

## TangoSTEP Quick Reference Manual

Thank you for choosing TangoSTEP Intelligent Motion Control. Depending on your software release, you are able to control up to 15 independent dimensions with a user friendly desktop application. Besides individual movement, also scripting is possible to automatically execute a series of commands.



### Hardware description:

For each dimension (each stepper motor) a TangoSTEP controller PCB is required. The operating voltage can be from 15 to 48 VDC, depending on your motor. The maximal current is 3 amps per motor. Please provide sufficient cooling when operating motor.

An on-board microprocessor controls both communication with the PC and the stepper motor. This processor is factory pre-loaded with our fast controller firmware and provides maximum reliability. This allows real-time\*) execution of the commands and excellent synchronicity of multiple dimensions. **However, we do not recommend to use this product in medical life supporting applications or aviation applications.**

\*) only when using a real-time operating system on your PC

The board provides microstepping with 16 microsteps per full step. For example, a regular stepper motor with 0.9 degrees per step can be controlled in 6400 steps per rotation (3200 steps for 1.8 degree motor). This resolution is sufficient for most applications and provides sub-micron resolution with regular GCD-stages. Any higher resolution would decrease speed of the stage but would be senseless due to physical limitations of the mechanics.

The maximum operating frequency is 40kHz, which equals 40,000 microsteps per second (about 12.5 rotations per second with a 1.8 degree motor). However, many motors cannot handle such high speed. In this case you can select the speed from 5Hz to 40 kHz by software. As additional feature, a ramp modus is implemented. This means that the motor will start at slow speed and accelerate until maximum speed. When reaching the final position, motor will also decrease speed instead of stopping immediately (exception: when hitting the end position switches). The ramp length can be selected from 0 to 255 (equals 0 to 2550 microsteps). With high loads on your motorized stage, a ramp length of up to 50 is recommended. Selecting the ramp length too high may result in very slow speed, especially if the travel length is short. (In fact, the acceleration and deceleration ramps cross each other when the total amount of steps is smaller than 2 x (Ramp Length x10) steps).

### Getting Started:

### Setting up the Hardware:

1. On one communication bus, you are able to operate up to 15 controllers. However, each controller must have its unique address for successful communication with the computer. On the PCB you will find the address selector with 16 positions. Please use a small screwdriver to adjust the address to your requirements:

Pos.	1	2	3	4	5	6	7	8	9	A	B	C
Adr	1	2	3	4	5	6	7	8	9	10	11	12
Pos.	D	E	F	0								
Adr	13	14	15	self test								

Please make sure that power is turned off before changing this setting!

For TangoSTEP Basic, you are limited to 4 dimensions. The addresses of your controllers must be from 1 to 4.

2. Connect your motor according with the supplied cables to the controller.

3. Connect data bus (RS-485) to pins 10 and 12 of the controller. There should be resistor of 150 ohms on your last controller on the bus for terminating.

4. Connect power supply (15~48VDC) to pins 1 (ground) and 2 (+VDC), where Pin 1 is ground and Pin 2 is +VDC.

When turning power on, a green LED on board will indicate power status. At the same time, the yellow LED flashes according to the set address (e.g. 2 flashes for address 2). After this initial self test, yellow LED will go out and the blue LED indicates "ready".

If you send a corrupted byte sequence to the controller, this may cause the microcontroller on board stopping. In this (seldom) case, the continuously lit yellow LED will indicate malfunction of the board. This can only be reset by turning off power for two seconds.

When not in motion, the controller still keeps the motor under current to avoid unintended moving. This can be heard by a low volume, but high frequency "twirp" sound at the motors. This sound is normal and does not mean any malfunction of the system.

### Connecting the controller to your computer:

The TangoSTEP controller uses the industrial standard RS-485 protocol (2-wire). Compared to any other serial protocol, the RS-485 is extremely stable and versatile and very resistive to external influences. Use any 2-wire cable for connecting the controller to the interface. Maximum cable length is 1200 meters and can be extended by using repeaters.

If your computer does not have a RS-485 output, you can simply use our adapter plugs for either USB or RS-232. The RS-232 does not need any drivers to operate. For the USB to RS-485, the drivers and installation software is included on the disc or can be downloaded free of charge from our website.

When installing the USB to RS-485 adapter, your new RS-485 communications port will appear as new COM port on your system (e.g. COM3). This new port will be used for communicating with your TangoSTEP controllers.

## Installing and using the TangoSTEP Software:

The TangoSTEP controllers are open architecture protocol and can be implemented into many applications. However, for a convenient stand-alone use or quick setup, we provide the TangoSTEP software. This software allows you to fully control up to 15 dimensions (controllers) with comprehensive features.

There are different versions of the controller software:

**TangoSTEP Basic:** Control up to 4 dimensions with digital position readout (latest version available free of charge from our website)

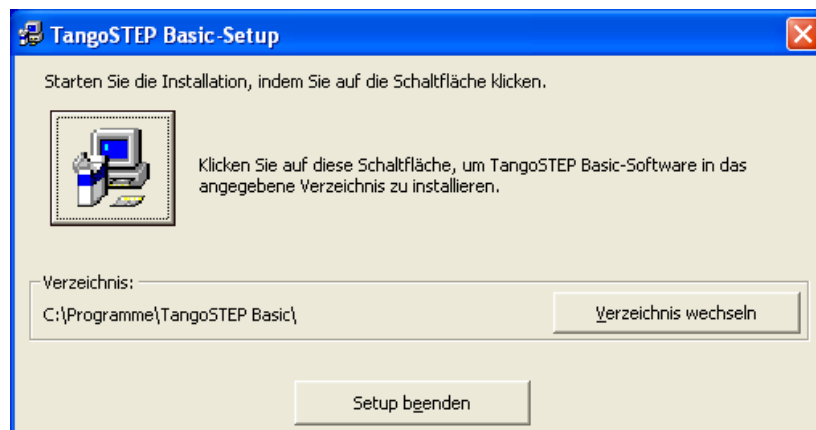
**TangoSTEP Instructor:** Control up to 8 dimensions with digital position readout, scripting and joystick support (30 days full functional trial version for free download from our website)

**TangoSTEP Studio:** Up to 30 dimensions control with digital position readout, scripting, joystick support, and controlling additional 33 I/O ports (digital and analogue inputs and outputs)\*\*)

\*\* ) requires additional hardware, included in TangoSTEP Studio package

The manual will base on the TangoSTEP Basic software, but can be scaled up to Instructor version of course.

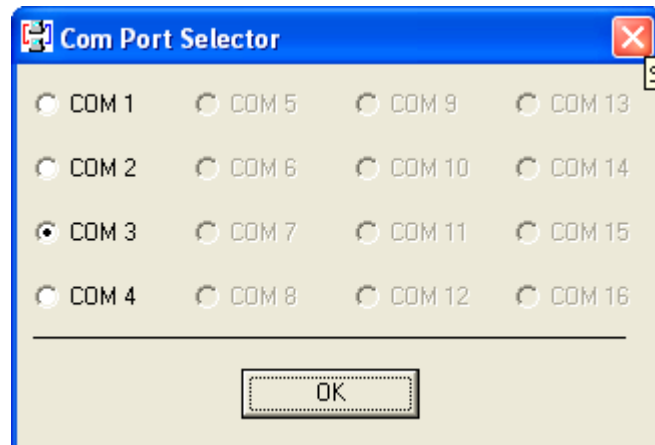
Download the latest version free of charge from our website. Run the *setup.exe* file and follow the instructions during the installation process. The software is very compact and requires about 1MB disc space. When using the software under a different user login at a later time, please be sure to have write access to the TangoSTEP directory. This is necessary to update and save your configuration data. In fact, TangoSTEP Instructor 4 could be even run from a floppy disk.



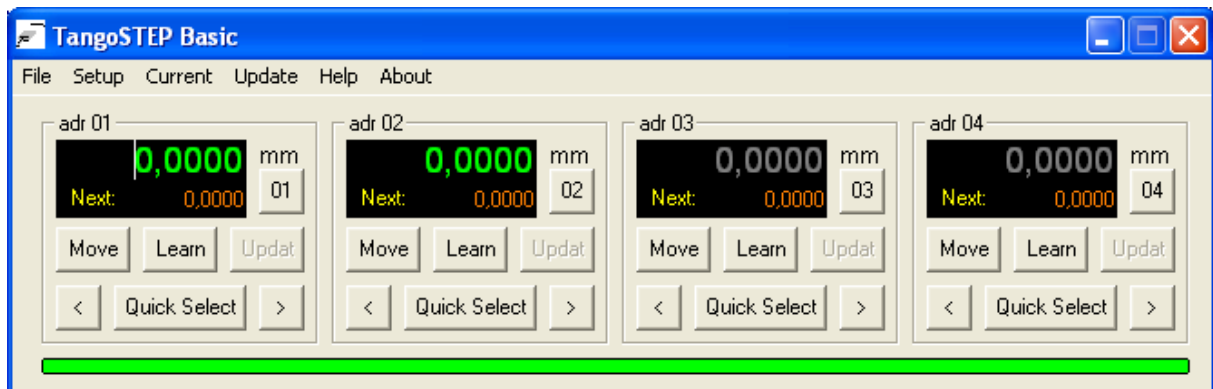
After installation, run the *TangoSTEP Basic* from your desktop (Start → Programs → TangoSTEP Basic). When starting for the first time, the software will create the necessary ini-files.

In a start-up window you will be prompted to select your COM-port. All present COM-ports from COM1 to COM16 are displayed highlighted. Simply press the radio button

of your desired COM-port to select it. Of course this setting can be changed at any time (Menu Setup → COM ports).



The main screen will appear and show the four windows (one for each dimension). The green digits represent the absolute position of your stage and should be "0,0000" when the software is executed for the first time. Please note that the addresses for the four controllers are fixed and cannot be changed. It is mandatory to hardware select the addresses on the PCB board to 1~4 (see *hardware setup* at the beginning of this manual).



The software has an auto-detection function integrated and will display the present controllers (by address numbers) on the screen. The absolute position display is highlighted green when the controller is present. If the controller is not present or fails during operation for any reason, this display will turn grey and cannot be accessed anymore.

Another helpful indicator for the status of your system is the status bar, the slim bar underneath the control panel. After running the first successful command and receiving answer from one or more controllers, the status bar will turn green. When the controller is still busy with the execution of your sent command or if any failure occurs, the status bar will turn red. On a single dimension system this would mean, that the controller is not ready to receive further commands from you at this time. If you override and send new command, it will be discarded (in fact TangoSTEP Software has a security function which does not accept new commands for the same dimension before it finished its job and returned the "ok" signal).

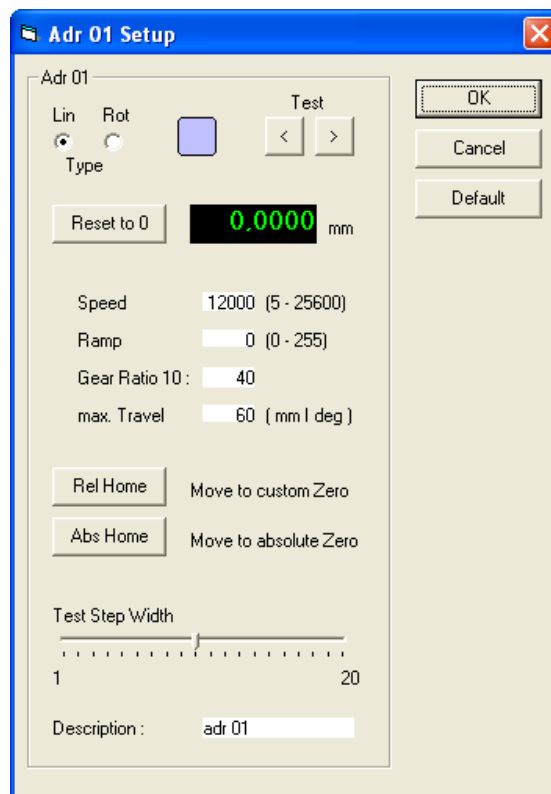
When turning power of the controllers on or off while the TangoSTEP software is running, the status bar will become deep blue. Our controllers are programmed in a way so they send out a special response when power failure or power restore.

After successfully executing a command, each controller will respond with its address (e.g. "02") to signal the PC that he is ready for further instructions. The TangoSTEP Basic software uses this feature also for detecting timeouts. TangoSTEP Basic can calculate the time which is used to execute each command. If the controller does not response immediately after this time, a timeout error will be displayed on your screen. This could mean that either the power was interrupted during operation or the controller address is not present. In this case you should check the power supply and the data connection of the controller.

The TangoSTEP Instructor allows you to operate each dimension individually or multiple dimensions simultaneously by using a script. To ensure proper function of your display readout, it is necessary to setup the present motorized stage.

Simply press the setup-button (which also shows the address number of the controller) to access the setup panel.

You will find different parameters which must be defined once for proper operation:



Type: Select linear (lin) or rotational (rot). Readout display will toggle between mm and deg. (factory pre-set: *linear*)

Speed: Set the appropriate default speed for your stage. Can be set from 5 to 25,600 (factory pre-set: 12,000)

**Ramp:** When moving heavy or sensitive loads, or moving the stage at very high speed, it may be useful to accelerate and decelerate motor speed. Can be set from 0 to 255 (factory pre-set: 0)

**Maximum travel:** defines the physical length of your stage in full mm (or maximum rotating angle in full deg with rotating stages). Theoretically unlimited. Can also be used to limit stage operation to a specified range.

**Gear Ratio:** defines the physical transmission ratio of your stage mechanical gear, displayed in values 10:xx, while xx means the absolute travel in mm or deg that your stage moves when the motor performs 10 full rotations (recommended values: 40 for GCD-L and 36 for GCD-R. When using other stages, some testing might be necessary) (factory pre-set: 40)

**Description:** Enter any description you wish to be displayed in the window on your main screen. Limited to 15 chars length (factory pre-set: *adr ##*)

**Abs Home:** By pressing this button, your stage will return to the physical zero (home) position (CCW, end position next to the motor) and will only be stopped by the end position detector switch. Travel length is limited by the value you have stated in the *maximum travel* box. Position display will jump to 0,0000

**Rel Home:** Will move your stage to your custom defined zero position

**Reset to 0:** Will reset position readout to zero without moving the stage. Can be used to user-define the zero position of your stage (which can be different from the physical zero position). Position display will jump to 0,0000

**Test:** These two buttons allow you to immediately test your settings. You have a forward and a backward button. The travel length can be selected by using the slider (test step width)

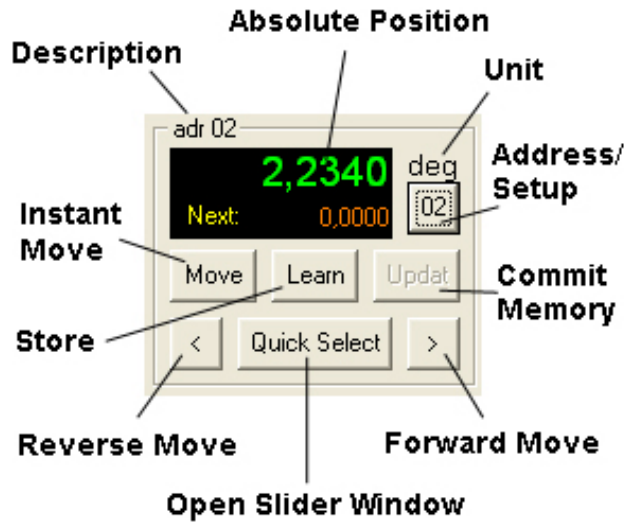
**Test Step Width:** Selects the travel which stage will perform when pressing one of the test buttons. Can be set from 1 to 20 mm/deg. This setting will also be stored for the control buttons (forward/reverse) on the front panel (factory pre-set: 1)

Press the Abs Home button to arrange your stage in the physical absolute zero position (CCW, next to the motor of the stage). Now you are ready to use the TangoSTEP Basic software.

Please note: the absolute position in your display readout will be stored to your harddisk when terminating the software correctly (Menu: File → Exit → Yes) and recalled the next time you start the software again. However, this function is only reliable if the stages has not been moved in position manually after power off.

## Using the TangoSTEP Basic:

For each dimension, a small window is displayed and contains the following information:



### Displays:

Green digits: absolute position at the moment

Orange digits: next absolute position when hitting the "Move" button

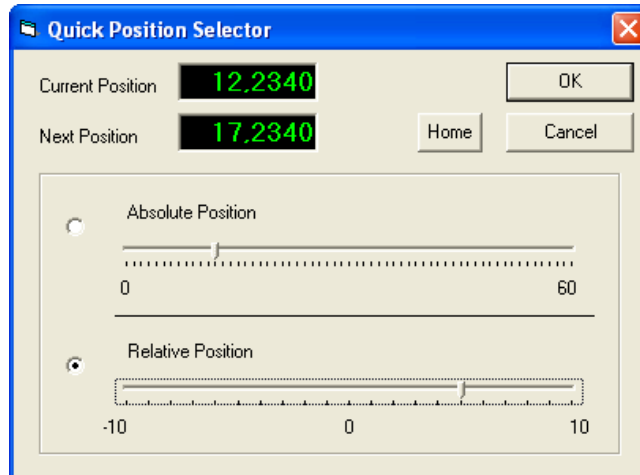
### Buttons:

**Move:** Move the stage to the position displayed in yellow digits. If the value of the actual position and the value of the next position are identical, no movement will occur

**Learn:** Controller will store the next position but will not do any movements until you press the "Update" button.

**Update:** Trigger the controller to execute movement to the previously taught in position. This function is essentially when moving multiple stages simultaneously, please refer to chapter "Updating" and "Scripting". This button is only enabled when a new position has been taught in with the Learn button.

**Quick Move:** By pressing this button, a new window with two sliders will appear:



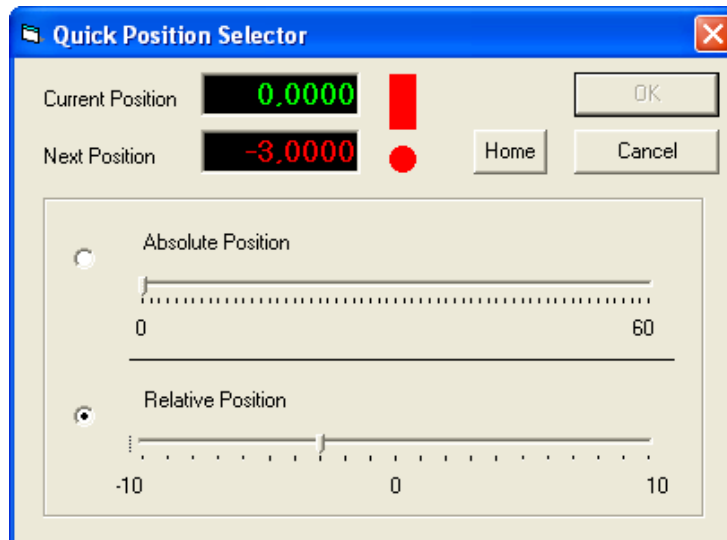
Here you will find also two digital readouts which are identical with the address window displays (current position / next position). There are three possibilities to move your stage to the desired position:

- 1) Use the slider “Absolute Position” to move your stage in full mm or deg to any value between zero and the maximum travel length (defined in setup). However, the slider is already scaled to the full travel range in steps of 1 mm (or deg).
- 2) Use the slider “Relative Position” to move your stage relatively to the current position from  $-10$  to  $+10$  mm or deg in integer values
- 3) Enter the desired position directly into the “Next Position” display. This is very useful if you have values with fractions of mm or deg (for example: 23,5641). Please be sure to use the comma (,) instead of the decimal point (.) as decimal separator to ensure proper operation.

By clicking the “OK” button, the new position value will be displayed in your main screen display readout (Next Position). When hitting the “Move” button now, the stage will immediately move to the new position.

The position of the slider “Absolute Position” also indicates the current position of your stage (of course only in integer values mm or deg).

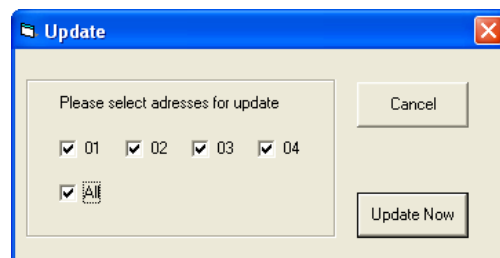
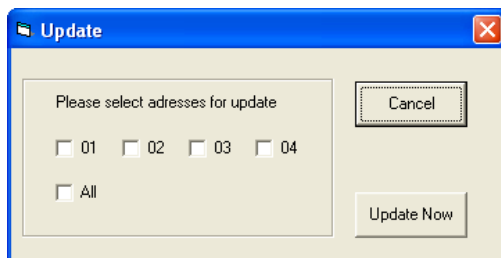
While the slider “Absolute Position” is limited to the physical dimensions of your stage, the slider “Relative Position” has integrated a security feature to avoid invalid values. For example, if your stage is already at the absolute zero position and you try to move it  $-3$  mm (or deg), a warning will appear on the screen:



At this moment, the OK-button is disabled until you select a valid value or press the Cancel button. This warning will also occur when you try to exceed the maximum travel range.

Performing immediate movement an multiple dimensions:

After defining the next positions for multiple dimensions, the synchronous movement start can be achieved by selecting the “Update” function from the menu bar. A window will appear and you can freely select the dimensions which you want to update at the same time:



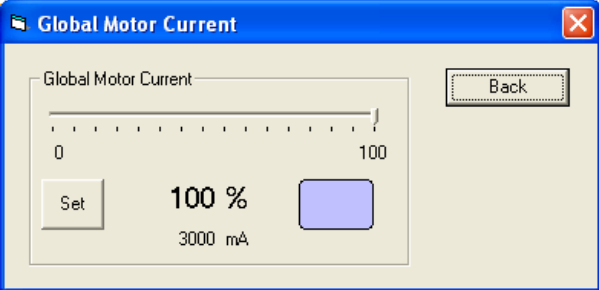
When hitting the “Update Now” button, all selected stages will start moving at the same time.

### Global Current setting:

When powering up the TangoSTEP controllers, the operating current will be automatically set to maximum (max. 3 amps). However, sometimes it may be useful to reduce the current to avoid unnecessary power consumption and heat development. Especially if you have small motors which cannot handle the full power, limiting current to the maximum allowed rating is important to avoid any damages of your motor.

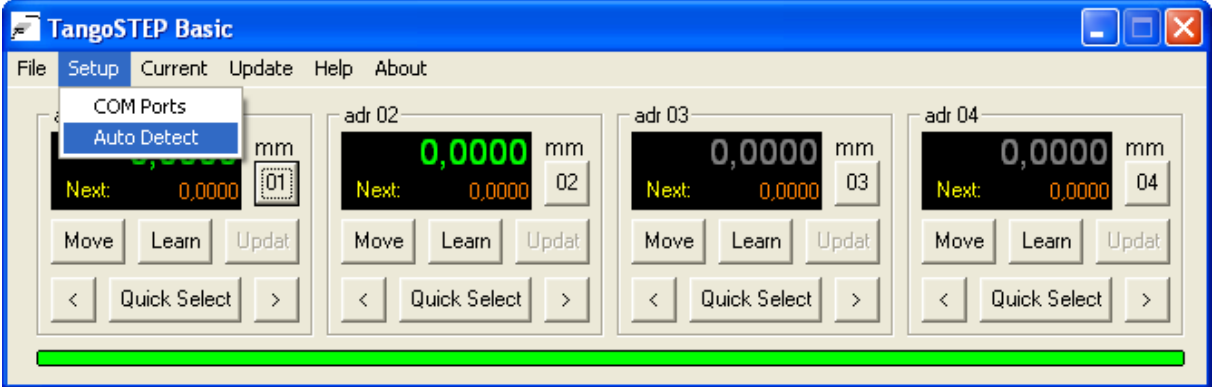
In fact, the current does not have influence to the speed of the motor, but only on its torque. With the slider in the “Global Current Settings” frame, you can adjust the current for all present controllers from 0 to 100% in 15 steps. The maximum current will also be displayed in milliamperes (mA). When hitting the “Set”-button, the new

current settings are transmitted to the controllers and the status bar will turn green. This is also a useful tool to check the presence of your controllers. All present controllers will send a response to your PC and the digital display for absolute position will turn green for each address. If a controller failed or is not present, the readout digits on your main panel will remain grey.

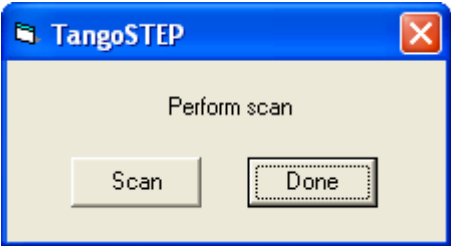


**Auto detect present controllers:**

Each time you select a new COM port, TangoSTEP will immediately send out a broadcast command to this port and waits for the response of the controllers. However, you can also manually release the auto detect function if you want to check the presence of the controllers. On the taskbar, simply press Auto Detect:



A new window will open and prompt you to perform the scan by pressing the “Scan”-button. All present controllers will be indicated by turning the color of the front panel position display into green, non-present addresses will remain grey. In above example, you can see that addresses 01 and 02 are present (green digits), while addresses 03 and 04 are not responding (grey digits)



## Scripting (not available in TangoSTEP Basic):

So far, the functions described above allow you to manually control your stages to the desired positions. However, if you need a sequence for one or multiple dimensions, TangoSTEP *Instructor* and *Studio* gives you a very powerful feature.

With just a very few, easy to learn commands, you can take control of any dimension in your system and run a sequence custom tailored to your requirements.

The most important command is the Move command (M), followed by either absolute (A) or relative (R) position:

*Madr Apos*

Example:

M01 A24 Moves address 01 to absolute position 24

M02 R5 Moves address 02 to relative position +5 from current position

M02 R-5 Moves address 02 to relative position -5 from current position

The commands can be entered in the script-window of your main screen. Please note that relative movement can be dangerous in long scripts where you might exceed the allowed travel range of your stage. Of course, the end position detection switches will prevent your hardware from being damaged, however, the absolute position will not be displayed correct anymore if you hit one of the two end positions of the linear stage.

A combined script for operating multiple stages may look like this:

```
M01 A45
M02 A23
M01 A10
M02 A36
```

This will cause the both stages moving at the same time. If one stage is still busy, the script will wait with executing any new command for this stage and may pause at this point until the "ok" returns from the stage.

Even if the stages appear to start movement simultanoulsy, there is a delay of about 3 microseconds caused by the communications protocol. To eliminate this delay if you want to move all dimension at the same time, you can also select the broadcast adress "00":

```
M00 R45
```

This command will cause any controller on your bus to move to relative position +45 from current position. Start time is absolute identical with no delay. If the motors have the same parameters for speed and ramp (defined in setup), also the stop time is identical.

If you have a three-dimension system, but only want to move two dimensions without changing the third, you can perform the following (learn) command:

```
L01 R45  
L02 R45  
U00
```

The Learn command (L) programs the controllers to next position without executing the movement. The Update command (U), sent to any controller on your bus, will cause immediate and simultaneously execution of the stored command. The above example considers that you did not send a learn command to the third stage.

```
M01 A24  
M01 A10
```

Will cause the controller 01 to move to absolute position 24 and then return to absolute position 10.

Every time a script is finished successfully, the message "Done" will appear in the progress line box.

Setting speed for each movement:

Now you know the principles of the scripting language. Of course you want to move the stages with different speed. Any integer value from 5 to 25600 can be used. This can be also implemented into the scripting language:

```
M01 A34 V8000
```

Causes address 01 to move to absolute position 34 with speed (velocity, v) of 8000 (8kHz). The speed parameter (Vxxxx) is optional. If you don't enter it, the default speed from your defined setup will be used.

```
M01 A10 V1000  
M01 A50 V12000
```

This commands will cause the stage to move slowly to absolute position 10 and then move to absolute position 50 with 12 times higher speed.

Using the ramp modus:

Especially when moving heavy or sensitive load, the acceleration/deceleration mode is very useful. Of course this "Ramp" mode can be included into your script:

```
M01 A23 V8000 D25
```

The Ramp parameter (Delay, D) is also optional and can be any integer value from 0 to 255. If not stated, the default ramp value from user defined setup is used.

Please note that setting ramp too high may cause unnecessary delay. In practical tests, a maximum ramp value of 50~75 appears to be useful.

Setting user defined break in the script:

Once a script is running, it will continue until it is finished or interrupted by physical fault. Sometimes it is helpful to integrate a break point where the script waits for user

input to continue. You can easily integrate this break point by using the “B” command, combined with your text:

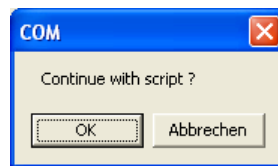
Syntax:

*B Text*

Example:

B Continue with script ?

When the script reaches this line, it will pause and display a message box with your customized text on your screen:



When hitting “OK”, the script will continue. If you press Cancel, the script will stop at this point and return to editing mode.

The displayed text can be freely entered to your demands or even left blank. By simply executing the following command

B

an empty message box will pop up and just shows the OK and cancel button.

Delay function:

When the script is intended to stop at a certain position and continue after a while (without user input), the TIMER-command can be implemented. This will cause the script to pause for n seconds before continuing:

Syntax: (no space required)

*Tn*

Example:

*T6*

When the script reaches this line, it will pause for 6 seconds and then continue.

Adding comments:

Especially when executing long scripts, you may want to know at which position the interpreter is at the moment. You can simply add some comments before the command you want to check by using the “/” character and get them displayed in the result field:

Syntax: (no space required)

*/Text*

Example:

```
/ Moving Z-Axis to the pipette dispenser
```

Of course this command can be used to comment out command lines from your script. Every character following the "/" in a line will not be processed by the interpreter.

The homing command:

Sometimes it can be useful to bring the stage to its physical zero position (re-aligning). This can be committed in your script by using the "H" command (Home).

```
H01
```

This command will cause stage 01 to return to its absolute zero position (CCW, next to the motor). Of course, you can also use the broadband address to move ALL stages on your bus to home position:

```
H00
```

Before executing homing commands, please be sure to have the maximum travel set correctly in your setup, especially on stages without end position detection switches (like rotating stages).

### **Some hints about the scripting syntax:**

there is no difference between capital and non-capital letters. The options can also be separated by space or tab for better visibility.

The examples above showed integer position values. This is just for demonstration and better readability. Of course, any value with up to four digits after the decimal point can be entered for position (e.g. 23.4567).

It is just important that the address is directly entered after the command in two digit mode without any spaces:

```
M02      is correct
```

```
M 02     will cause syntax error
```

```
M2       will cause syntax error
```

When using optional parameters like speed and ramp (v and d), please make sure to enter them in the correct sequence (M or L / A or R / V / D)

```
M01A12V8000D50      is correct
```

```
M01A12D50V8000      will cause syntax error
```

```
M01A12D50           is correct by using the default speed from setup
```

```
M01A12V8000         is correct by using the default ramp from setup
```

## Troubleshooting:

- Problem:** There are no COM-ports available for selection on startup  
**Solution:** Your system does not have any COM ports which can be used by TangoSTEP. Please install our USB-adapter to create new COM-ports on your PC.
- Problem:** An error message "Device not available" is displayed on the screen  
**Solution:** You have tried to open / use a COM port which is already used by another device (modem, mouse, etc). Please select another COM-port.
- Problem:** TangoSTEP starts up, but all address displays remain grey.  
**Solution:** The software can not detect your controllers. This might be caused by one of the following:
1. your controllers are not powered on
  2. your controllers do not have the correct address settings
  3. the connection between your controllers and the PC is broken
  4. the adapter (USB/RS-232) is not installed correctly
- Problem:** When sending a command to the controller, the motors make strange noise but don't move at all or move only small range  
**Solution:** The speed of the motors is set too high. Reduce it in the setup window of each address. Sometimes the problem can also be solved if a ramp value is added.
- Problem:** When testing without load, the stages are moving correctly. When adding load, the travel is not correct anymore.  
**Solution:** Add a ramp value in the setup menu for the according address. If problem still occurs, reduce the speed value.
- Problem:** When sending commands to the controllers, the digits and the status bar turn green after a certain time but the stage does not move.  
**Solution:** The current is set to zero or below operational value. Increase current settings.
- Problem:** When re-starting TangoSTEP, all settings are default and positions are gone.  
**Solution:** The ini-files are not located in your TangoSTEP folder (tango.ini, adr\_xx.ini, where xx is the address of your controller). Probably you

don't have write access to this folder. Contact your system administrator.

**Problem:** After re-starting TangoSTEP, the customized settings are still here, but the position values are totally wrong.

**Solution:** The position values were not stored to disk because of abnormal program termination. Please always use the Menu: File → Exit → Yes function.

**Problem:** When entering a non-integer position value into the "next" position field, some strange values are displayed.

**Solution:** You have used the decimal point (.) for decimal separation. Please use comma (,) instead.

**Problem:** The stage has reached its physical end position, but I can still press the forward button several times. The position display changes to the new value, but stage does not move.

**Solution:** You have set maximum travel range in the setup too high or set the zero position different from the physical zero position. Press absolute home button in the setup to re-calibrate your dimension.