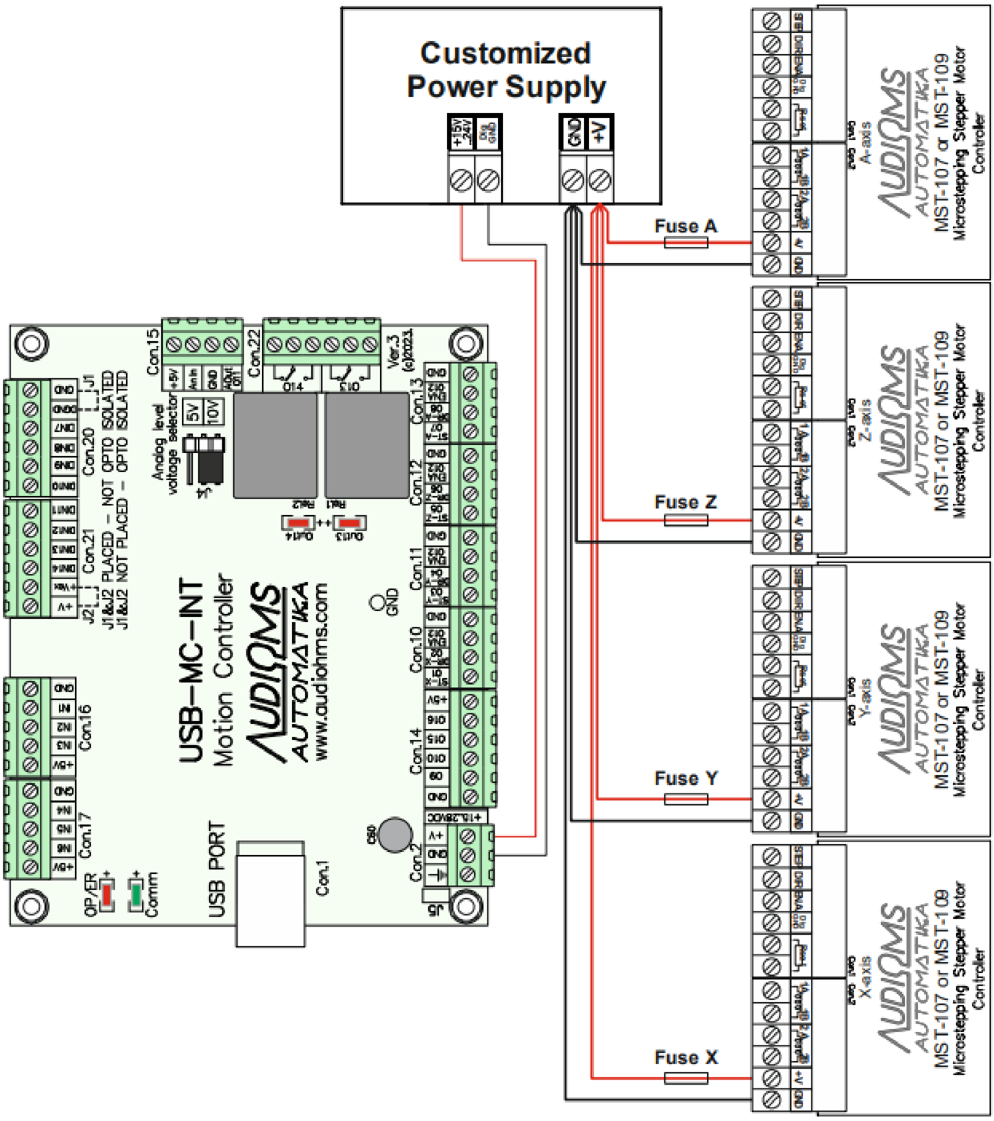


Figure 8.6

Connecting drives from other manufacturers to USB-MC-INT motion controller
Figure 8.7 shows the recommended wiring scheme for connecting 4 drives from other manufacturers to the USB-MC-INT motion controller. Used digital outputs on USB-MC-INT motion controllers are of TTL type. Drives from other manufacturers, regardless of whether they are intended for stepper, DC servo, or AC servo motors, usually have the same or very similar input interface.

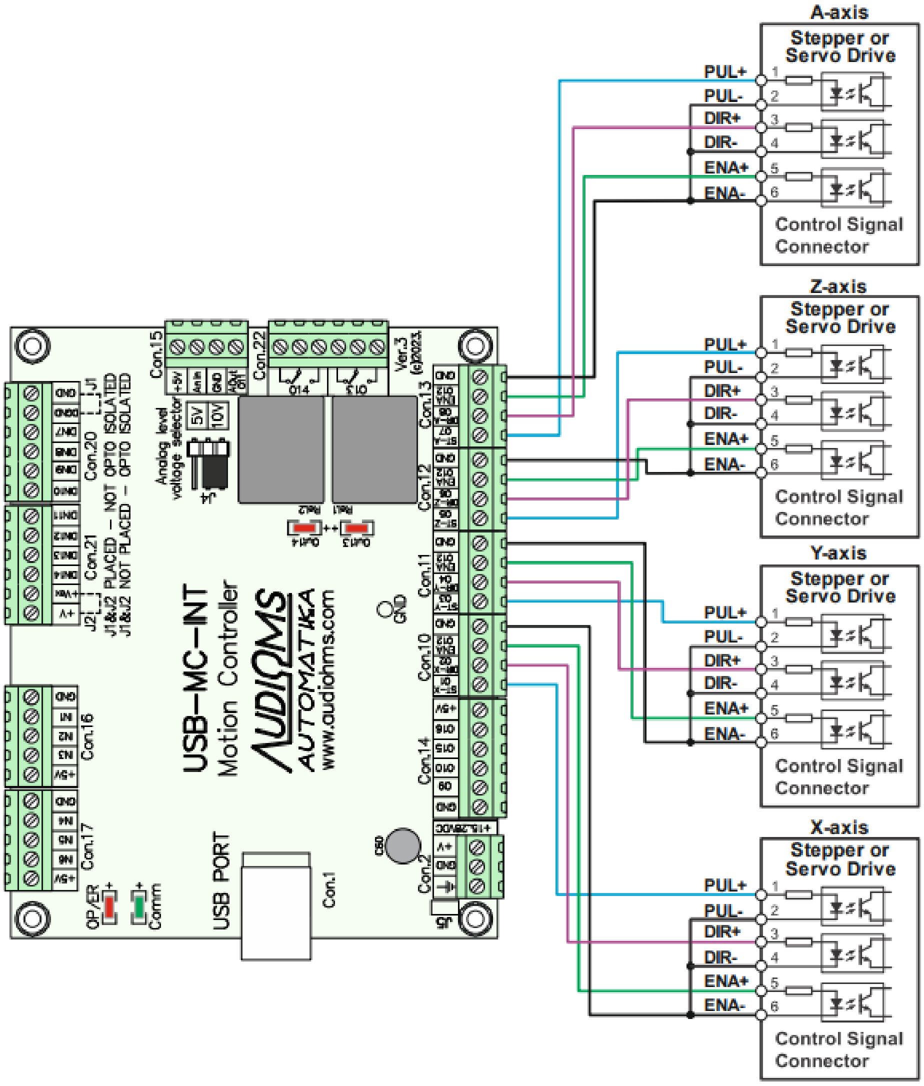


Figure 8.7

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 the USB-MC-INT motion controller (Figure 5.1 General setup). After changing the parameters the control software must be restarted for the setting to be activated.
- Check whether the driver from other manufacturers requires a 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 doesn’t connect ENA+ and ENA- lines (Figure 8.8). That way the driver will always be active.

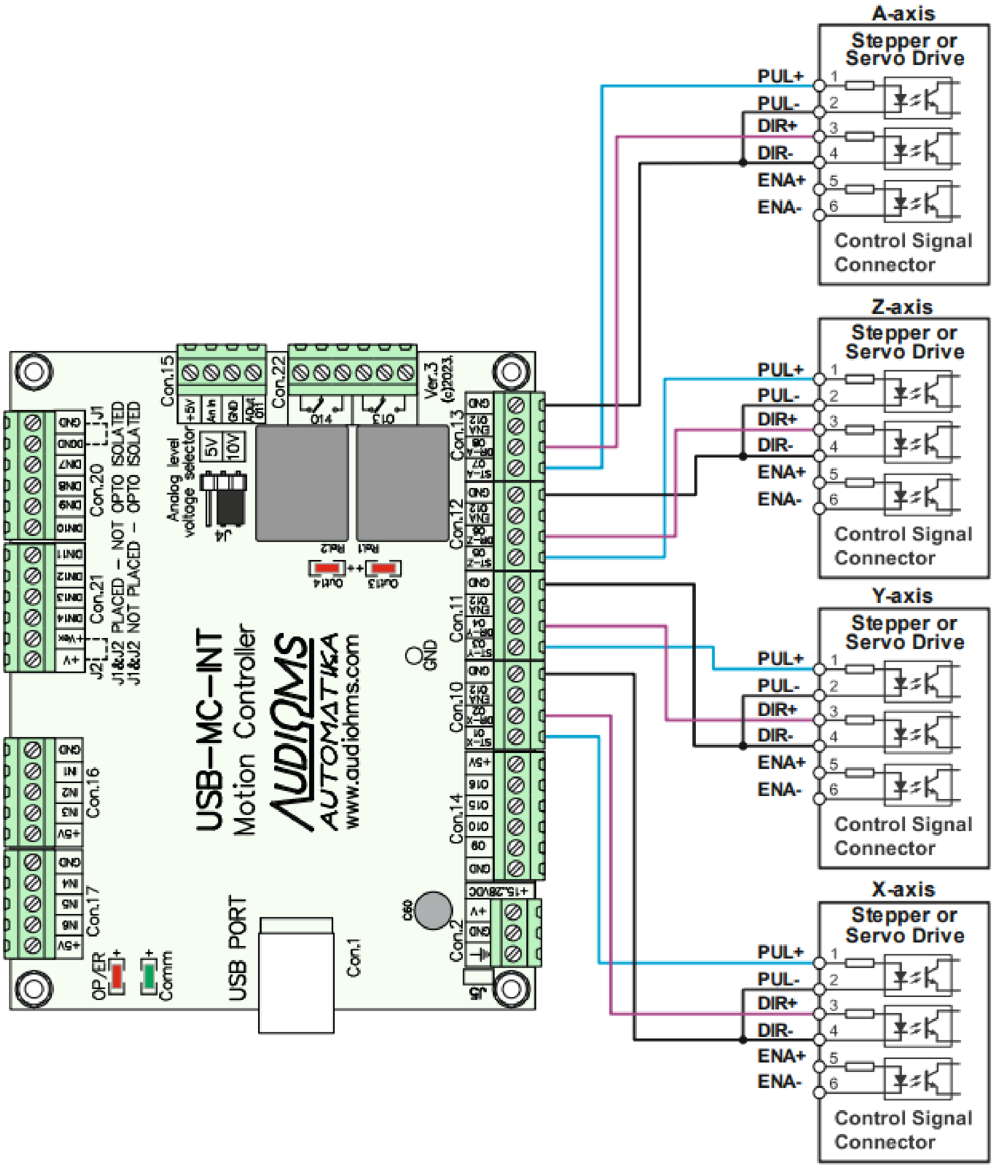


Figure 8.8 Connecting drivers from other manufacturers in the case of inverted logic on ENABLE input

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).

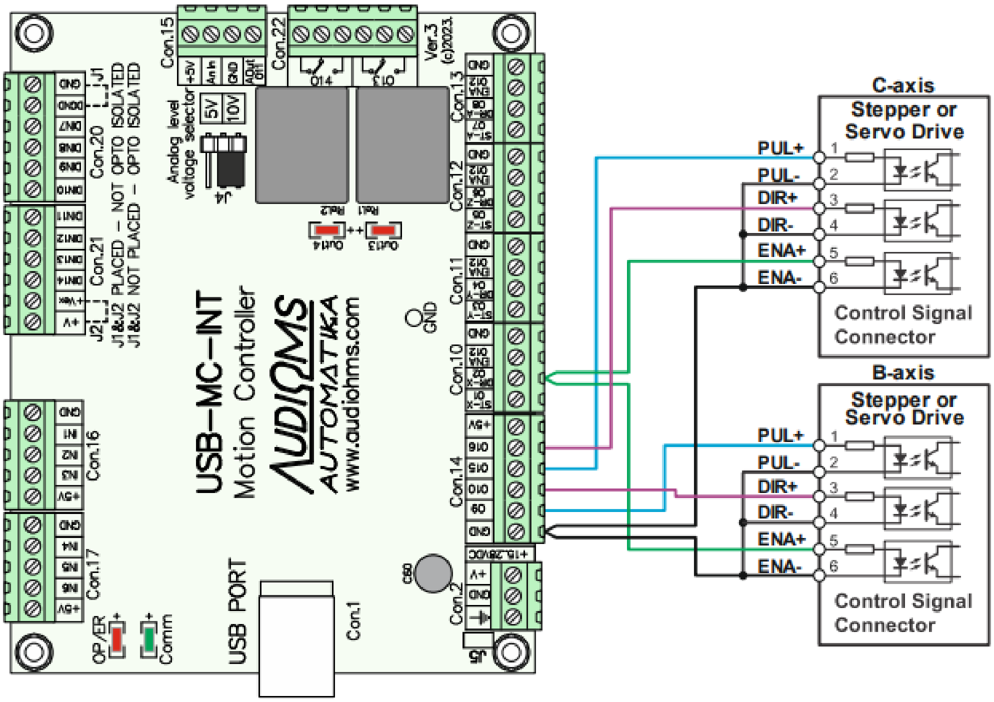


Figure 8.9

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

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 the possible wiring scheme of relay outputs on the 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 the USB-MC-INT motion controller.
- For activation of relay outputs digital outputs O13 and O14 are used and on the USB-MC-INT motion controller some indicators show the state of relay outputs.

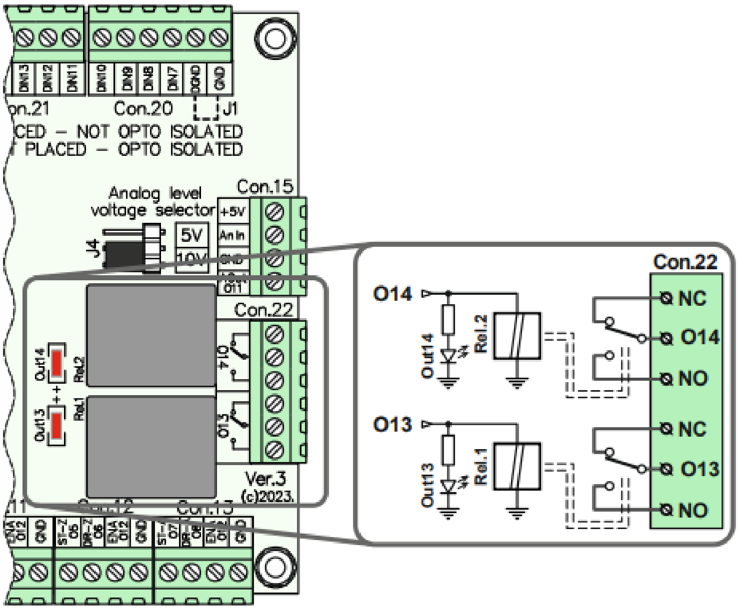


Figure 8.10 Possible connection of relay outputs

Analog output on USB-MC-INT motion controller

- Mach3 can 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.
- The voltage level for analog output is factory preset to range 0-10 V. Optionally it is possible to set the 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 the USB-MC-INT motion controller.

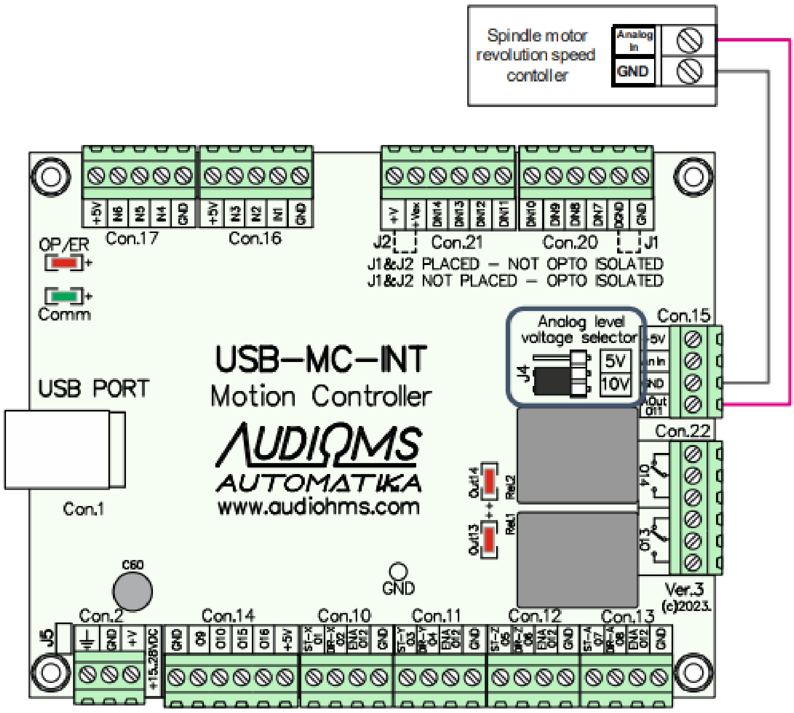


Figure 8.11 Analog output for controlling spindle motor revolution rate

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

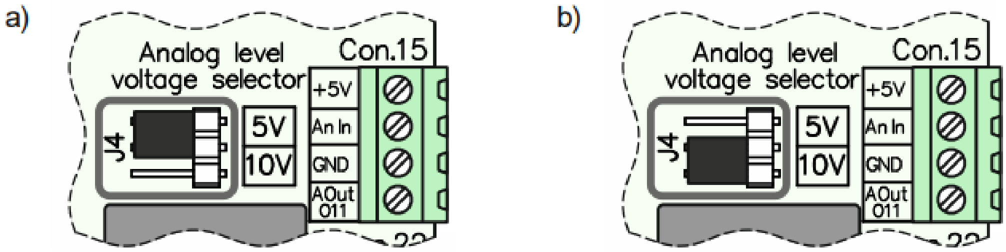


Figure 8.12 Jumper for analog output range selection, a) position for range 0-5V and b) position for range 0-10V

Analog input USB-MC-INT motion controller

- USB-MC-INT motion controller has one analog input (An in) with a 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 to realize some of the special functions (FRO, SRO, THC control, etc.).
- Figure 8.13.a shows the recommended method for connecting the potentiometer to the analog input An In, and Figure 8.13.b shows the recommended way for connecting the 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 a separate instruction manual.

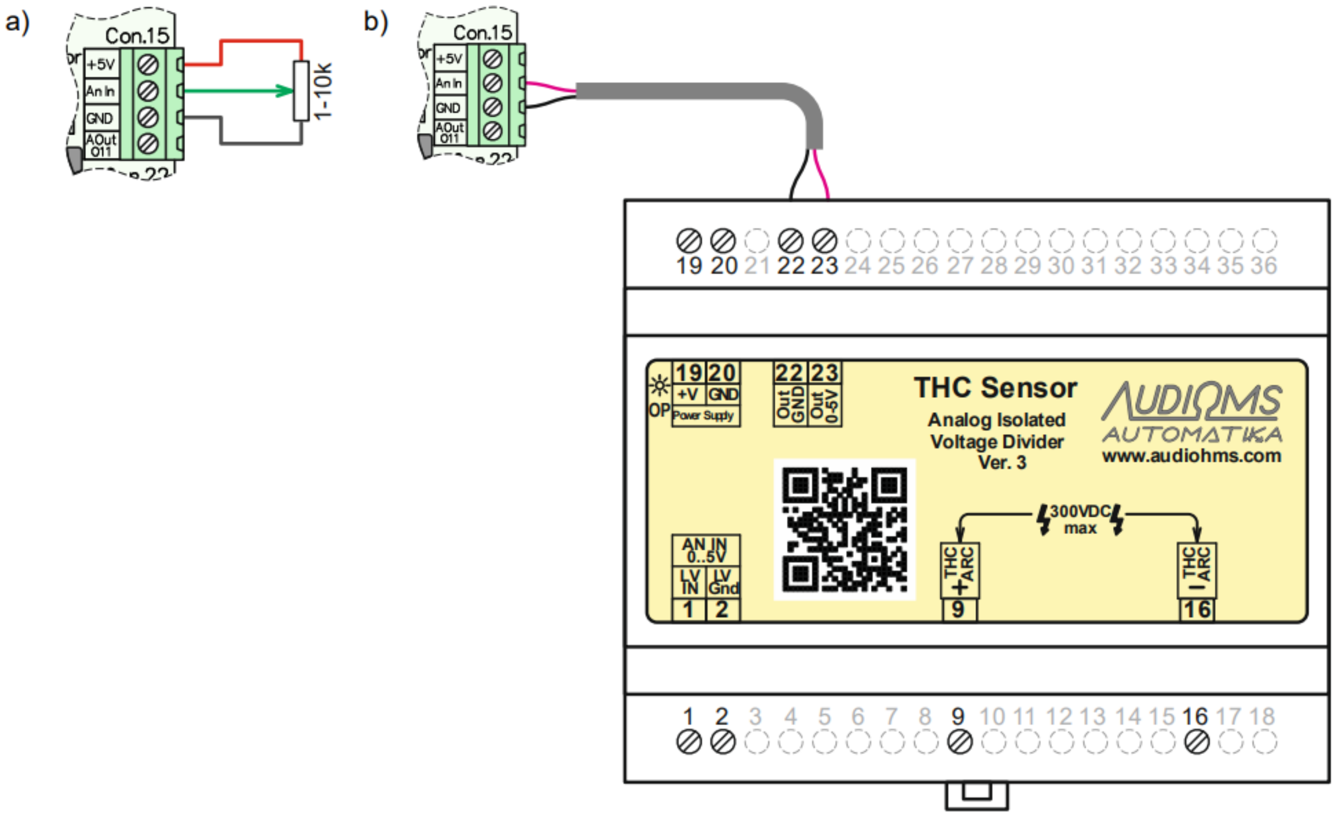


Figure 8.13 Connecting the source of analog signal to the analog input, a) using potentiometer and b) from THC sensor

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 a 3.4 kHz cutoff frequency implemented.

Digital inputs DIN7-DIN14 have a common negative supply line (DGnd).
In the following text, there is a detailed explanation of limit switches wiring.

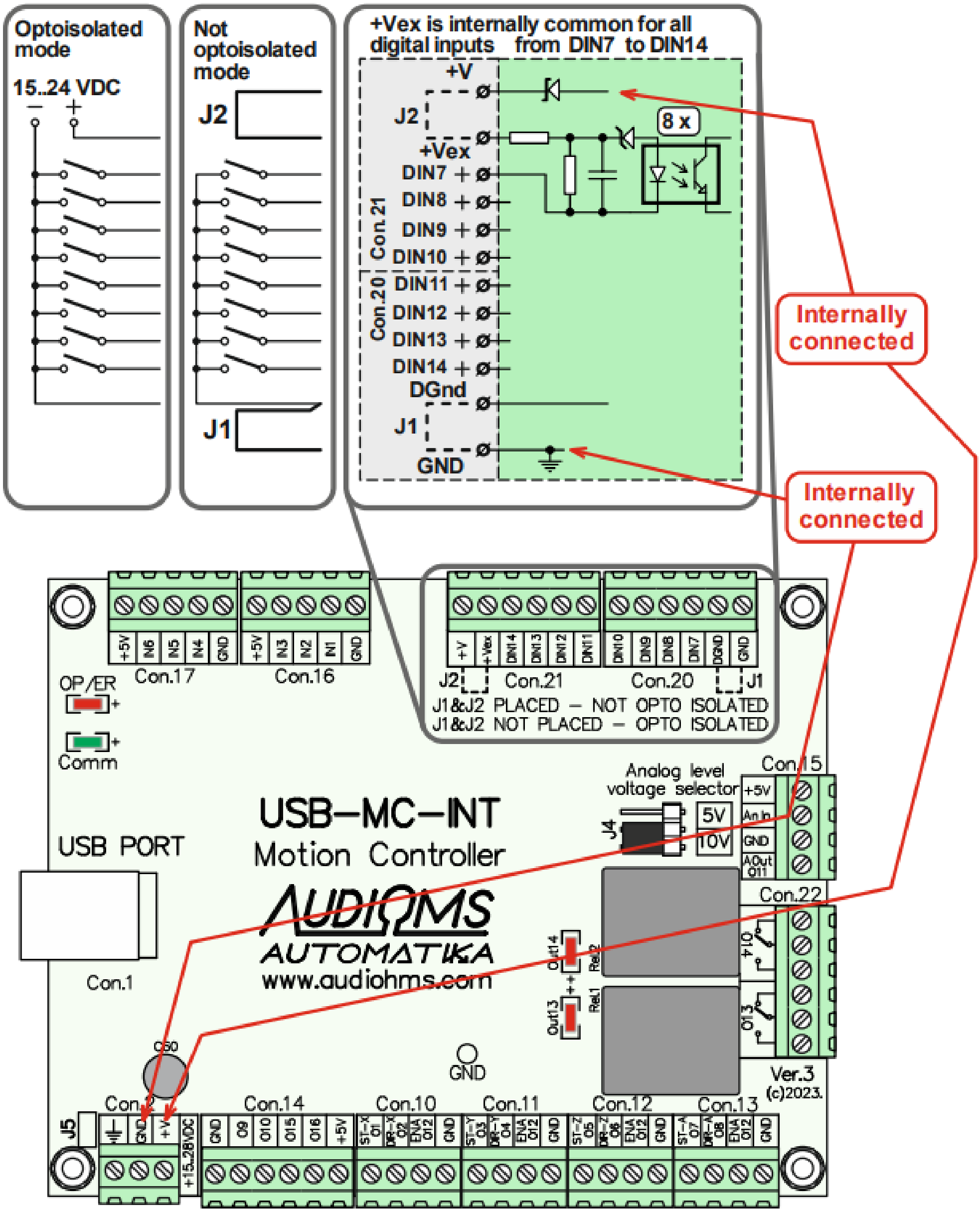


Figure 8.14 Location of opto-isolated digital inputs on the USB-MC-INT motion controller

Isolated mode for wiring limit switches to the optoisolated inputs
Isolated mode for wiring limit switches to digital inputs DIN7-DIN14 implies using an additional power supply with voltage in the range of 15-25 VDC. Figure 8.15 shows the 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. An inductive switch with an 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.

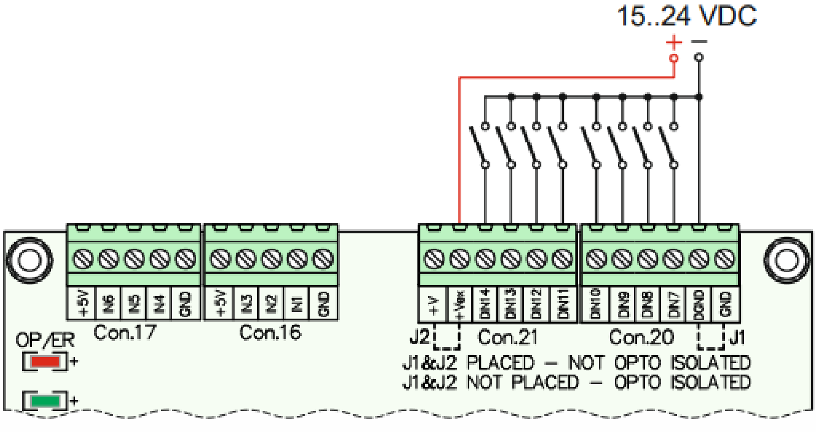


Figure 8.15 Isolated mode for wiring electro-mechanical type of limit switches

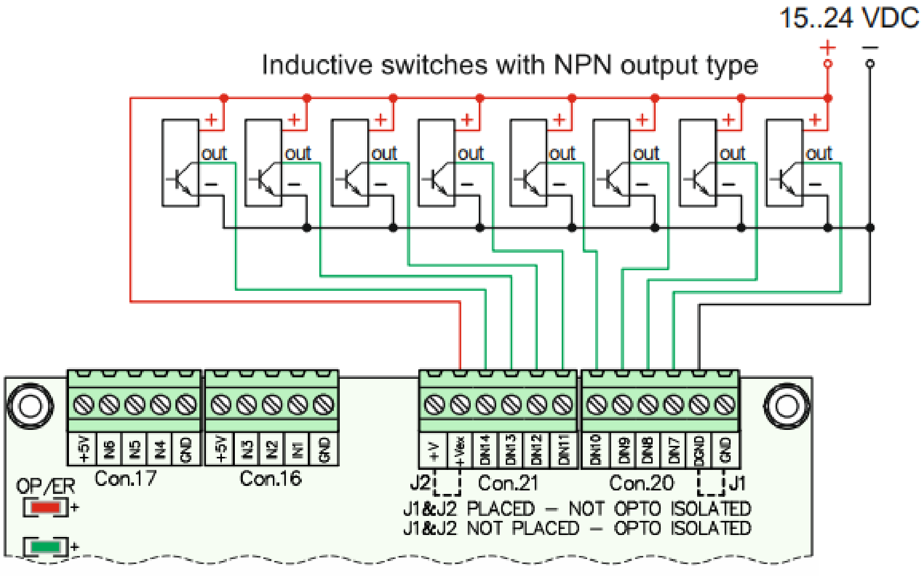


Figure 8.16 Isolated mode for wiring inductive type of limit switches

Non-isolated mode for wiring limit switches to the optoisolated inputs

This mode implies the usage of the power supply of the USB-MC-INT motion controller for activation of digital inputs DIN7-DIN14. In that case supply voltage of the USB-MC-INT motion controller must be in the recommended range (15-28 VDC). Figure 8.17 shows the 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.

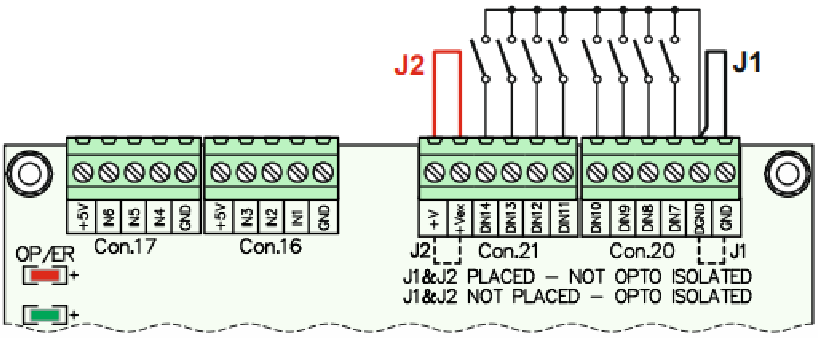


Figure 8.17 Non-isolated mode for wiring limit switches of electro-mechanical type

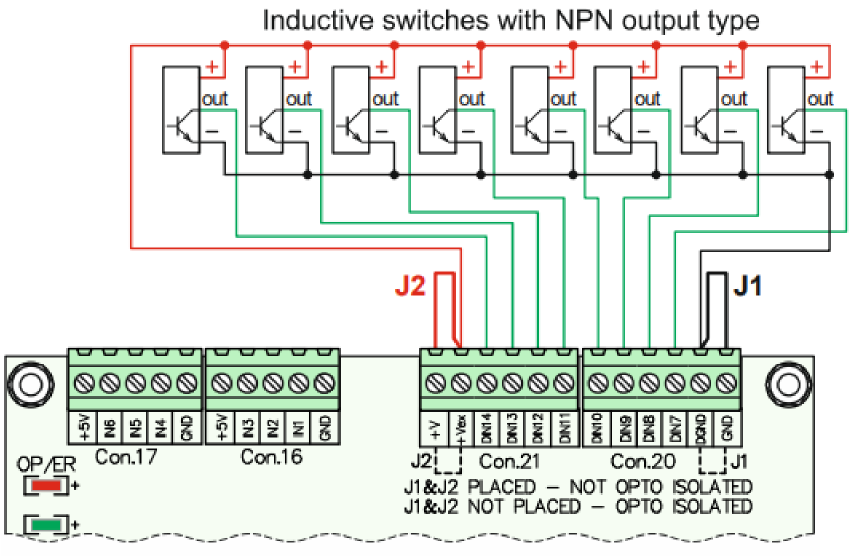


Figure 8.18 Non-isolated mode for wiring limit switches of inductive type

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 the 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 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 the 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.

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 to ensure an opto-isolated regime.

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).

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 the 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.

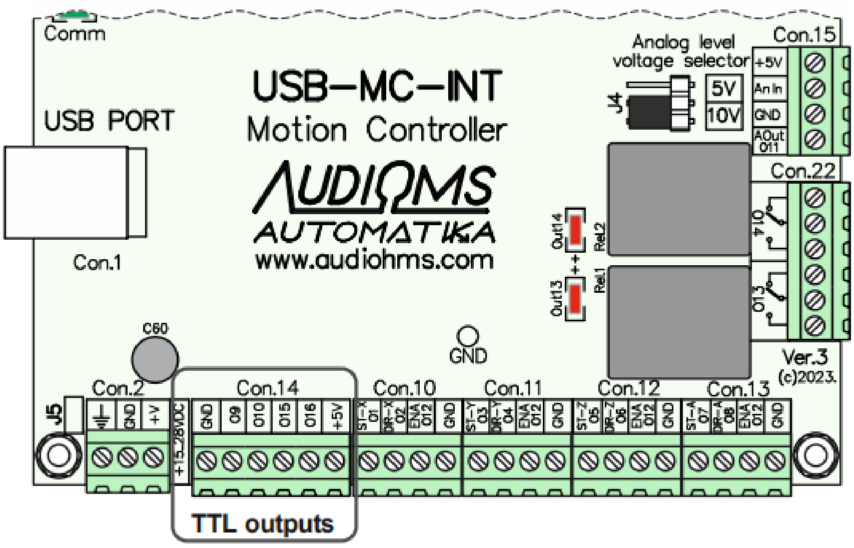


Figure 8.23 Location of general purpose digital outputs

LED indicators

OP/ER – Status LED

Does not light up	The controller is not powered
Blinking slow	The controller is in safe mode (outputs are in a high impedance state)
Constantly lights	Established connection with a computer, the 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 the Mach3 status line

Comm LED
Lights when there is a communication with computer.

Safety recommendations

- It is highly recommended to enforce galvanic isolation between the work environment and PC (using opto-isolators and similar).
- All Audioms Automatika doo drives for stepper and DC servo motors have built-in optocouplers 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 the operation of a complete work system, as well as awareness of possible risks of working with machines and tools.
- It is advisable to place the USB-MC-INT motion controller in a metal enclosure so that it is protected from external influences in the presence of a strong electromagnetic field, very high temperature, moisture, and similar.
- It is necessary to comply with safety standards like the installation of EStop buttons, limit switches, and similar.

FAQ

- **Q: How do I update the firmware?**
  - A: You can update the firmware automatically through the provided software. Please refer to section 3.3 in the user manual for detailed instructions.
- **Q: What functions are not supported by the USB MotionController?**
  - A: Refer to section 1.2 in the user manual for a list of functions that are not supported.
- **Q: How do I adjust ports and pins?**
  - A: To adjust ports and pins, please follow the instructions provided in section 4.1 of the user manual.

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

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

Documents / Resources

	AUDIOMS AUTOMATIKA USB-MC-INT-v3 Motion Controller [pdf] User Manual USB-MC-INT-v3 Motion Controller, USB-MC-INT-v3, Motion Controller, Controller

References

- Audiohms - drajveri za upravljanje koračnim i DC servo motorima
- Audiohms - drajveri za upravljanje koračnim i DC servo motorima
- User Manual