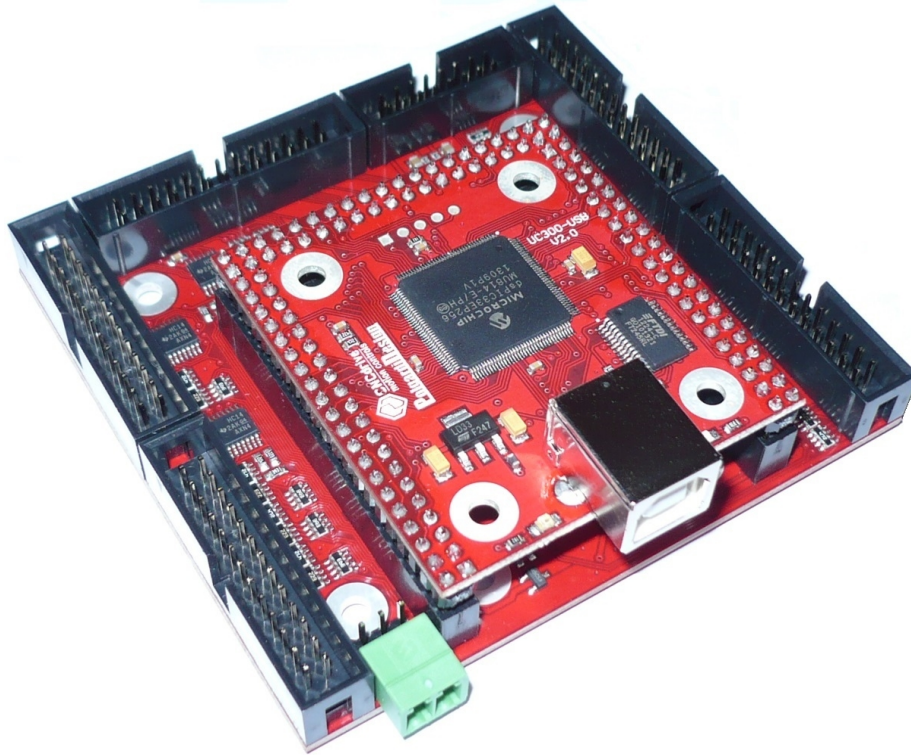# UC300-5LPT

USB CNC motion controller
to use with MACH3 software

Current plugin version: V1.053

Contents:

1. Product description and background of working

Mach3 is a popular CNC machine tool control software running on desktop computers and laptops under Windows operating system. Mach3 in default working the the computer's parallel (printer) port and sending all signals via this port. Windows is not a realtime operating system and therefor it is a difficult and CPU time consuming task for Mach3 to generate these signals in a precise manner. As the output signals frequency gets higher with using todays more and more advanced motor control electronics Mach3 needs the more processor time of the computer. If the computer gets overloaded by Mach3 or by running other software(s) in the background may leads to a lagging of the G-code code execution to even a falter in the motion interpolation which may lead to a catastrophic failure of some applications.
Another problem with the LPT port is that in today's informatic technology this kind of port is no more used and is a dying out device and non of the new laptops having this kind of port built in anymore.

The UC300 motion controller overcomes these problems with removing all time critical tasks from the control computer and Windows and executing all these tasks on inside it's own high speed DSP control chip outside the PC.
The UC300 controller connects to the PC via the USB port and this kind of port is more modern as an LPT port and exists on all today's computers.

Because of using a high speed DSP core the UC300 making the interpolations and other timings much more precise as Mach3 could ever do using it's standard LPT port driver and because the time critical tasks are no more done on the PC side, but on the UC300 controller the PC's CPU time usage is much lower and the risk of overloading the PC resources lowers with factors as the UC300 has a long enough data buffer so that it can handle a 100% CPU usage and overload for some seconds without interrupting the motion and the G-code execution.

For these reasons it is also possible to use a much slower and cheaper computer together with the UC300 as what is needed for Mach3 if using the LPT port drivers and this can even lower the system's overall cost.

When developing we also thought about backward compatibility with the old LPT printer port and therefor we've designed a motherboard for the UC300 motion controller. The UC300 plugs into the 5LPT motherboard and automaticly detects if plugged into the motheboards and reconfigures itself to work with the motherboard. The UC300 module together with the 5LPT motherboard is the product what we named UC300-5LPT.

This 5LPT motherboard has 5 pieces of IDC-26 connectors. These connectors have all has simmilar pinout as an LPT port and in extension they have an 5Volts power output on the 26.pin which pin does not exists on the DSUB-25 connector of the LPT port. This 26.pin could be optionally used to power external stepper or servo drive's optocouplers, if nessessary. All IDC-26 connectors can be easily converted to a DSUB-25 ports with simply plugging an IDC-26 to LPT-25 female crimped cable assembly to the port. This cable connection creates an LPT port type DSUB-25 female plug.

Because in most installations more inputs are needed than outputs only 2 of the IDC ports have exactly the same pinout as a standard LPT port. On the other 3 ports the lower 8 bits (pins 2. to 9.) are input pins. This input type connector is the same as a bidirectional type

LPT port switched to input type LPT mode.

There is a sixth connector also on the 5 LPT motherboard. This port contains 2 analog input and 2 analog output pins and 12V power output pins. The 12Volts is generated from the USB 5Volts with a step-up converter. This power is not isolated and is on the same potential as the control PC.

The analog inputs can be used to control for example SRO (spindle speed override) and FRO (feedrate override) using an external potentiometer connected between to between the 12V power output and the analog input.

The analog outputs can be used to control for example speed of a spindle motor using a VFD with analog input.

2. Pinouts

 a. Connectors placement and types.

The following picture shows the connectors placements of the device.
Each connector is marked.
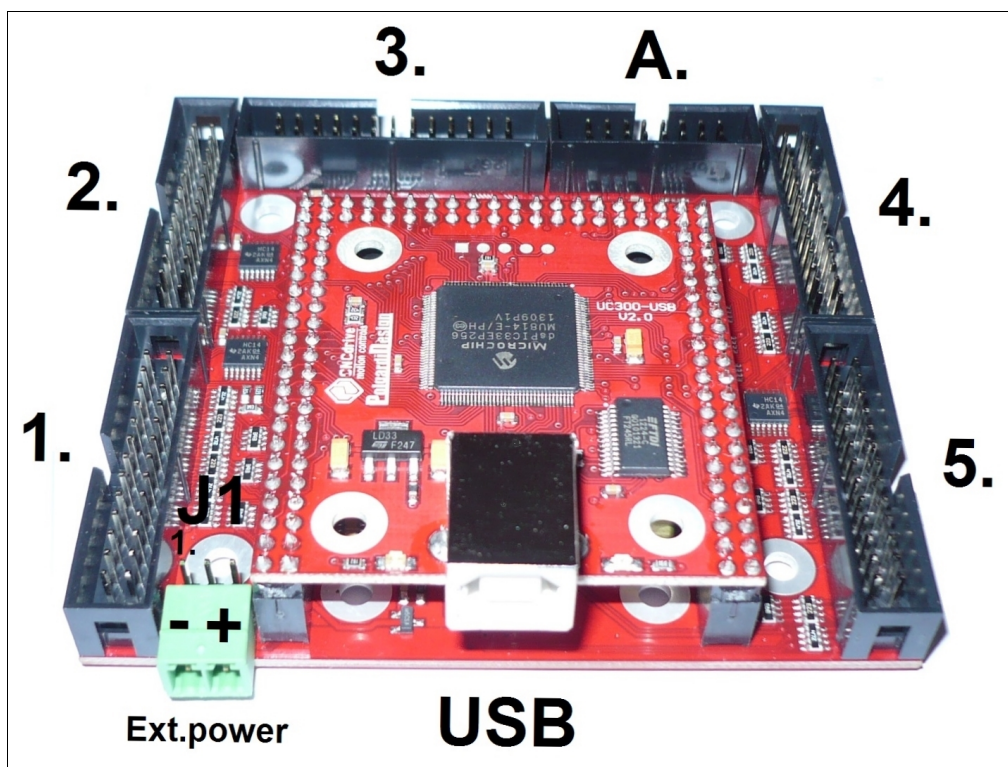
The ports 2. and 3. are standard type LPT connectors.
The ports 1. , 4. , 5. are input type LPT connectors.
The port marked with A. is an analog I/O port with 2 analog in and 2 analog output channels.
The USB port is used to connect the device to the control computer's USB port.
The Ext.power port is an external 5Volt input connector, this port can be used to power the device externally. To use this powering option, jumper J1 should be set to 2-3 positions.
If J1 jumper is set to 1-2 positions then the device is self powered, getting it's power from the USB port.

b. Connectors pinouts.

Standard and Input type LPT I/O port pinouts.

The LPT type ports contains digital input and output signals. The standard and input type connectors pinout is different. The following table shows the pinouts of each type of ports.
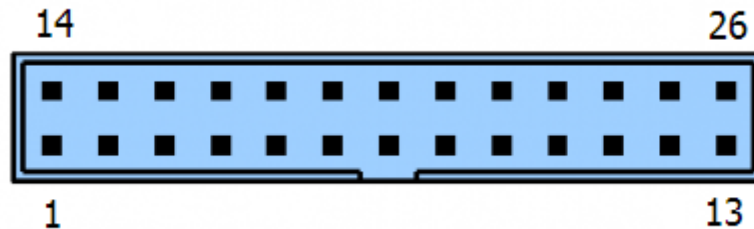

Pin number	Standard type LPT port signals direction (Ports 2. and 3.)	Input type LPT port signals direction (Ports 1. , 4. and 5.)
1	Output 1.	Output 1.
2	Output 2.	Input 2.
3	Output 3.	Input 3.
4	Output 4.	Input 4.
5	Output 5.	Input 5.
6	Output 6.	Input 6.
7	Output 7.	Input 7.
8	Output 8.	Input 8.
9	Output 9.	Input 9.
10	Input 10.	Input 10.
11	Input 11.	Input 11.
12	Input 12.	Input 12.
13	Input 13.	Input 13.
14	Output 14.	Output 14.
15	Input 15.	Input 15.
16	Output 16.	Output 16.
17	Output 17.	Output 17.
18-25	Ground	Ground
26	5 Volt output	5 Volt output

Important note: all in and output pins in all ports are referenced to the computer's grounding, there is no isolation in the UC300-LPT port, this means that the device not replacing a breakout board with isolation. An external isolation (for example optical isolators inside the motor drives) are necessary to make safe connections.

Analog I/O port pinout.

The analog port contains 2 analog inputs and 2 analog outputs. This port also contains a 12Volts power output. This 12Volts is internally generated from the 5Volts of the USB port or from the externally connected 5Volt power supply.(Depends on how the device is powered)
The following table shows the pinout of the analog I/O port.
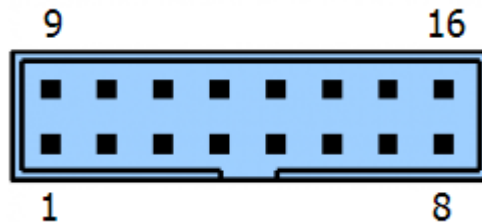
Pin number	Signal direction
1	12 Volt output
2	Ground
3	Analog input 1.
4	Analog input 2.
5	Ground
6	Analog output 2.
7	Analog output 1.
8	12 Volt output
9	12 Volt output
10	Ground
11	Analog input 1.
12	Analog input 2.
13	Ground
14	Analog output 2.
15	Analog output 1.
16	12 Volt output

Important note: all in and output pins in all ports are referenced to the computer's grounding, there is no isolation in the UC300-LPT port, this means that the device not replacing a breakout board with isolation. An external isolation (for example optical isolators inside the motor drives) are necessary to make safe connections.

3. Physical dimensions of the device

The following drawing shows the UC300-5LPT phisical dimensions.
The device has 4pcs of 3.5mm in diameter through hole drills with 7.5mm diameter circular plated pads to for attachment.
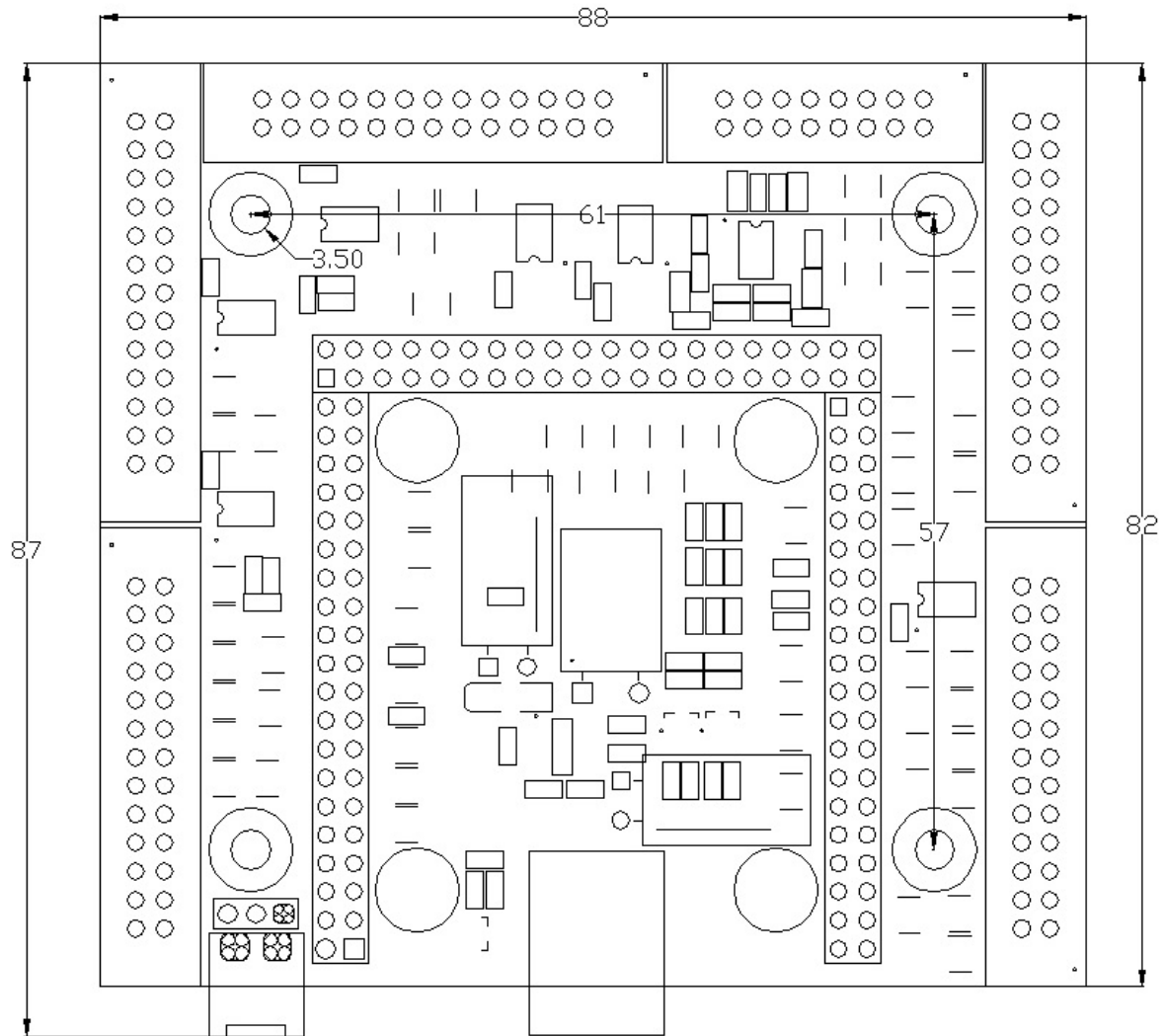
All dimensions are in millimeters.

4. Installation

The UC300 controller is compatible with the Windows XP, 7, 8 and 8.1. Operating Systems with both the 32bit(x86) and 64bit(x64) versions.
The installation can be done easily with our automatic installer software:
http://www.cncdrive.com/UC300.html

The automatic installer is an online and offline installer which means it connects to the internet and downloading and installing the latest plugin and the USB drivers for the UC300 controller. If the software cannot connect to the internet (due to missing internet connection of the computer) then it installing the prepacked plugin and drivers versions, this is the offline installation mode.
Currently the automatic installer is working under the following operating systems:
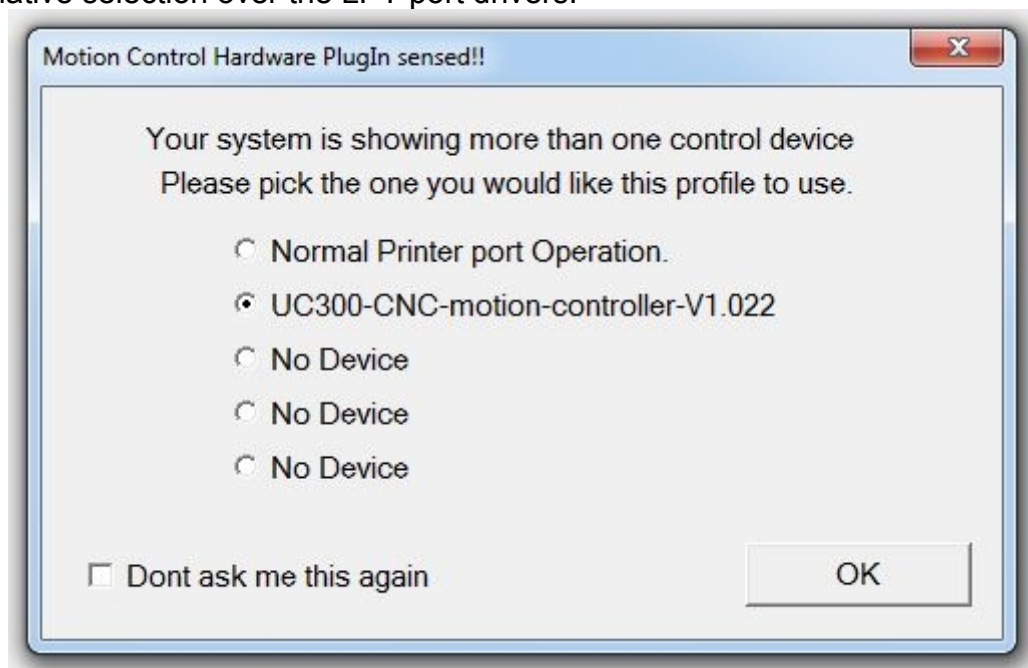 – Windows XP
  – Windows 7 32bit and 64bit versions.
  – Windows 8 32bit and 64bit versions.
  – Windows 8.1 32bit and 64bit versions.

Our USB drivers are WHQL certified by Microsoft.

5. System setup
a. The first run

Start Mach3 and the following screen will popup indicating the UC300 motion controller as an alternative selection over the LPT port drivers.

Select the UC300 CNC motion controller from the list.

If selecting the "Dont ask me this again" then this screen will not popup anymore when starting Mach3 and the default driver will be the UC300 in this case.
If once the "Dont ask me this again" was selected and if for any reason the LPT port drivers will need to be used at a later time then pressing the "CFG's->Reset device sel..." menu item in Mach3 will reset this popup screen and at the next start of Mach3 the LPT port drivers will become selectable again.

In the bootup procedure the plugin automaticly checks the actual firmware version in the UC300 motion controller. The firmware and the plugin versions must be matched, so if Mach3 finds an uncompatible (forexample an older version) of firmware in the UC300 which is not compatible with the installed plugin then Mach3 will popup a warning screen and will download the compatible drivers to the UC300 automaticly.
This automatic checking procedure at each Mach3 startup guarantees that the firmware in the UC300 and the plugin in Mach3 will be always compatible with eachother.

b. Setting up Mach3 with the UC300 controller

There are in total 5 LPT type digital ports. Set the Port# in Mach3 to a number 1 to 5, to refer to the different ports.

To check the status of the pins the "Plugin control->UC300 I/O monitor" screen can be used.

The I/O monitor screen has 5 tab pages, these are the following:

- – Output pin state
- – Input pin state
- – Status
- – Analog in/out
- – Setup

The **Output pin state** tab page shows all of the digital output signals' logic state. The gray colored box next to a pin means the output is actually in a logic low and the red box next to the input pin means the output is actually in a logic high state.
The Output pin state tab page is shown below:
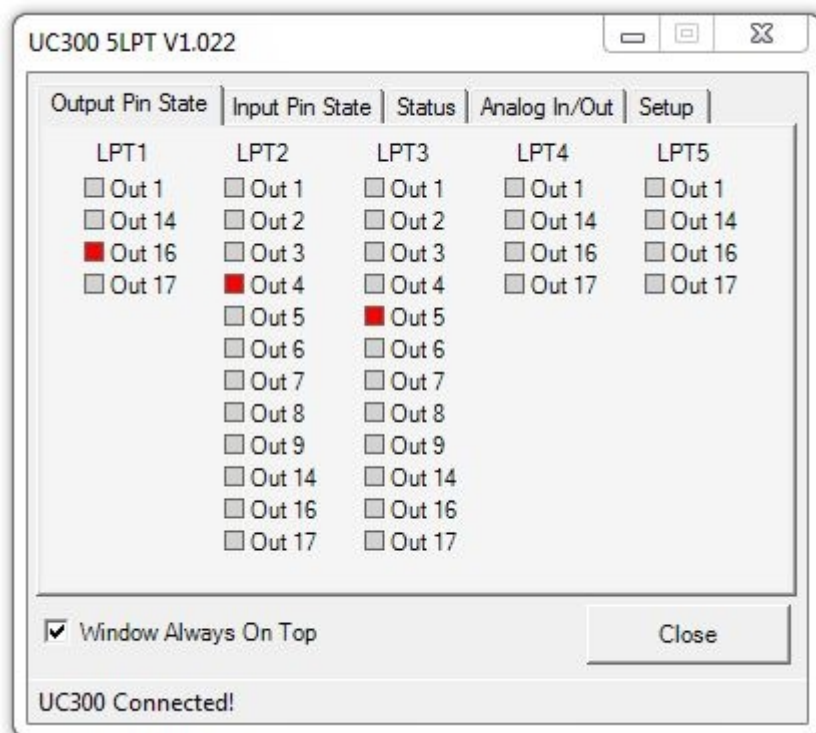
The **Input pin state** tab page shows all of the digital input signals' logic state. The gray colored box next to a pin means the input is actually in a logic low and the red box next to the input pin means the input is actually in a logic high state.
The Input pin state tab page is shown below:
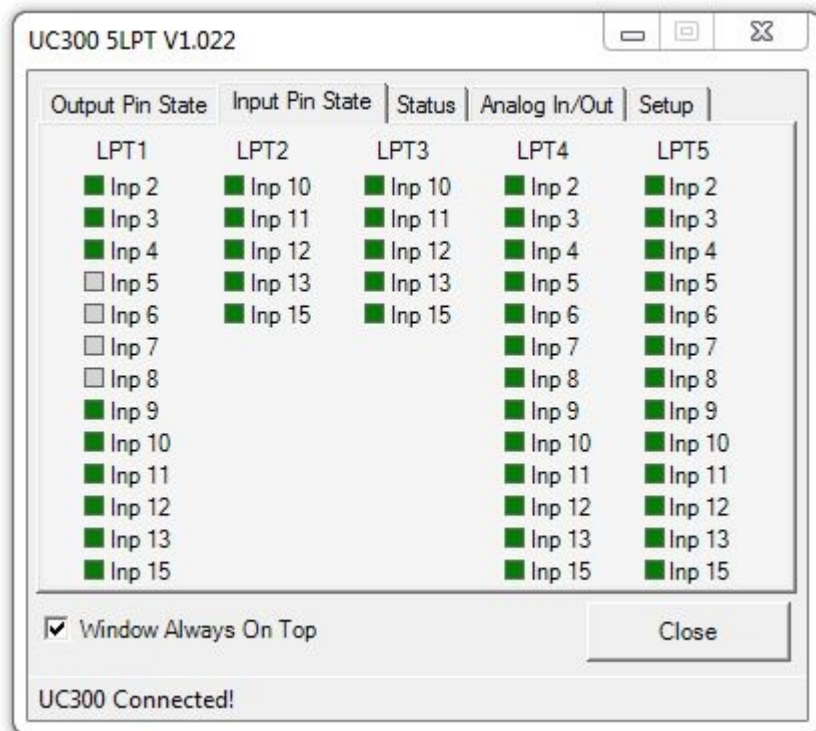
The **Status** tab page providing informations on the UC300 running state which can be Run or Idle. The screen shows if the machine is currently jogged. It also shows informations on different setup properties, like if the Backlash compensation is ongoing or if there is a homing action is executed or if the machine is actually measuring the a tool length (probe). The screen shows if the E-stop or hard limit switches are pressed or if the software set coordinates limits are reached.
There is also an indication of the axis coordinates, the internal time counter of Mach3, and an Error counter and the spindle PWM actual setting.
The Status tab page is shown below:
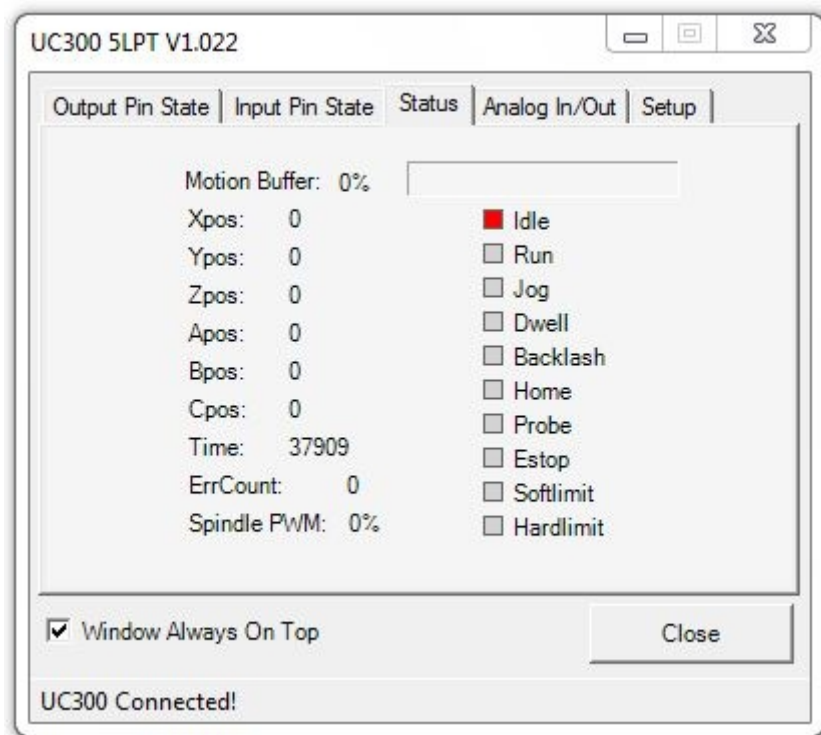
The **Analog In/Out** tab page has parameters to set and to indicate in regards the analog in and outputs of the UC300-5LPT controller. The 5LPT motherboard has 2 analog inputs and 2 analog outputs onboard. The values of these analog signals are shown on this page.

The analog input 1 signal can be used for SRO (Spindle speed override), setting the SRO checkbox assigns the analog input 1. signal to the SRO function.
A potentiometer can be connected to the analog port with the center tab connected to the analog input signal and one end of the potentiometer connected to 12Volts output of the analog port and the other end connected to ground of the analog port. This external potentiometer can then control the Spindle speed.

The analog input 2. signal can be used for FRO (Feed rate override), setting the FRO checkbox assigns the analog input 2. signal to the FRO function.
A potentiometer can be connected to the analog port with the center tab connected to the analog input signal and one end of the potentiometer connected to 12Volts output of the analog port and the other end connected to ground of the analog port. This external potentiometer can then control the Feedrate.

The analog output 1. signal can be used for SP PWM (Spindle speed PWM), setting the SP PWM checkbox assigns the analog output 1. signal to the spindle speed PWM function. If this checkbox is set the proportional analog Voltage of the actual spindle speed PWM signal will appear on this analog output pin of the device. The range of the signal is 0-10Volts.

The analog output 2. signal has no special function to be attached to.

If the special function for the analog signals are not assigned then the value of the signals go to the internal variables of Mach3. The number of the variable the signals go to can be set next to the signal name, in a textbox. The defaults are variables are 1000, 1001, 1004 and 1005.

The unit of the analog signals can be "Value" which means a digital integer range of 0-65535. Or it can be "%" which range is 0-100% or "V" which stands for Volts where the indicated range is 0-10Volts.

The analog in/out tab page is shown below:
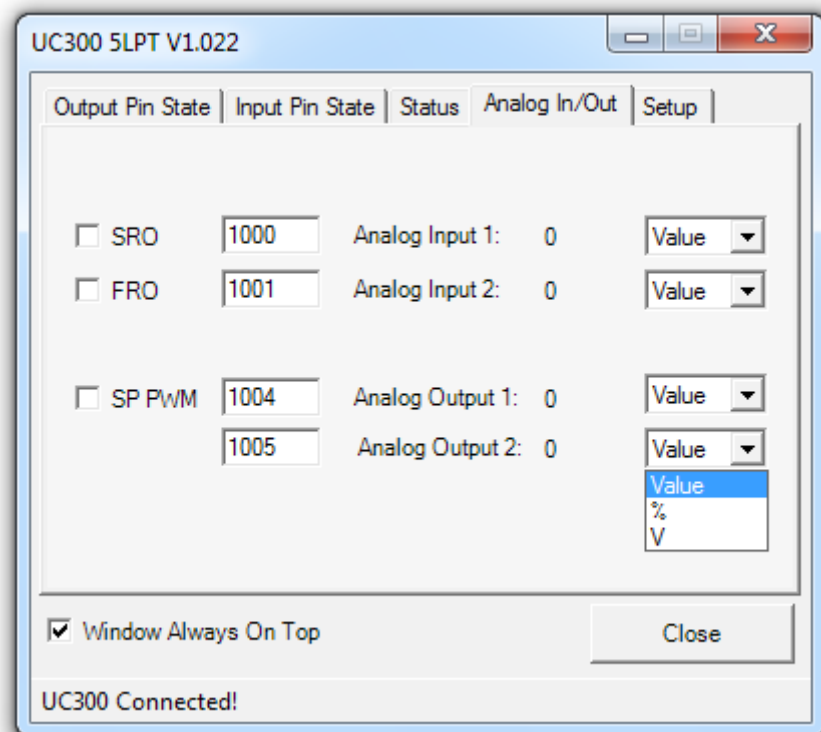
The **Setup** tab page shows two parameters to set. The first one is the kernel frequency of the UC300. It can be 100kHz, 50kHz and 25kHz. Note that changing the kernel frequency needs a restart of Mach3 to take effect.

The index prescaler is a special function of the UC300. It makes it possible to use a more than one slot position sensor (disk/encoder) for the spindle speed feedback.

This index prescaler function works only for the Mach3mill and not for Mach3turn. In other words this function can be used for milling motors and not for lathe main spindles.
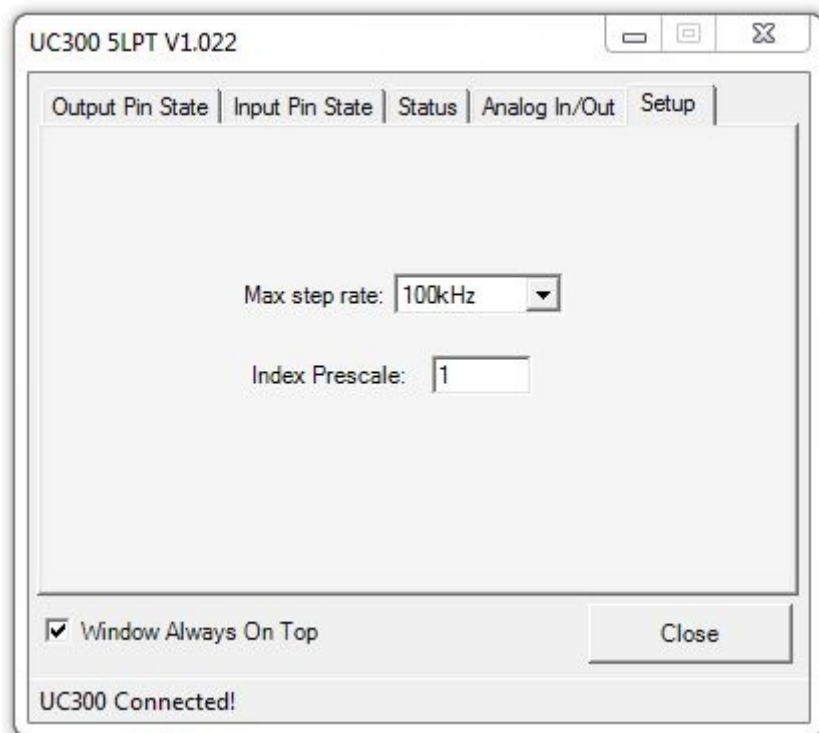
The **Input Functions** tab page contains a table which makes it possible to easily align any Mach3 OEM function to any input on the UC300 board. This input function table is currently available for our 5-LPT motherboard and for CNC4PC's M44 motherboard.

To align a function to an input simply find the Port# and Pin# wanted and select the required Mach3 function from the dropdown list and select the active edge of the signal triggering to active high or active low. Once the physical input signal triggers the aligned Mach3 function is getting called and triggered by the UC300 plugin.
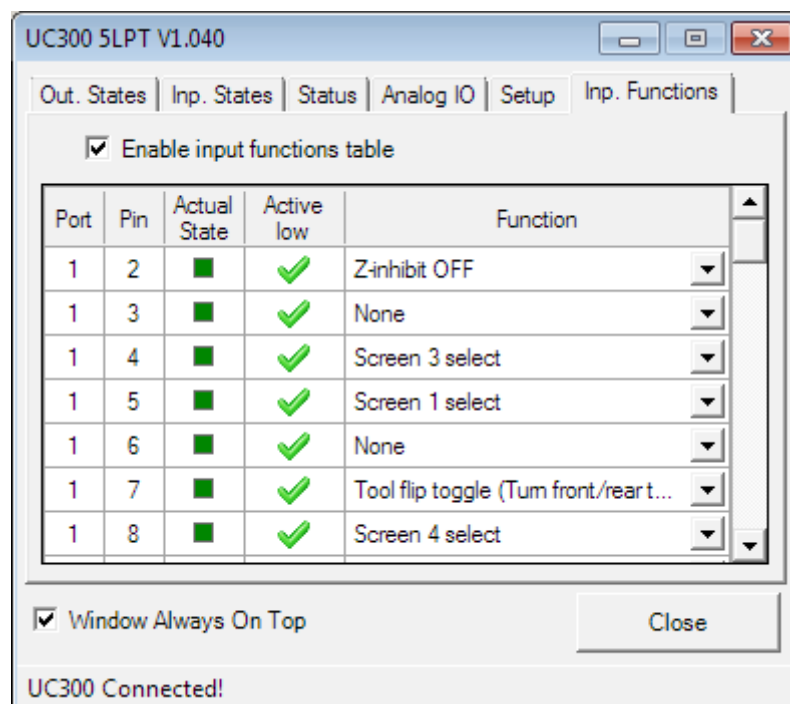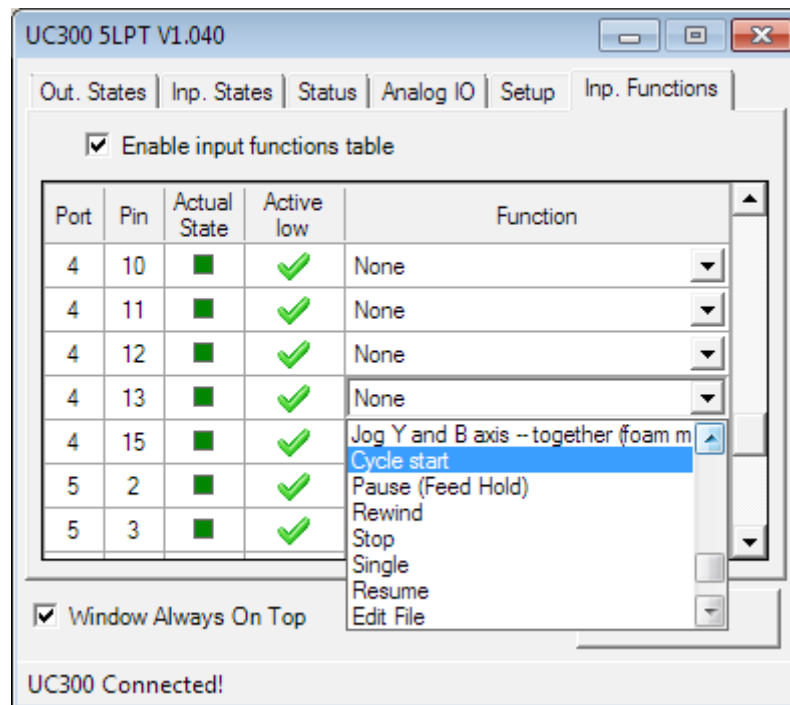
c. Updating the UC300 plugin

To update the UC300 plugin to the most upto date version in Mach3 go to the Config – Config Plugins menu and find the UC300 motion controller in the list and press the yellow config label. This will popup the following screen. Pressing the Check for new plugin version will connect to our website over the internet and will download and install the most upto date version of the plugins. Note that an internet connection on the computer is needed to update the plugin this way. If there is no internet access on the control computer then use our automatic installer software package uptodate version to update the plugin.
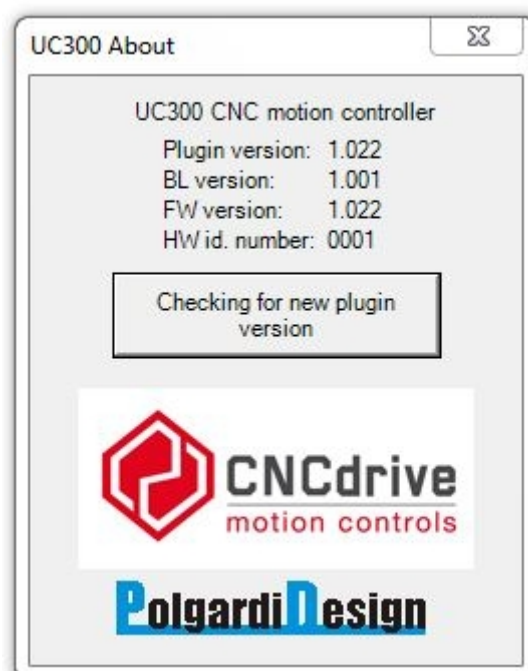
## 6. LED feedback signals on the UC300 controller

There are 2 LEDs located on the top of the UC300 module.
These LEDs providing informations about the UC300 working states and these states are the following:

- The green (power LED) lighting continiously indicates normal operation and that the UC300 is up and running normally.
- The green (power LED) blinking with about 5Hz frequency indicates a firmware error.
- The green (power LED) blinking slow, with about 1Hz indicates a firmware update in progress and in this case wait till the firmware update procedure ends and the green LED returns to a continuous lighting state.

- The blue (communication LED) if on indicates that the connection between Mach3 and the UC300 controller is active. The LED sometimes blinks (mostly on slower computers) and sometimes lights continiously (mostly on fast computers).

7. Errors and installation debugging

If the following screen pops up when starting Mach3:
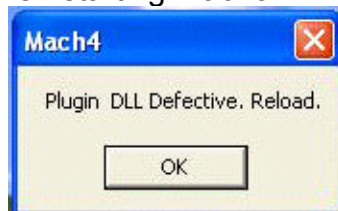
then the .NET framework was not installed on the computer. The .NET framework 2.0 is the prerequirement for running the UC300 controller plugin. The framework can be downloaded from the UC300 product page, here: http://cncdrive.com/UC300.html or from Microsoft's website. The .Net framework 2.0 is part of Windows7 and therefor it is not required to install it on Windows 7 operating systems. It is only required to install it on Windows XP as it not containing this tool by default, it must be installed separately, by the user on the Windows XP operating system.
The following popup screen indicates that Mach3 is unable to establish the connection with the UC300 controller, check the USB connections and the LED states of the UC300 and restart Mach3.
If the error does not go away then check and if nessessary reinstall the USB drivers.
The following popup screen appears if Mach3 loosing the connection with the UC300 meanwhile it is operating. This event may happen if the USB cable is broken or if the cable connector was accidentally slipping out from the UC300 or from the PC. The workaround is checking the USB cable connections and plug it back and restart Mach3.
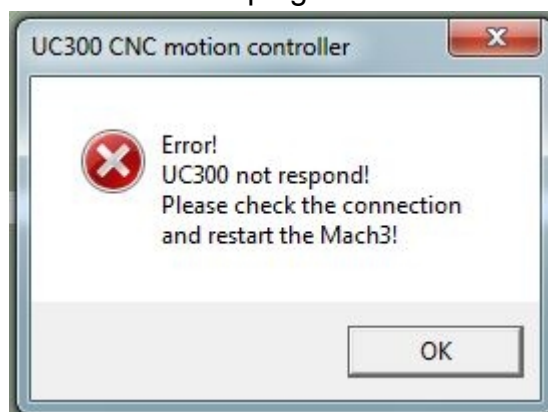
If Mach3 triggers the E-stop event and if the "UC300 Sync Error!" message appears in the statusbar of Mach3 then the UC300 lost the communication syncronisation with Mach3, this can happen if the computer is too slow or if the PC is so much overloaded with running other software in the background that there is not enough CPU or memory resources for Mach3 to keep the step with the UC300. Also the indication of this kind of error is that the blue LED in the UC300 backshell is blinking slowly with about 1Hz frequency only. The workaround is to check and close the running processes in Windows which overloads the PC too much, or if the PC itself is too slow and does not comply the minimal requirements to run Mach3 then exchange the PC to another, faster one.

8. Known limitations and bugs

Known limitations:

There are no known limitations in the current firmware version.

Known bugs:

There are no known bugs in the current firmware version.

9. Parameters and functions summary

General properties:

- Automatic firmware checking and firmware update.
- Motion control on upto 6-axis (X, Y, Z, A, B, C).
- Configurable maximum stepping frequency, the options are 25kHz(with 20usec pulse length), 50kHz(with 10usec pulse length), 100kHz(with 5usec pulse length).
- On the fly configurable 36 pieces of 5Volt (TTL level) buffered outputs. The current sink/source capability is 20mA max. per output.
- On the fly configurable 49 pieces of 5V (TTL level) schmitt triggered and filtered inputs. The input internal pullup resistance to 5Volts is 4.7kOhms.
- On the fly configurable 2 pieces of analog inputs and 2 pieces of analog outputs.
- About 1 second long communication buffer.
- LPT port compatible pinout.

Supported Mach3 functions:

- Jog.
- Reference inputs.
- E-stop input.
- Softlimits.
- Limit switch inputs.
- Limits override.
- Index input (extended function supports multi slot spindle sensors, for Mach3-mill only, not for Mach3-turn!).
- Spindle speed PWM control output.
- Step and direction spindle control output.
- Spindle and coolant relay control.
- Charge pump safety signal output (configurable to active/inactive when in E-stop).
- Charge pump adjustable frequency (12.50kHz in normal or 5kHz in laser mode).
- All signals configurable to active High/Low.
- General purpose I/O signals handling.
- Offline mode.
- All MPGs and encoders support. (2pcs maximum one time)
- Slave axis.
- Backlash compensation.
- Digit/probe input.
- THC control inputs.

10. Safety notes

! It is important to install and use optical isolation between the environment and the computer, therefor it is recommended to connect the UC300 to the motor drives and external sensors on the machine via signal isolators, e.g. via an optically isolated breakout board. A good example for this is our HDBB and HDBB2 breakout boards, the datasheet of these devices can be found and downloaded on our website.

! Use the UC300 motion controller product only if you understood it's working and also understood the risk of working with machine tools.

! It is important to comply the safety standards like installing the external E-stop button, limit switches, charge pump safety circuit.

! The UC300 motion controller should be installed in a an enclosure to protect the device from falling chips or liquid, protect the device from taint damage.

! Protect the device from direct intensive sunshine beams and from extreme temperature levels and from extra high humidity.

! In electrically noisy environment it is adviced to place and install the UC300 controller into the same electric cabinet where the motor drives are installed to.

! Keep the UC300 controller away from high Voltage parts and cables of the installation.
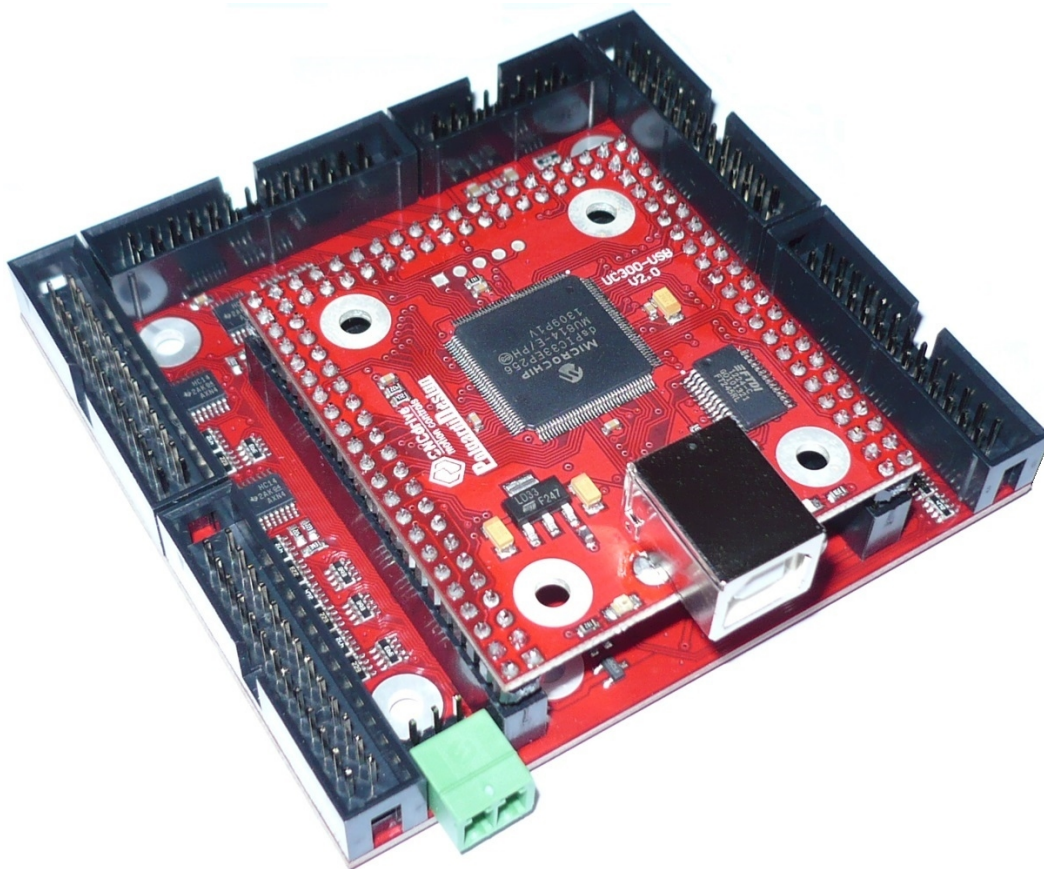
The actual look of the UC300-5LPT motion controller product.

For more informations please visit us at:

CNCdrive
motion controls

http://www.CNCdrive.com

Appendix A. : New functions and bug fixes:

Plugin version	Description of change(s)
V1.022	- First release for production.
V1.023	Bug fixes 1.) When homing and reaching the home sensor the acceleration/decceleration was set uncorrectly with some possible setups, bug fixed.
V1.027	Big fixes 1.) Analog inputs to OEM DROs were mapped uncorrectly which overlapped the block height gauge DRO in Mach3. Also The analog in/outputs were not saved correctly into the XML. The saving of these were now fixed and also the variables were remapped, bug fixed. 2.) The index prescaler function of the UC300 device did not handle out of range settings, the correct setting range was missed to being checked. Now the range must be 1-999 which is checked and new set value is ignored if out of range. Bug fixed. 3.) A red marker was added on the analog I/O window which indicating a possible out of range of the user variables settings. The allowed and valid range in Mach3 is between 1000-2255. The out of range setting is still possible, we kept the possibility for the users to use an out of range address to support any later address extensions (in case Machsupport adding more addresses later), but a red color is now indicating and giving a warning if the user setting is probably out of range. 4.) It was possible to switch the spindle on when e-stopped with a short pulse going out on the spindle output signal. This bug was fixed. 5.) Standard I/Os (excluding step/direction signals for axis) were reversed(uncorrect) in polarity on the 5LPT panel to the plugin settings. These signals were now inverted in the plugin as nesessary. 6.) The default (off) state, when Mach3 was not loaded the I/O states were all high on the 5LPT panel. This was in relation with point 5. bug above and the I/O states were corrected now to all logic low on the 5LPT outputs when the Mach3 is not loaded and the driver is not engaged. New features 1.) The new plugin supports the CNC4PC – MK44 motherboard. If the UC300 module is plugged into an MK44 board, it detects the motherboard and the motherboard specific settings appears on the plugin screen automaticaly.
V1.028	Bug fixes 1.) The plugin updater located on the plugin screen inside Mach3 was not working correctly. This bug was now fixed. And to update from previous versions to V1.028 plugin version, the automatic installer software on our website have to be used or the new plugin can be installed with manual copying. The Mach3 plugin updater in previous versions not worked correctly. This bug was fixed in this plugin.

V1.032	Functions were missing in previous version and were added in this release:
	1.) Added jog to motor tuning window. Now after entering the motor tuning window and changing the motor parameters and after pressing the Apply button the new settings can be tested with the keyboard jog keys without leaving the motor tuning window. This makes axis calibration faster and more comfortable.
	2.) Errors indication on the UC100 I/O monitor window's bottom side.
	Bug fixes
	1.) Feedhold and offline mode was not working. Bug fixed.
	2.) Index prescaler only appeared if loading the default (Mach3mill.xml), the prescaler now appears with all Mach3 xml's. Bug fixed.
	3.) At the end of the G-code program executions if the jogging was executed, the G-code line pointer was jumped to random line locations. Bug fixed.
	4.) Probing was working with errors in some cases. Bug fixed.
	5.) SetMachZero() function was not working correctly, it did not zero the axis. Bug fixed.
	6.) Analog inputs indications reworked.
V1.033	Bug fixes
	1.) Issues with probing if separate homing slave axis was setup. Bug fixed.
	2.) If slave axis was setup with separate homing then the homing function was not working. Bug fixed.
	3.) Program execution stopped in some cases if a slave axis was setup. Bug fixed.
V1.034	Bug fixes
	1.) The THC inputs for plasma were not working via software control like via brains. Bug fixed.
V1.036	Bug fixes
	1.) Minor correction in the firmware update process.
	2.) Safe-Z conflict with softlimits. Bug fixed.
	3.) Some input pins on port#4 was mapped uncorrectly with the CNC4PC M44 motherboard. Bug fixed.
V1.040	Functions were missing in previous version and were added in this release:
	1.) New selectable inputs to Mach3 OEM buttons alignment table. This table makes it possible to quickly configure any Mach3 button functions to physical inputs. The new function is available on the UC300 plugin screen. The plugin is available for both the 5LPT and the M44 motherboards.
	Bug fixes
	1.) If SRO potentiometer reached 100% value and if the over 100% set spindle speed was over the defined maximum spindle speed then the plugin threw an error message in the status screen in a loop. Bug was fixed, now the message shows up only once.
V1.049	Functions were missing in previous version and were added in this release:
	1.) M10/M11 P1 fast laser outputs support added.
	Bug fixes
	1.) Probe timing delay bug and probe zero speed exception bug fixed.
V1.050	Bug fixes
	1.) A charge pump to reset syncronisation problem was found and fixed.
V1.052	Bug fixes in this release:
	1.) Probe made some overrun when probing (G31), issue fixed.
V1.053	Bug fixes in this release:
	1.) Modification in the M10/M11 fast outputs handling.
	2.) Analog outputs value display in "Volts" issue fixed.
	Having a problem, found a bug? Inform us and we will fix it quickly!