Chapter 11

Appendix F: Connecting a Toolsetter

11.1 Introduction

Thank you for purchasing the DamenCNC toolsetter.
This device is capable of measuring Z-axis coordinates, which enables the operator to perform 2 actions:

1. **Zero-ing the Z-axis**
   The operator can zero the Z-axis by placing the toolsetter on top of the to-be-machined material. The USBCNC V3 software can detect the toolsetter, and therefore the thickness of the material becomes evident.

2. **Perform tool length measurements**
   The operator can also let different tools touch the toolsetter. The different tool lengths are stored in the tooltable of USBCNC. Also the tool diameter can be entered here manually.

In this Appendix we explain how to connect and use the toolsetter in the following order:

- Hardware Connection procedure
- Testing procedure
- Using the toolsetter to zero the Z-axis
- Using the toolsetter to measure tool length
- Detailed info on hardware connection

Scope of delivery

- The toolsetter itself with 3 meter cable and connector
- A conversion cable
- A Sub-D Mount Screw Set
- This user manual

Figure 11.1: Scope of delivery

11.2 Hardware Connection procedure

In order to use and connect your toolsetter, please select your system.

1. You have a DamenCNC RTR Classic or Performance, with USBCNC CPU V4 or V5
2. You have an USBCNC CPU V3, V4 or V5 (No RTR set)

First the DamenCNC RTR set with USBCNC CPU V4 or V5 is explained. After this section we discuss the installation of USBCNC CPU's without a RTR set.

1. You have a DamenCNC RTR Classic or Performance, with USBCNC CPU V4 or V5

If you have a DamenCNC RTR Classic or Performance, select if you purchased this set before January 2010, or after January 2010:

You purchased your RTR system after January 2010

In this configuration, you do not need the delivered 10 pole cable. This is because this component is already integrated in the RTR housing. Simply plug the toolsetter's SUB-D connector into the designated slot (with the notification "PROBE") at the back of your RTR housing, as shown below.

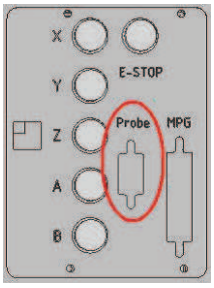


Figure 11.2: Plug the SUB-D connector into the Probe slot

You purchased your RTR system before January 2010
In this configuration, you do need the 10 pole conversion cable, since the required component is not yet integrated in the RTR housing.

- Open the RTR set by unscrewing the 8 screws, and lift the top cover.
- Remove one of the white cover plates at the backside of the RTR set as shown in the figure below.
- Mount the conversion cable's SUB-D connector in one of the free slots, with the cable on the inside of the RTR set.
- plug the 10-pole connector inside the RTR set into your CPUV4, in the terminal labeled "PHW".
- plug the toolsetter's SUB-D connector into the SUB-D connector you just connected to the USBCNC CPU V4 PCB.

Figure 11.3: Plug the SUB-D connector into the connector you implemented

2. You have a USBCNC CPU V3, V4 or V5 without a DamenCNC RTR set

The installation of your toolsetter depends on the version of your USBCNC CPU. First we will discuss USBCNC CPU V3, then V4, and finally V5.

- **USBCNC CPU V3**
  In the unmodified configuration of the connector cable, the toolsetter will not work. When you press the button on the toolsetter, connector pin 1 and 6 of the SUB D connector will be connected. In the unmodified case, pin 1 and pin 6 of the SUB D connector match with pin 1 and 2 of the 10P connector. Follow the following steps in order to prepare your toolsetter with USBCNC CPU V3.

  - Cut the connector cable (the 200mm cable with a SUB D Connector and a 10P connector attached) in two equal pieces, orthogonal to the wire direction
  - From the SUB D connector piece, strip the cable which is attached to pin 1 and 2 of the ribbon cable (this is the RED cable and the cable adjacent to the RED cable; see Figure 11.4)
    Warning: Ribbon wire 1 and 2 of the ribbon cable are attached to pin 1 and 6 of the SUB-D connector. Ensure that you install the wires to ribbon wire 1 and 2 of the ribbon cable; **don't** refer to the pin numbering of the SUB-D connector!
  - Install heat shrinks
  - Solder this cable to the other halve (with the 10P connector) by connecting the stripped ribbon you made in the previous step to the other halve; connect them to the ribbon wires attached to pin 4 and 10. Bear in mind that the RED cable is numbered one. Apply heat to the heat shrinks.

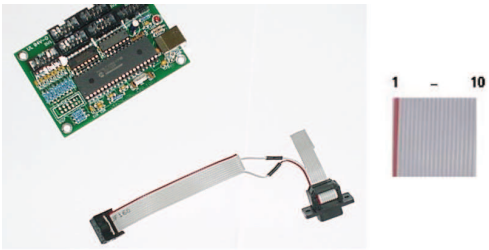


Figure 11.4: Attach ribbon wire 4 and 10 (ribbon connector side, left on this figure) to ribbon wire 1 and 2 (SUB-D side, right on this figure)

With your custom connector cable now ready, mount the 10-pole connector in the CPU3 slot which is labeled as "SV-5".

Now proceed with the Testing procedure.

- **USBCNC CPU V4**
  Connect the SUB-D connector from the 10 pole cable with the SUB-D connector from the toolsetter.
  10-pole connector from the 10-pole cable should be connected with the CPU4 slot labeled "PHW".

  Now proceed with the Testing procedure.

- **USBCNC CPU V5**
  In the unmodified configuration of the connector cable, the toolsetter will not work. When you press the button on the toolsetter, connector pin 1 and 6 of the SUB D connector will be connected. In the unmodified case, pin 1 and pin 6 of the SUB D connector match with pin 1 and 2 of the 10P connector. Follow the following steps in order to prepare your toolsetter with USBCNC CPU V5.

  - Cut the connector cable (the 200mm cable with a SUB D Connector and a 10P connector attached) in two equal pieces, orthogonal to the wire direction
  - From the SUB D connector piece, strip the cable which is attached to pin 1 and 2 of the ribbon cable (this is the RED cable and the cable adjacent to the RED cable; see Figure 11.5)
    Warning: Ribbon wire 1 and 2 of the ribbon cable are attached to pin 1 and 6 of the SUB-D connector. Ensure that you install the cables to ribbon wire 1 and 2 of the ribbon cable; **don't** refer to the pin numbering of the SUB-D connector!
  - Install heat shrinks
  - Solder this cable to the other halve (with the 10P connector) by connecting the stripped cables you made in the previous step to the other halve; connect them to the ribbon wires attached to pin 1 and 10. Bear in mind that the RED cable is numbered one. Apply heat to the heat shrinks.

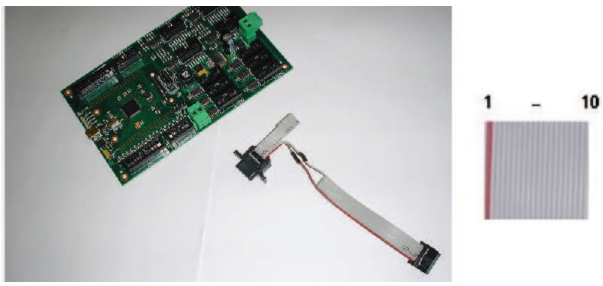


Figure 11.5: Attach ribbon wire 1 and 2 (SUB-D side, left on this figure) to ribbon wire 1 and 10 (ribbon connector side, right on this figure)

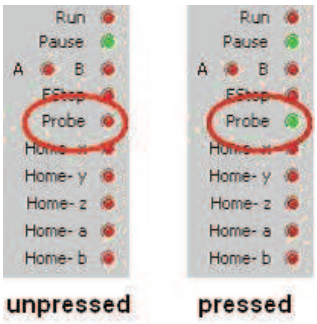
With your custom connector cable now ready, mount the 10-pole connector in the CPU V5 slot which is labeled as "IN-1".

Now proceed with the Testing procedure.

11.3 Testing procedure

To test your toolsetter with any RTR System, or USBCNC CPU PCB, follow the next steps.

- Connect your USBCNC CPU to your PC and make sure the toolsetter is connected.
- Start the USBCNC V3 Software
- Ensure that the USBCNC V3 Software is not in simulation mode!
- Press the button of the toolsetter, and verify that at the lower-left corner of the main menu, the red light next to "Probe" changes color to green when you press the button.



* As an alternative, the status of the probe input can also be monitored in the IO tab. (CPU / PROBE IN)

11.4 Using the toolsetter to zero the Z-axis

The toolsetter can be used in 2 different ways; Zero-ing the Z-coordinate of the raw material, and measuring the tool length. First we will explain how the operator can Zero the Z-coordinate of the raw material.

This section covers:

- Calibrating the height of the toolsetter
- Using the toolsetter to zero the Z-axis

Warning:
DamenCNC assumes that you are familiar with your CNC machine and with USBCNC software.
If you have just purchased your CNC machine or system, it is not recommend to start using the toolsetter directly. It is better to first get familiar with your machine before using this feature.
If the toolsetter is not operated correctly, damage to your machine and tools will occur!
We assume you have USBCNC software V3.49 or higher, which has the user defined cycles.

Calibrating the height of the toolsetter
The first time the toolsetter is used the height needs to be calibrated.
The switching point of the toolsetter is about 43mm above the zero plane. This can differ slightly, so be sure to calibrate this for the first time you use the toolsetter.

During a standard installation of USBCNC V3 the required files you need to use for the calibration procedure should be stored in the following directory:

C:/Program Files/USBCNCV3

(it can differ, if you have installed USBCNC in a different location)

- In this folder there is a file called macro.cnc
- Open the macro.cnc file using Wordpad or any other basic text editing program (**do NOT use Microsoft Word**)
- The lines that need to be edited are stored in Sub user1; at the top of the macro.cnc file

Zero tip example
This is a macro.cnc textfile. In this file we point out which lines you must modify.

Sub user1
msg "user1, Zero Z (G92) using toolsetter"
f30 (Start probe move, slow)
g38.2 z-100
g0 z#5063 (Move back to touch point)
G92 z43.0 (Set position, the measuring device is 43mm in height, adapt for your measuring device)
G91 (incremental distance mode)
g0 z5.0 (move 5 mm above measuring device)
g90 (absolute distance mode)
m30
Endsub

- Adjust the macro.cnc file as indicated above (from the line Set position,... up until ...distance mode) , save the macro.cnc file and restart the USBCNC software.
- After the compensation has been set to 43mm, you need to verify if this is indeed the correct value, often a small change in the order of 0.1mm needs to be made
- The procedure will leave the tool at 5mm above the toolsetter
- Using the MPG handwheel or the normal JOG keyboard keys, JOG the machine down to the top plane of the material to be milled.
  If all is set correctly, the DRO in the upper right corner of USBCNC should read zero for the Z-axis (in the work CS!). If the Z-axis value is not equal to zero, repeat the previous steps.(re adjust your macro.cnc file)
- **Note:**
  All changes made in the macro.cnc file take affect only after Saving your changes, and restarting the USBCNC V3 Software!

Using the toolsetter to Zero the Z-axis in Work CS (Sub User 1)
Now the operator is ready to use the toolsetter for the Zero-ing of the raw material. In order to do this succesfully, follow this procedure:

- Clamp the raw material which you wish to machine on the table of your CNC machine
- Place the toolsetter on the top surface of the material to be machined
- Using the MPG handwheel or just the manual JOG keys, move the machine to the approximately 10mm above the center of the toolsetter
- Go to the user defined cycles menu and choose the first toolsetting option (In the 'Operate' tab: press F12, F11, F1)
- As a result, the machine will now move down until the switch is activated. As soon as the tool has touched the toolsetter, the tool will move to 5mm above the toolsetter.

Your raw material is now correctly Zero-ed.

11.5 Using the toolsetter to measure tool lengths

On more advanced CNC machines (i.e. with toolchanger) the toolsetter can be used in order to measure the length of tools (Sub User 2). It is also possible to automatically store the tool lengths in the tool table of USBCNC.

When you are using the sub user 2 cycle in order to automatically measure a tool's length, you really need to be familiar with your machine and USBCNC. This is because this is an advanced feature which needs to be calibrated correctly before it can be used.

It is very convenient to have your tools in designated tool-holders such that when they are placed back into the machine, the total tool length has not changed. Sometimes spacing rings are also used for this purpose.

If you don't have tool-holders or spacing rings the length of the tool protruding from the toolholder/collet wil always be different. Be aware that in this case you need to re-measure the toollength every time you use it after a changing a tool! Using Sub User 2 in the software this is an easy task.

Figure 11.6: Tool-holders prevent changes in the height offset of your tool

Section outline

This section consists of the following 2 parts:

- Calibrating the XYZ position of the toolsetter
- Using the toolsetter to measure tool lengths

Calibrating the XYZ position of the toolsetter

In order to calibrate the toolsetter for tool measuring, you need to take the following steps.

- Determine a permanent place for the toolsetter within the working range of your machine; mark this location or mount the toolsetter in this position.
- Clamp a milling cutter in the milling motor
- Measure the distance between a reference point which is suited for your milling machine (e.g. the clamping nut) and the tip of the clamped tool; as can be seen in Figure 11.7.
  You are free to choose your own convenient reference point; as long as you are consequent in using the same convenient reference point after your choice!

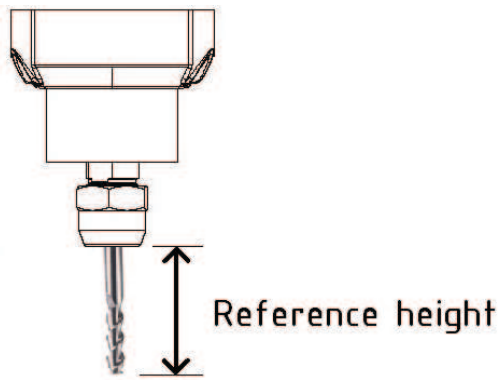


Figure 11.7: Measure the height of the tool with respect to a convenient reference point (e.g. the clamping nut)

- Go to USBCNC V3's Tool tab
- Enter the measured length in the tooltable (ZOffset of **Tool 16**) and click Save
- Open MDI (F12, F6)
- Type "gosub calibrate_tool_setter" and press Enter
- Close the MDI pop-up window
- Click Run (F1)
- In the Jog menu, Jog to the maximum (safe) Z-height.
  This is very important, as USBCNC V3 remembers this "Safe Z coordinate"!
  Be sure to choose this coordinate such that you can load all your tools from this position.
- Click Run (F1)
- Jog to just above the toolsetter. The tip of the mill has to be right above the **center** of the toolsetter (max 10mm higher).
- Click Run (F1) when done.

This concludes the calibration procedure.

If you wish to re-calibrate your system, you can always go to the MDI (F6) and type "gosub calibrate_tool_setter".

Note: Many clients have 2 toolsetters, one has a permanent position on the machine and is used for measuring tool lengths, the other can be moved freely and is used to Zero the Z axis. Using only one toolsetter does not have to be a problem. If for some reason you would forget to put the toolsetter in the correct position, the software stops the measurement procedure if it does not find a tool after 20mm of movement.

Using the toolsetter to measure tool lengths

The calibration procedure has been done. The USBCNC V3 software knows the position where the toolsetter is located, and will move there automaticly when a tool length measurement is done. So you are ready to start measuring tools. The procedure to measure a tool length:

- Go to USBCNC V3's Tool table in the USBCNC v3 software navigate to the user defined cycles menu and choose the second option (In 'Operate' tab: F12, F11, F2).
- A dialog will pop up, in this dialog enter the tool number of the tool to be measured
- Enter the approximate tool length, Simply measure the distance between the tip of your tool and your (unchanged) reference point. Your measurement does not need to be very precise; aim to measure your tool with an accuracy of around ± 2mm. The toolsetter will do the precise measurement for you.
- Enter the tool diameter (only used when G41/G42 is active)
- Press OK (Lower right corner of the Pop Up dialog)
- The machine will move to the XY position where the toolsetter is located and start its probing move
- The length of the tool is automatically stored in the tool table.

In order to use the length offset, it needs to be activated via the **g43** command. Deactivation happens through the **g49** command.

There are three configuration options, and they will be discussed below:

1. **Procedure with Toolchanger and Toolrack**
   If the operator has a machine with an automatic tool changer, it is required to initially measure the tool length of each tool. Each measurement will be stored in the tool table. The operator does not need to measure the tool lengths again, as long as the tools remain in their holders. If the operator installs a new tool in a holder, he needs to measure the new tool length.

2. **Procedure with manual tool changer**
   Many machines have manual toolchangers. These can be pneumatic or mechanical. Each millingtool has its own toolholder which can be numbered, that is the important issue.This means that each individual tool holder has its own height offset.
   It is important that the operator organizes the tools such that the tool numbering does not get mixed up. If this is the case the tool table can be used in order to save the tool lengths. Since when a tool holder is placed back into the machine, the height offset has not changed. All you need to do is set the correct toolheight offset corresponding the the tool number. For example using g43h1, height offset voor toolholder 1 set activated.

3. **Procedure for tool changing by hand**
   In this configuration you exchange tools without a tool holder. This is quite common in the hobby CNC world, using mainly KRESS motors, that allow the tool to be directly mounted in the collet. After each tool change, the operator must measure the toollength.

Note: When using height offsets (g43h command), the order in which offsets are set is quite important. There are many different procedures. But we would recommend always first measuring the tool lengths, activating the length via the g43h command. And only after the tool length is active zeroing the Z axis using the toolsetter. Using this procedure no errors can be made with incorrect height offsets.
Note: When using the g49 to cancel the height offset, be careful with G0 or G1 codes in the same line. Our practice is to cancel tool offset g49, and in the next line move in machine coordinates g53 g1 z0 In our machines the Z0 position is always the safe height, this can differ per machine.

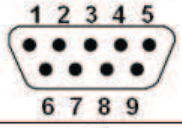
On the following page the operator can find an example G-code concerning the toolsetter.

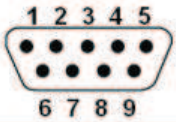
Example G-code Program

```
m6 t1 (change tool to Tool 1)
g43 h1 (activate height offset Tool number 1)
g0 z50
g0 x0 y0
g0 z5
g1 z-2
g1 x100 y100
g0 z50
g49 (deactivate height offset)
g53 z0 f1000 (move to safe z height)
```

11.6 Detailed information of the toolsetter's wiring scheme

For most clients this information will not be relevant, however the technical data is still attached and can be seen in the figure below:

CPU V3.0 (SV-5 input)		
Function in USBCNC	Pin nr 10 pole flatcable	Pin nr SUB D
	1 – 10 	Sub-D 9 male (Looking at the pins) 
EOS-X	1 Red	**1**
E-stop	2	**6**
EOS-Y	3	**2**
Probe	**4**	**7**
EOS-Z	5	**3**
Pause	6	8
EOS-A	7	**4**
Run	8	9
+5 USB	9	**5**
GND	10	Not Connected

CPU V4.0 (PHW input)		
Function in USBCNC	Pin nr 10 pole flatcable	Pin nr SUB D
	1 – 10 	Sub-D 9 male (Looking at the pins) 
Probe Input	**1 Red**	**1**
GND	**2**	**6**
Handwheel A	3	2
GND	4	7
Handwheel B	5	3
GND	6	8
+V ext	7	4
GND	8	9
+5 USB	9	5
GND	10	Not Connected

CPU V5.0 (**IN-1** input)		
Function in USBCNC	Pin nr 10 pole flatcable	Pin nr SUB D
	1 – 10	Sub-D 9 male (Looking at the pins) 1 2 3 4 5 6 7 8 9
Probe	1 Red	1
Spindle Pulse	2	6
E-Stop	3	2
Extern Error	4	7
AUX-IN-6	5	3
AUX-IN-5	6	8
+5V	7	4
GND	8	9
+5V	9	5
GND	10	Not Connected