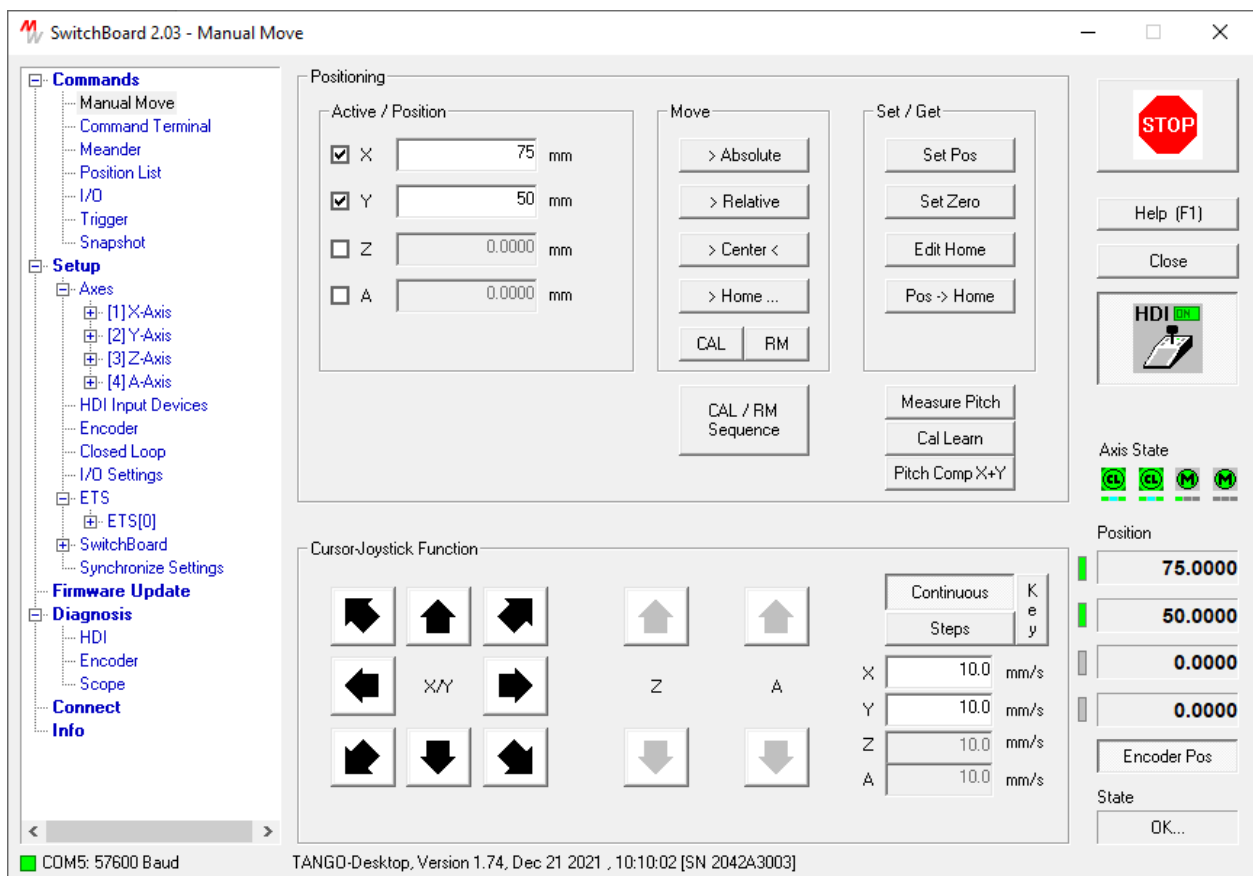


Operating Manual

SwitchBoard

TANGO Controller User Interface



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1 The SwitchBoard Software

Terms of use

The SwitchBoard Software is designed to be used with Maerzhaeuser Wetzlar TANGO Stepper Motor Controllers. SwitchBoard only supports the TANGO Instruction Set. This software serves as a tool to demonstrate the features of the TANGO controller. It is provided as is without any warranty of any kind, either expressed or implied. In no event shall we be liable for any damages including, but not limited to, direct, indirect, special, incidental or consequential damages or other losses arising out of the use of or inability to use this software. This software is designed to run under Windows 7 / 8 / 10 / 11, 32 and 64 bit.

Abstract

The SwitchBoard functions are accessed by navigating through the menu tree, which is located on the leftmost side of the program window.

The menu tree is divided into sections

- Commands (Move and I/O commands)
- Setup (Motor current, pitch etc. settings)
- Diagnosis (Encoder signals, HDI/Joystick)
- Connect (Connect to the TANGO controller, select COM port or IP address)
- Info (Information about SwitchBoard and the connected TANGO)

with further sub menus, depending on the TANGO controller type, installed modules, peripherals, and firmware version.

Language: After installing SwitchBoard, the program language is set to the Windows operating system language - English, German or French. In case of other Windows languages, English will be set as the SwitchBoard default.

The language can be changed in the sub menu [Setup\SwitchBoard\Program Settings] or by the key-combination "alt+L". The selected language will be applied immediately and permanently.

Program Help is available via F1 of the PC keyboard. It offers information about the currently displayed program dialog. A PDF reader must be installed in order to display information.

The remaining function keys F2...F12 can be assigned to SwitchBoard functions, like switching to different program dialogs [Setup\SwitchBoard\PC Function Keys].

The [ESC] key of the PC keyboard has the same functionality as the STOP button function (red button on the upper right corner in SwitchBoard).

Position Display: The position display is located on the lower right of the SwitchBoard window. If axes are equipped with an encoder / measuring system, the displayed position can be selected from the (theoretical) open loop motor position or from the currently measured encoder position. If encoder positions are available, a button [Encoder Pos] is displayed below the positions. Also, the LEDs aside the position display then appear green (dark green indicates that encoder position is available but not selected, light green indicates that the encoder position is currently displayed). The position display is not available in all program dialogs and not all dialogs permanently update the position.

Axis State: The axis state display provides quick information about the TANGO axes. Amplifier state (present/on/off/error), Closed Loop, Cal/Rm, position correction and more is displayed as an icon per axis.

Connecting the TANGO Controller

To connect SwitchBoard with the TANGO controller, the COM Port and the Baudrate (usually 57600 Baud) must be selected. The connection is established by pressing the [Connect] button. If the controller's Baudrate is unknown, SwitchBoard offers connecting via the [Baud Auto Detect] function. SwitchBoard shows available COM ports in the range from COM1 to COM127. Higher port numbers may be entered manually in the Serial Port dropdown box and are remembered from the next program start. Connecting over Ethernet is available by entering the IPv4 address instead of the COM port, e.g. 192.168.1.162 (depends on TANGO ipaddr setting).

If the connected TANGO controller uses a Venus compatible instruction set, SwitchBoard will change the interpreter temporarily to native TANGO and set the controller back to Venus when SwitchBoard is closed. In such case, a message window will be shown.

TANGO Controller Setup

The sub menus of [Setup] provide access to all the parameter and options of the TANGO hardware. Velocities, pitch, limit switches, encoder and I/O functionality can be configured.

Remarks:

Changes made in the setup are not passed through to the TANGO Controller automatically.

In order to take effect, the setup must be sent to the TANGO. It can be done in two ways:

- a) Write to the TANGO (volatile, only remains until power off or reset)
- b) Store to the TANGO (remains permanently in the TANGO controller)

The [Store] button causes a write and store, so for storing the parameters it is not required to first press [Write] and then [Store].

The buttons for Read, Write and Store can be found in the lower right area of the SwitchBoard window. Alternatively, the [Setup\Synchronize Settings] dialog can be used.

The setup can be saved to an INI file, making it possible to restore individual settings or apply the same settings to multiple TANGO controllers. INI file handling, read out and storing of the TANGO setup can be done in the menu [Setup\Synchronize Settings]. SwitchBoard also supports Drag&Drop of INI files e.g. by dragging them from the Windows Explorer.

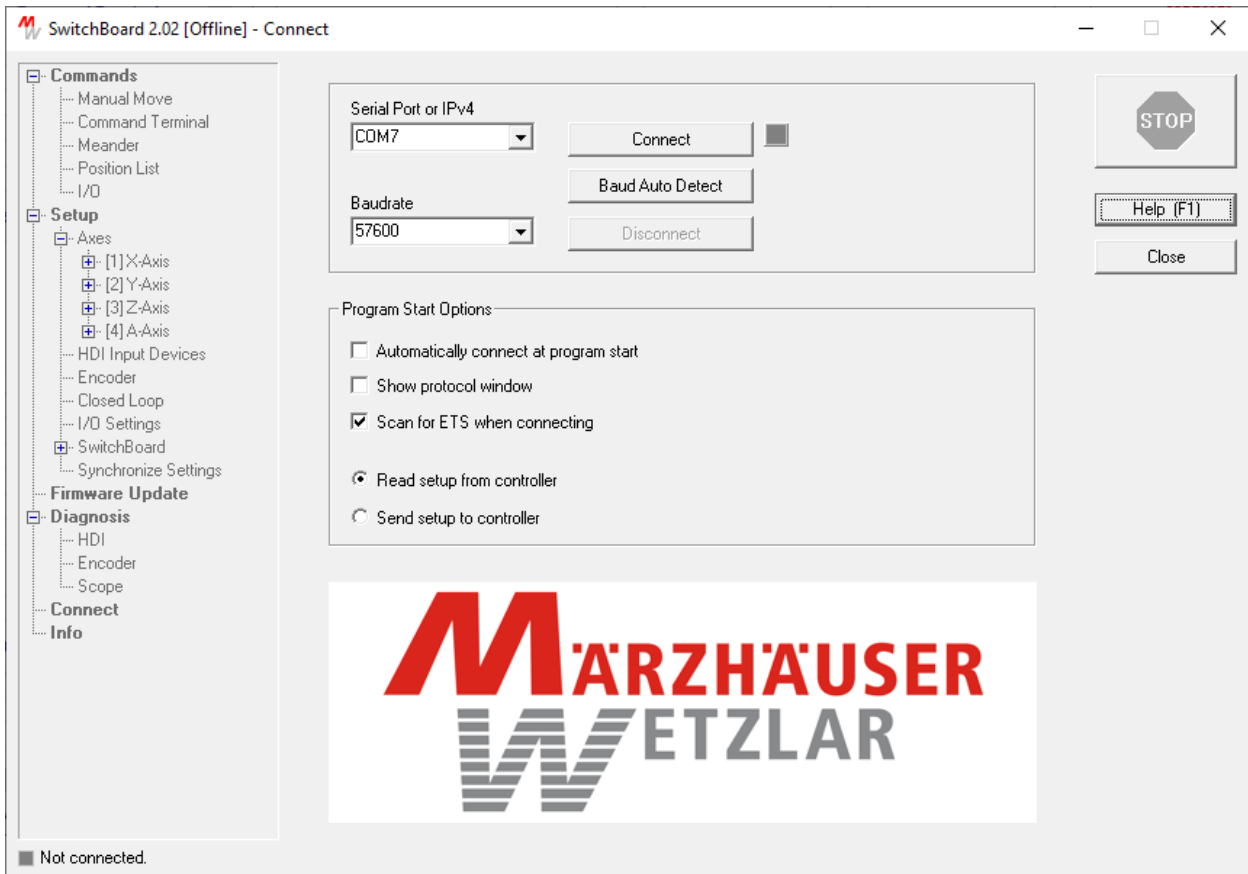
Service Print

Service Print generates a parameter list of the most important TANGO states and settings.

The function is available in the [Commands\Command Terminal] dialog. By pressing the [Service Print] button, a list is generated and can be stored to a text file by [Save]. Providing a convenient way to send information via email, e.g. in case of technical inquiries.

2 Description of the SwitchBoard Dialog Windows

2.1 Connect – Connecting the TANGO Controller



Procedure

- Select the Serial Port (COM1...COM256 or enter a valid IPv4 address)
- Select the baudrate (typically 57,600)
- Press the [Connect] button

If the baudrate is unknown, press [Baud Auto Detect] instead of [Connect].

Remarks: Check the [Automatically connect at program start] check box. Beginning from the next start, SwitchBoard will connect to the last used serial port automatically.

Remarks: COM ports higher than COM127 are not detected by SwitchBoard. In order to access higher COM port numbers, e.g. COM128, the number can be entered in the [Serial Port] selection manually.

Ethernet: To connect TANGO Desktop HE via Ethernet, the IPv4 address can be manually entered in the Serial Port dropdown field, e.g. 192.168.1.162 (depends on TANGO "?ipaddr").

If connected successfully, the program directly opens the recent program dialog or the [Manual Move] dialog.

If connecting fails, the menu tree remains disabled (grayed) and the [Connect] dialog is visible. The Connect dialog is accessible all time, e.g. to reconnect or change connection to another TANGO controller (here: [Disconnect] + [Connect]).

The status of the connection is displayed in the lower left corner of the program window.

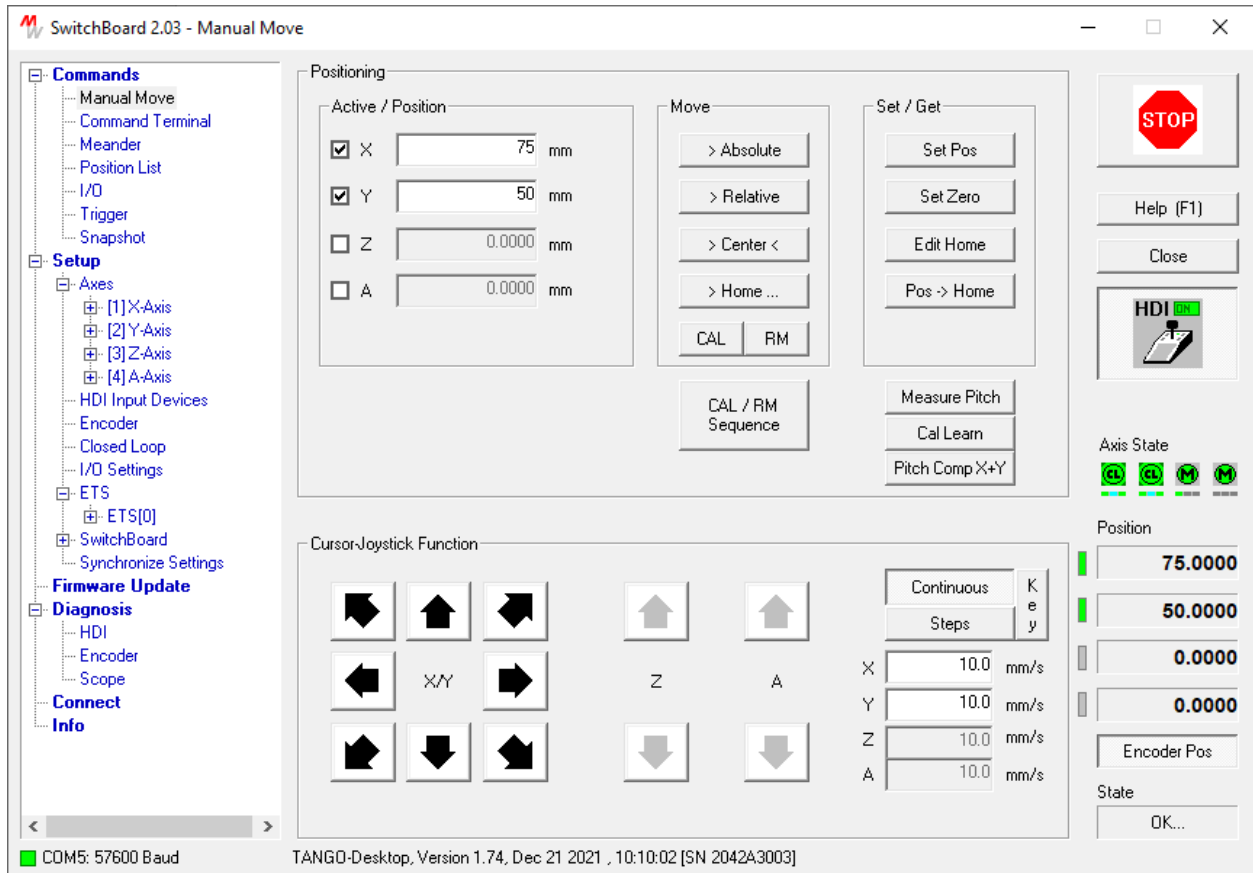
Option: Offline Mode

The menu tree can be enabled in offline mode (when no Controller is connected) by a left click on the gray connect status LED aside the [Connect] button. Then all program options are accessible. It can be used to edit INI files or to demonstrate SwitchBoard even without TANGO.

Description

Serial Port:	COM port to which the TANGO Controller is connected Select from drop-down list or enter COM number manually (to connect with TANGOs via Ethernet, the IPv4 address can be entered, e.g. 192.168.1.162)
Baudrate:	COM port data rate (typ. 57600 baud, used for RS232 only)
[Connect]	SwitchBoard connects to the Controller using the here selected port settings.
[Baud Auto Detect]	SwitchBoard connects to the Controller on the selected COM port and detects the correct Baudrate automatically.
Automatically connect at program start:	When SwitchBoard is started, it automatically connects to the recent COM port and Baudrate.
Show protocol window:	Opens an additional window which shows the communication between SwitchBoard and the TANGO controller. Saving the recorded data to a text file is also possible. The window can be opened and closed any time, even if the controller is connected. The protocol window can also be opened and closed by simply pressing alt+p in any SwitchBoard dialog window.
Scan for ETS when connecting:	When connecting, the TANGO re-scans the ETS data bus. This ensures that the correct ETS states and parameters are available. E.g. when axes are connected while the TANGO was already switched on, only this scan will detect a change of ETS or ETS data.
Read setup from controller:	When connecting, SwitchBoard reads the current setup from the TANGO controller (recommended).
Send setup to controller:	When connecting, SwitchBoard transmits its current SwitchBoard setup to the Controller. The TANGO internal parameters are overwritten, but not stored permanently.

2.2 Manual Move



Abstract

Provides access to positioning functions.

Emergency stop is possible via the STOP button on the upper right or the keyboard ESC key.

A joystick button is displayed on the right side of the window. Checking/unchecking this button enables/disables the HDI device (Joystick) temporarily. Remarks: When reading or writing to the Controller, the [Joystick Mode] parameter can be affected by changing the state of this button.

PC Keyboard F-Key commands can be executed in this window. Further information is available in [PC Function Keys](#) description.

Axis State display: Active motor amplifiers are shown in green, disabled amplifiers are shown grayed. An error state is indicated by red symbols. Arrangement: [X][Y][Z][A].

	Motor amplifier is enabled	Closed Loop is on and active
	Motor amplifier is enabled	Closed Loop is on and active in weakened mode
	Motor amplifier is enabled	Closed Loop is on, but momentary not active **
	Motor amplifier is enabled	Closed Loop is off because encoder is off
	Motor amplifier is enabled	Closed Loop is off due to encoder error
	Motor amplifier is enabled	Open Loop mode
	Motor amplifier is disabled	(by !axis 0 instruction: motor current is on)
	Motor amplifier is switched off	(by !axis -1 instruction: no motor current)
	Motor amplifier is switched off	(by !pa 0 instruction)
	Error, motor amplifier off ***	
	Another axis switched off due to error, because of that this axis is also switched off ***	
	Axis is not available	
	Calibration state: No CAL or RM executed yet (no zero-position or position limits set)	
	Calibration state: CAL required (no move possible before CAL, CAL not executed yet)	
	Calibration state: CAL completed	
	Calibration state: CAL completed and 1D axis position correction active	
	Calibration state: CAL completed and 2D axis position correction active	
	Calibration state: Only RM completed, no CAL executed	
	Calibration state: CAL and RM completed	
	Calibration state: CAL and RM completed and 1D axis position correction active	
	Calibration state: CAL and RM completed and 2D axis position correction active	
	Thermal Compensation is activated (activation by CAL instruction)	
	Thermal Compensation is activated and Temperature Value is up to date (working)	

** Axis in E0 or EE limit switch or closed loop mode=1 (until target) or current reduction <30%.

*** If the amplifiers are switched off due to error (red symbol), they can be switched on again by right clicking on the symbol.

Position display on the lower right: A gray LED to the left of the position display indicates that no encoder position is available, and the motor position is displayed, a dark green LED signals that encoder position is available but not shown, a green LED signals that the encoder position is displayed. If the LED is red, it indicates an encoder error. The button [Encoder Pos] appears when at least one encoder is present. The button then enables switching between motor- or encoder-position displays (dark green/green LED).

Active checkboxes [X,Y,Z,A] : Enable or disable axes for use in this SwitchBoard dialog. Here disabled axes are not used for moves, CAL/RM or the cursor keys. The settings don't affect the TANGO.

Position: Target positions for [Absolute] move, or distances for [Relative] move, or position for [Set Pos].

Move: Commands only affect the [Active] checked axes.

- **Absolute:** Move to absolute positions entered on the left.

- **Relative:** Move relative distances entered on the left.

- **Center:** Axes **X & Y** move to the stage center position (CAL+RM necessary!).

- **Home:** Move to the home positions (0, editable by [Home Pos] button).

- **CAL:** Starts a calibration move to the lower (origin) limit switches. Can be aborted by again pressing the [CAL] button or [STOP]. The CAL sequence can be selected by the [CAL/RM Sequence] button.

- **RM:** Starts a calibration move to the upper (end) limit switches. Can be aborted by again pressing the [RM] button or [STOP]. The RM

sequence can be selected by the [CAL/RM Sequence] button.

- **CAL/RM Sequence:** Configures the sequence that is started by pressing [CAL] or [RM]. A sequence can consist of up to 4 steps. Simultaneous, consecutive, or even multiple limit switch moves are possible. The default after a clean install of SwitchBoard is X calibrates first, followed by Y while Z and A are not selected for [CAL] / [RM] to avoid Z-axis collisions. The used axes also depend on the "Active" Checkboxes [X,Y,Z,A].
 Alternatively, a certain velocity and acceleration can be specified which will be used by SwitchBoard for [CAL] and [RM].

Set / Get: (Depending on the Active Checkboxes X,Y,Z,A):

- **Set Pos:** Set the axis positions to the values entered in the Position fields.
- **Set Zero:** Set axis positions to zero.
- **Edit Home:** Edit the home position used by the [< Home] button (a dialog appears).
- **Pos -> Home:** Set Home Position to the current controller position. (Affects only the axes which are enabled by the [Active] checkboxes, as described above.)

Cursor-Joystick Function: The arrows can be pressed by either the mouse or the PC keyboard (cursor block & NUM block). It is possible to move continuously or in single steps. Continuous velocity or step width may be edited below.

[Key] Enable the keyboard (cursor- and NUM block) for Joystick functions. Caution: Do not enter numbers via the NUM block. This will lead to moving axes (XYZ).

[Continuous] Move with constant velocity, as long as arrow or cursor key is pressed. Availability also depends on TANGO HDI joy / joydir setting.

[Steps] Move one step per keystroke.

INI-File Option 'AnyKey' The SwitchBoard.ini entry AnyKey in [DLG\1] can be modified by a text editor:

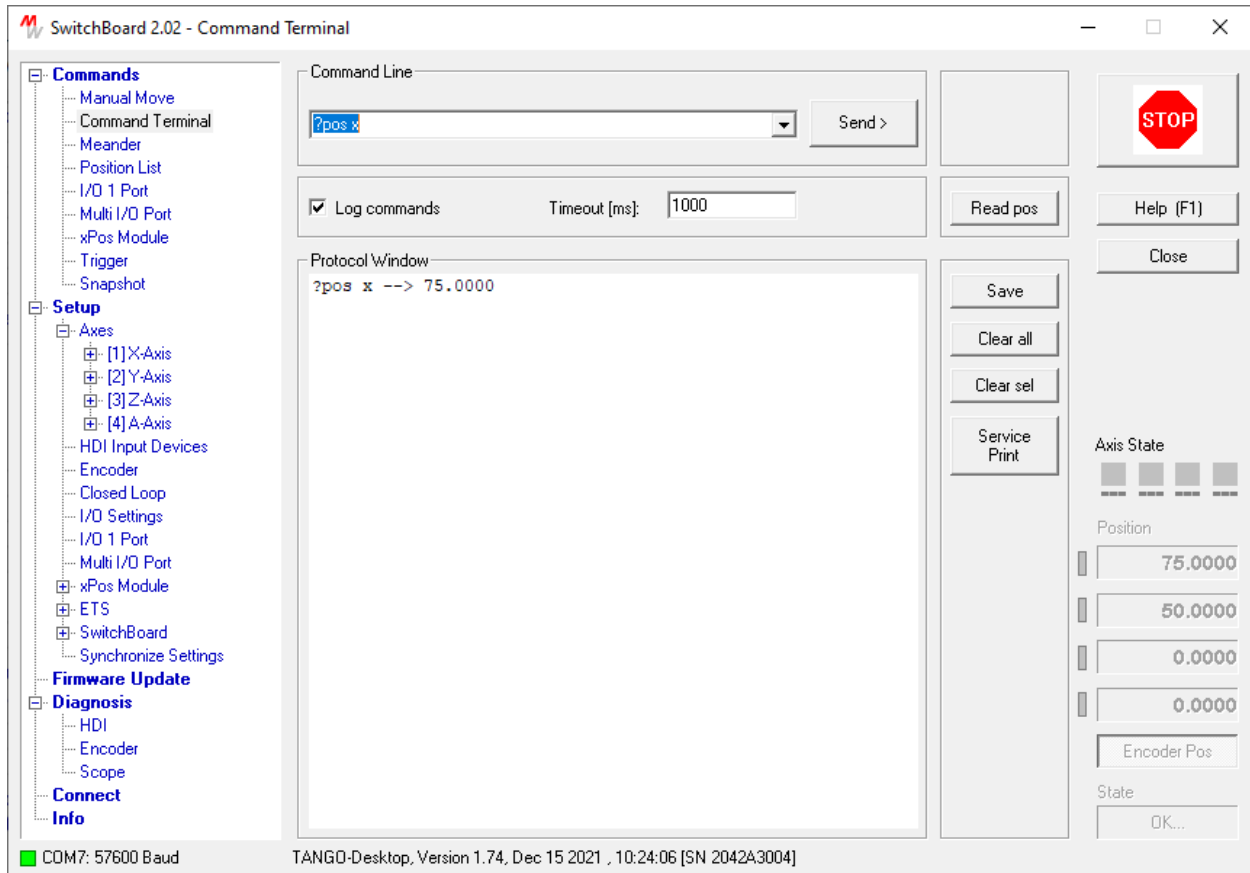
AnyKey=0 → AnyKey function off / normal cursor function
 AnyKey=1 → Any Keyboard key moves X positive (as cursor right)
 AnyKey=-1 → Any Keyboard key moves X negative (as cursor left)
 AnyKey=2 → Any Keyboard key moves Y positive (as cursor up)
 AnyKey=-2 → Any Keyboard key moves Y negative (cursor down)

The function is active when the Key Button is pressed. The AnyKey active warning will then be displayed in the Joystick headline.

If any key (a-z, 0-9, ... except the special functions e.g. shift, tab, F, cursor, ...) of the PC Keyboard is pressed, it will cause the same behavior as the desired cursor key.

SwitchBoard.ini entry: `[DLG\1]`
`CurJoyKeys=0`
`CurJoyType=1`
`AnyKey=0`

2.3 Command Terminal



Abstract

This Dialog provides a direct command line interface to the controller, and the [Service Print] diagnosis option. Also, .mac Macro files can be uploaded to the TANGO by Drag&Drop here.

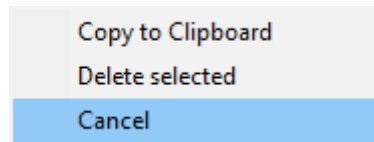
- For available commands please refer to the TANGO Instruction Set Description.
- The most recently sent commands are available in the command line dropdown list.
- By default, the last entered command remains in the command line after sending. This behavior can be changed in the “Program Settings for SwitchBoard” Dialog.
- The position display is not updated automatically; [Read pos] must be pressed to update the Position and Status display once.
- Changes made to the TANGO by the command line interface are not automatically updated in the SwitchBoard settings. Therefore, after changing a parameter by command line, the TANGO must be read out again afterwards.

Command Line: For entering TANGO commands. The command is sent after pressing Enter on the keyboard or the [Send >] button.

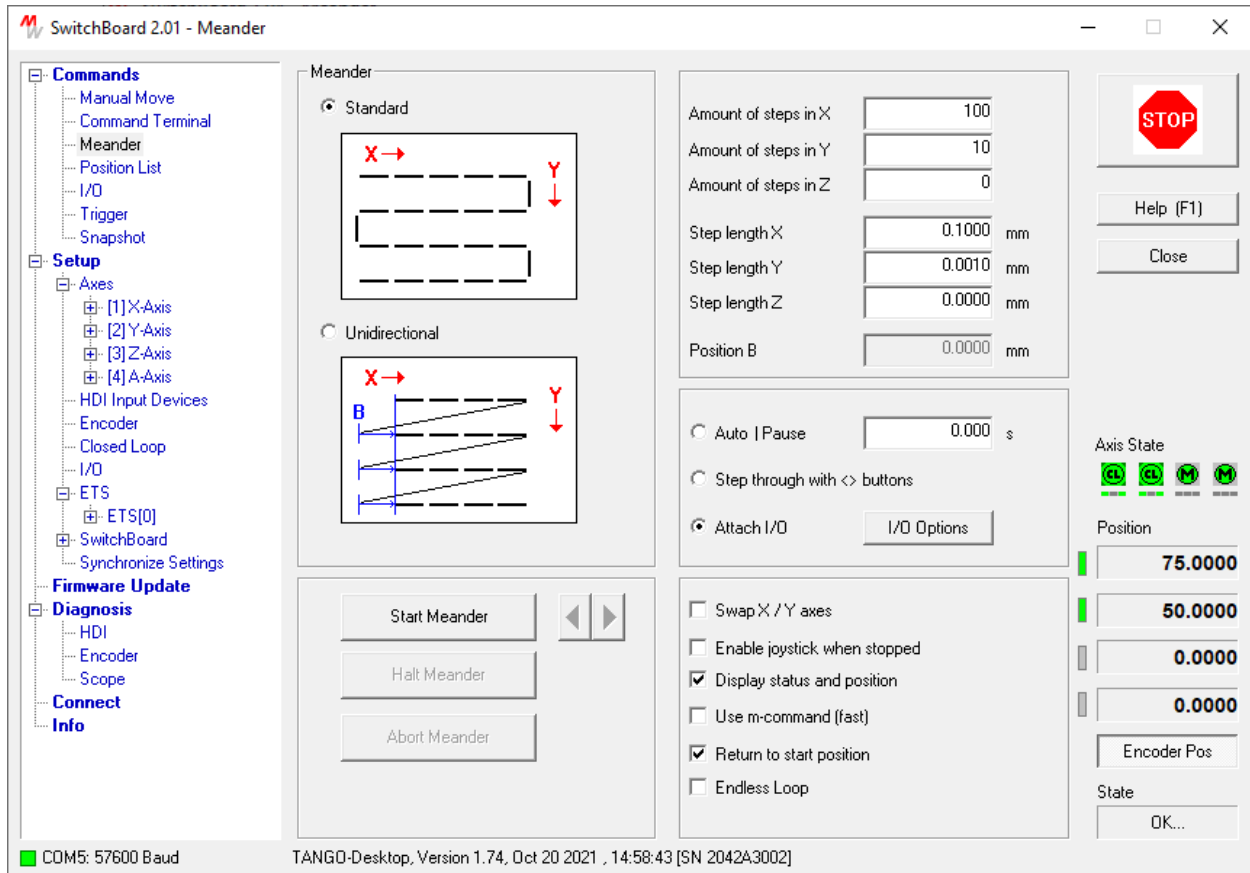
Log commands: Write the sent command to the Protocol Window. If unchecked, only the TANGO replies are listed.

Timeout [ms]: Maximum waiting time for a controller response. Move commands like *moa*, *mor*, *cal*, *rm* response when the target position is reached, which can take longer than the default 1 second. If required, a longer waiting time can be specified for the reply.

[Read pos]	Manually update the SwitchBoard position display (Axis State and Position on the lower right)
[Save]	Save the Protocol Window content to a file.
[Clear all]	Delete entire protocol.
[Clear sel]	Delete the selected protocol line(s).
[Service Print]	Executes the TANGO <i>service</i> instruction. Generates a listing of the most important controller states and settings.
Protocol Window:	<p>Shows the controller response and optional the sent command also.</p> <p>'CTRL+left mouse button' can be used to select multiple lines 'CTRL+a' selects all lines 'CTRL+c' copies the selection into the Windows clipboard (for external copy&paste of selected lines, e.g., into Word or email) Right click into the Protocol Window opens a menu to either copy or delete the selected lines. Here use 'Cancel' to exit without changes.</p>



2.4 Meander



Abstract

Processing of meander scans.

Axis State display: Active motor amplifiers are shown in green, disabled amplifiers are shown grayed. An error state is indicated by red pictographs. Updated only if [Display status and position] is checked, after every time a position is reached.

Position display: Updated only when the option [Display status and position] is checked.

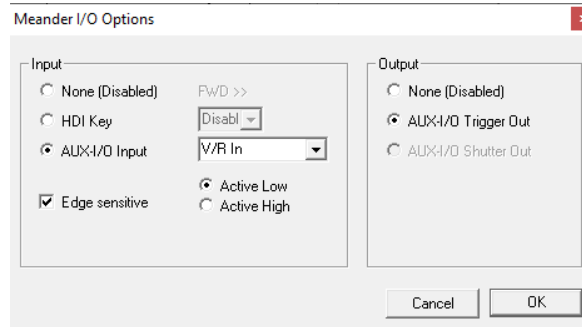
Standard/Unidirectional: The standard meander processes the steps in both X directions, the unidirectional meander moves back to the beginning of the next line and processes the meander in one direction only. Also, a start position B can be specified to start each meander line before the first meander position.

Auto | Pause: The default setting. Scans are executed automatically without user interaction. After each position the axis is halted for the specified time, which usually is 0 for no wait.

Step through: The arrow button [>] right of [Start Meander] becomes enabled. The meander can be processed forward, step by step, manually.

Attach I/O:

Executing meander steps can be triggered by an external event. E.g. by pressing a joystick key or by edge and level of I/O signals. A trigger output signal can be generated after reaching a position.

**Swap X / Y axes:**

The meander is processed in a 90 degrees angle.

Enable Joystick:

The Joystick (HDI device) should be disabled during the meander. When the m-command is used, having the Joystick/HDI enabled may cause an increasing position deviation each step.

Display status and pos.:

Position and state display is updated after each step. This can be deactivated in order to increase performance, mainly with true RS232 communication at low data rates.

Use m-command (fast):

Can be activated in order to increase performance, mainly with true RS232 communication at low data rates. If the performance impact is not noticeable it is recommended not to use the m-command.

Return to start position:

Returns to start position after processing the meander.

Endless Loop:

Endless repetition of the meander until stopped or aborted.

[Start Meander]

Button pressed: Start meander, button remains pressed
Uncheck button: Currently running move will be completed, then ends the meander.

[Halt Meander]

Currently running move will be completed, then the meander is halted until the halt button is unchecked.

[Abort Meander]

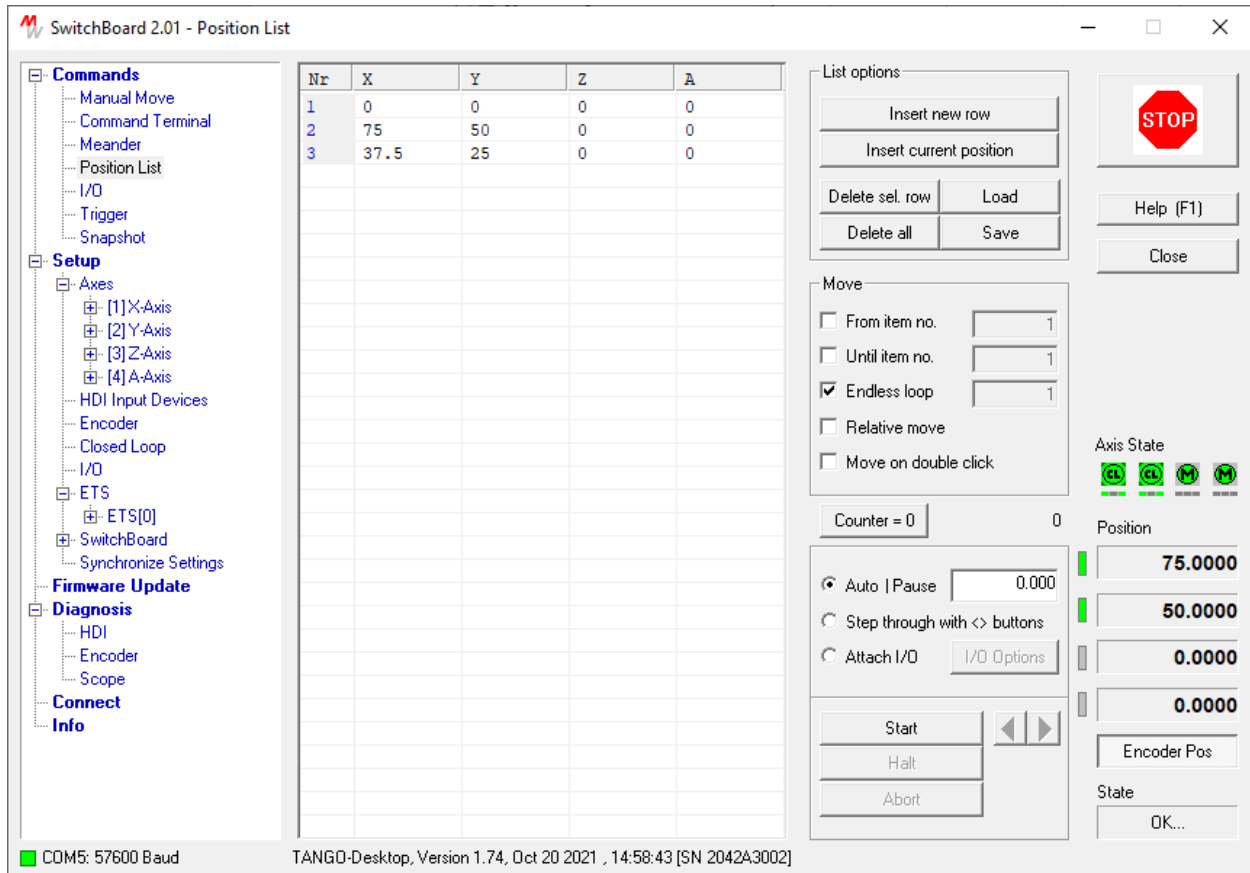
Immediately aborts move and ends the meander.

Z Stacks:

It is possible to execute meanders in several Z layers. Therefore, the number of steps in Z must be set to > 0. After completion of each X,Y meander and returning to the X,Y start position, the next Z position is set and the X,Y meander is executed again. The step length in Z is the relative position change for the next layer. (If set to 0 this will lead to executing a X,Y meander in the same Z layer for n times.)

Remarks: It is recommended to disable the Joystick (HDI device) during the meander. [Enable Joystick] must then be left unchecked, at least when using the m-command option. Else it can cause slight position deviation.

2.5 Position List



Abstract

Managing of position lists. Position lists can be created, edited, loaded, saved and executed. The most recently saved or loaded list file is restored (reloaded) on SwitchBoard startup.

Creating a new list:

A new list can be created by first adding the desired number of rows. Which then can be edited.

Extra functionality for TANGO Snapshot: If the TANGO Snapshot is enabled, a menu for transferring the position list to and from the TANGO Snapshot array can be opened by pressing the right mouse button.

Axis State display: Active motor amplifiers are shown in green, disabled amplifiers are shown grayed. An error state is indicated by red pictographs. Updated only after reaching a position.

Position display: Updated only after reaching a position.

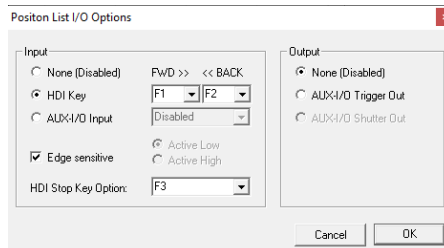
[Insert new row] Inserts a new row underneath the currently selected row in the list.

[Insert current position] Inserts a new row with the controller positions underneath the currently selected row. (Can also be done by a PC Function-Key (F2...F12), when assigned via [SwitchBoard→PC Function Keys](#))

[Delete sel row] Delete the currently selected row.

[Delete all] Delete the entire position list.

- [Load]** Open a TANGO Position List file (.tpl file format only).
Load can also be done by drag&dropping a tpl file onto the window.
- [Save]** Save current list as TANGO Position List file (as .tpl or Excel .csv).
The csv type (comma/dot) can be selected in the [Program Settings](#).
- From item no.:** Execution starts at this row. Rows above are ignored.
To item no.: Execution ends at this row. Rows below are ignored.
- Endless Loop:** If Endless loop is checked, the list will be executed until the [Start] button is unchecked or the [Abort] button is pressed.
If Endless loop is not checked, the list will be executed the amount of times entered in the edit field on the right (1 = list is executed once, 5 = list is executed 5 times, etc.).
- Relative move:** If checked, the position values are executed as relative move positions. Else they are regarded as absolute positions (default).
- Move on double click:** If checked, a mouse double klick on a row number (Nr) executes a move to this position. A double klick always sets the first start index.
- [Counter = 0]** Reset loop counter to zero.
- Number displayed right to the [Counter] button:** Loop counter, counting how many times the list has been executed. The counter is resetted when starting the SwitchBoard software, by loading a list file or pressing the [Counter=0] button.
- Auto | Pause:** Default mode, automatic execution of the position list. A delay time in seconds can be specified for each row (0 = no delay).
- Step through with <>:** Arrow buttons appear with whom the list can be executed row by row in either direction. The functionality depends on the Loop settings. Please refer to the next page for a detailed description.
- Attach I/O:** Executing position steps then are triggered by an external event: either by using HDI keys (e.g., of the Joystick) or AUX-I/O inputs. A trigger output signal can be generated after reaching a position. The functionality can be accessed trough the **[I/O Options]** button:



Please refer to the detailed description on the next page.

- [Start]** Execute the position list. The button remains pressed. Unchecking the Start button will end execution after current position is reached. The list is executed by the amount entered in the Loop field (default=1: only once, no repeat). If Endless loop is checked, the list will be repeatedly executed until Start or Abort buttons are pressed.
- [Halt]** Currently running move will be completed, then the position list execution is halted until the halt button is unchecked.
- [Abort]** Immediately aborts a running move and ends the list execution.

2.6 Manual Execution of Position Lists

The Position List options

- **Step through with <> buttons** and
- **Attach I/O** (when used with HDI Keys)

offer extended functionality for manually stepping forward and backward through position lists. Options and required settings are as follows:

Executing a Position List

07. within its limits (or the specified from/to limits)

The execution does not terminate, it only stops at the upper and lower ends of the list to remain within it. No wrap-around.

Endless Loop: *leave unchecked*

Loops: *set to 0*

2. within the limits but allow list wrap-around backwards

The execution does not terminate, it only stops at the lower end of the list. Stepping back wraps around (first→last).

Endless Loop: *leave unchecked*

Loops: *set to -1*

3. forward for a specified number of times (and back only until the top or “from” of list)

The execution terminates after wrapping around forwards (last→first) for *N* times. Stepping backwards does not wrap around. Wrapping around forwards (last→first) increments the counter.

Endless Loop: *leave unchecked*

Loops: *set to the required amount of loops through the list (1 to 2147483647)*

4. endless forward (and backward) wrap-around

The execution does not terminate and does not stop at the ends. Wrapping around forwards (last→first) increments the counter.

Endless Loop: *checked*

Loops: *don't care*

The active range of a list can be narrowed down by specifying “from” and/or “to” index limits. This also applies to wrap-around.

Changes of the from/to settings and the number of loops can be done even during execution.

AUTO | Pause and **AUX-I/O** options do not allow going backwards in the position list.

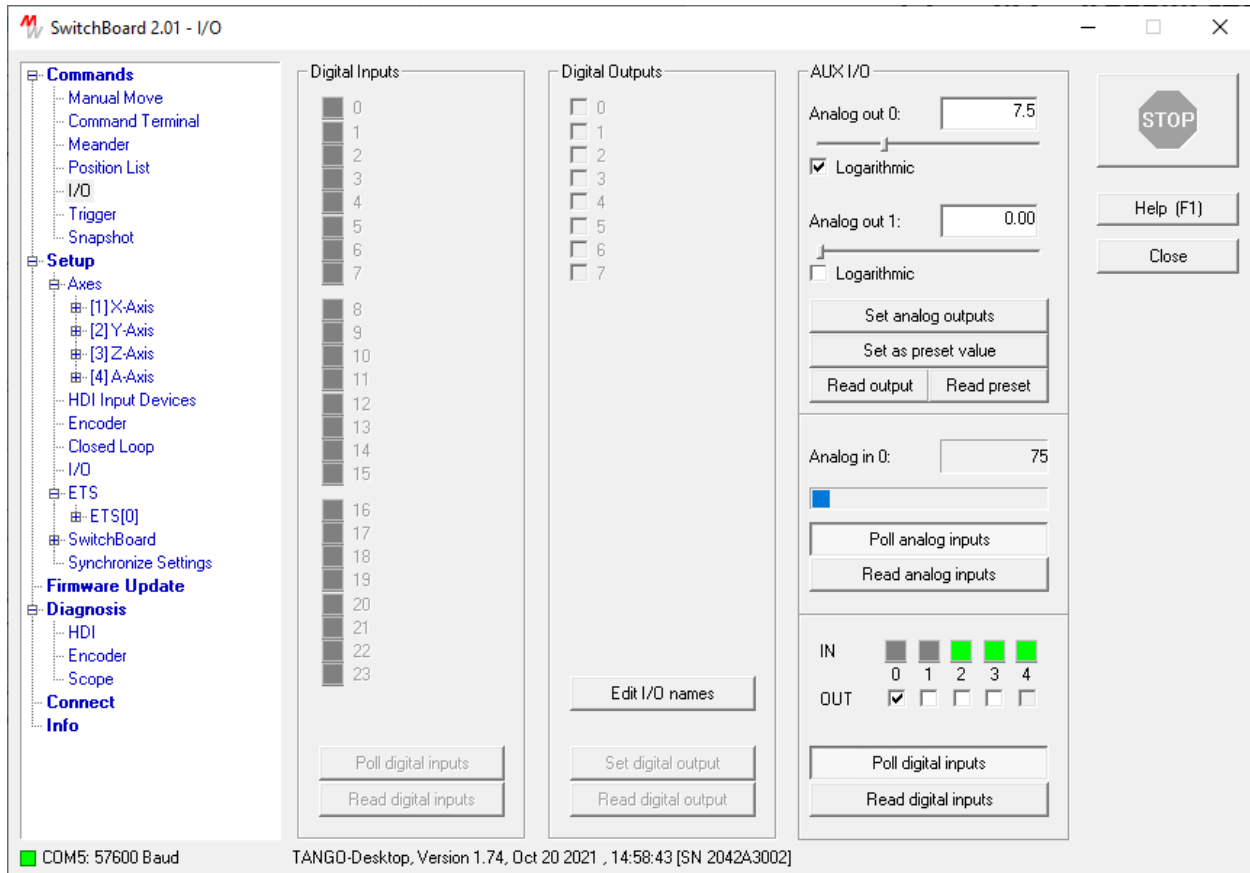
Stop Key can be specified when using HDI keys. It aborts the current move, which afterwards can be continued by again pressing the key of the previously used direction (FWD or BACK).

Edge sensitive option requires a new signal edge or keystroke to continue, else only a constant active state or pressed key lets the list execute without stopping.

Double clicking on the row index number can execute a move to this position (not if relative), when “Move on double click” is checked. Independent of that, the double click sets the start index for execution or changes the current list index while running. If the list should be executed from the first (or the “from item”) index, this can be ensured by double clicking on a free space

of the dialog, e.g. to right of the [START] etc. buttons. This removes any possible double click preselection for the start index for the list's first execution.

2.7 I/O Dialog – Set and Read the TANGO Input / Output Pins



Abstract

Provides access to the TANGO in- and output pins of the optional AUX-I/O connector and the the optional I/O1 and Multi I/O port extensions.

Digital Inputs: Optional I/O1 or Multi I/O Port: Read input state.

[Poll digital inputs] Continuously read input state.

[Read digital inputs] Read input state now.

Digital Outputs: Optional IO1 or Multi I/O Port: Set output state.

Relay: Optional IO1 or Multi I/O Port: Switch the optional relay.

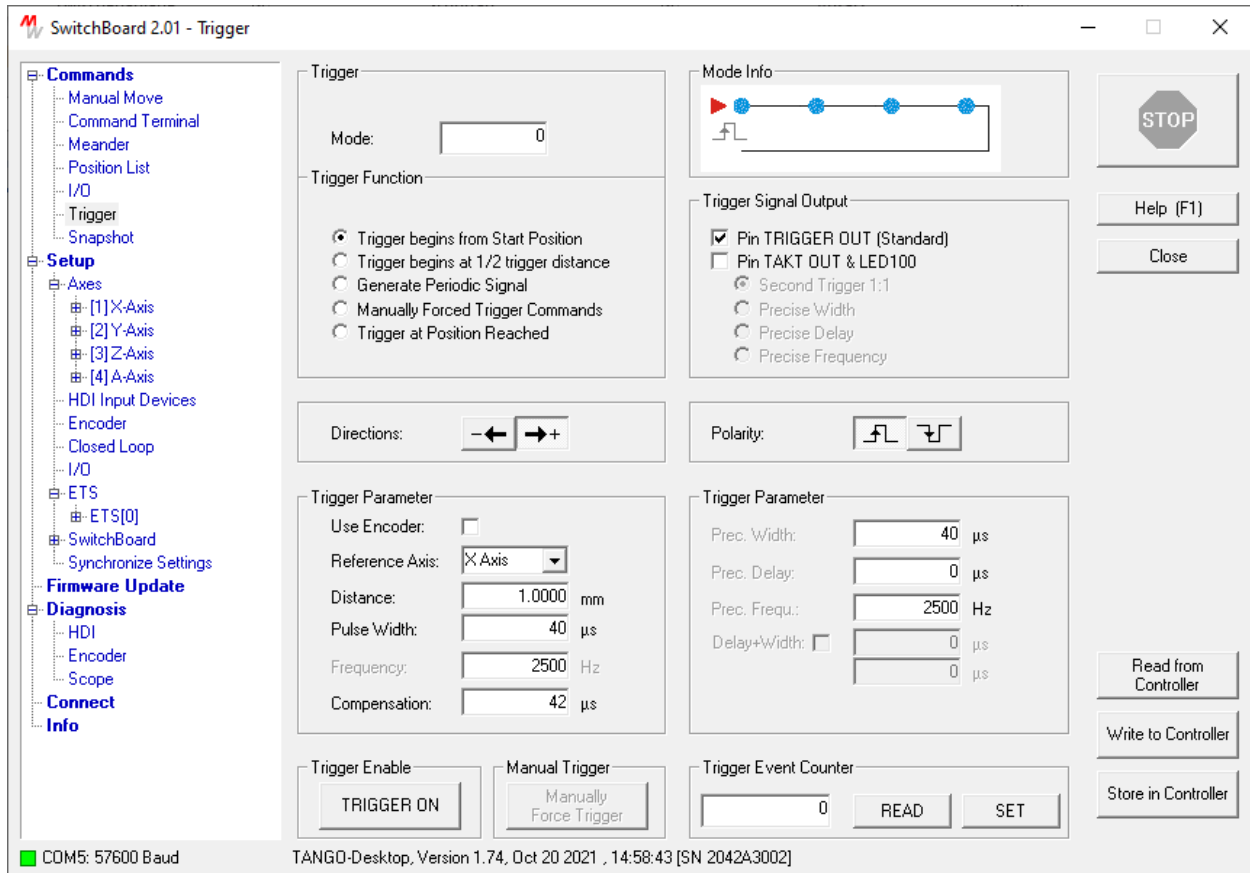
[Set digital output] Set outputs to the selected I/O bit pattern. Remark: The I/O output state is also updated each time an output bit is changed (checked / unchecked). So, pressing this button usually is not necessary.

[Read digital output] Read back the output states from the TANGO I/O1 or Multi I/O.

[Edit I/O names] Assign custom names to the digital I/O labels or delete all custom names

Analog Out:	Both analog outputs of the AUX I/O connector can be set either by the slider or entered as a value of 0~100 percent. Dragging the slider updates the analog outputs automatically. When typing in a percent value, the outputs must be updated by pressing the [Set analog outputs] button.
Logarithmic:	The analog out sliders can be set to logarithmic sensitivity. This increases the resolution of smaller values and may be used when e.g., controlling a light source like LED100.
[Set analog outputs]	Apply Analog out 0 and 1 values to the TANGO outputs.
[Set as preset value]	Store the Analog out 0 and 1 values as TANGO startup defaults.
[Read output]	Read back the Analog out 0 and 1 values from the TANGO.
[Read preset]	Read back the Analog out 0 and 1 presets from the TANGO.
Analog In:	Analog input of the optional AUX I/O connector.
[Poll analog inputs]	Continuously update the displayed analog input value.
[Read analog inputs]	Read the analog input value once.
Digital IN:	<p>Set or read back the state of the digital output pins. Up to 5 pins are available, depending on the type of controller and the AUX I/O connector.</p> <p>The input name of the connected TANGO controller is shown when moving the mouse cursor over the square shaped IN LEDs.</p> <p>Example: Digital inputs of the optional AUX I/O connector: 0 = Pin 1: TAKT_IN (might not be available with all controllers) 1 = Pin 2: V/R IN 07 = Pin 3: STOP 07 = Pin 4: SNAP_SHOT2 4 = TRIG IN signal from the Motor 1-3 connector, not the AUX-IO</p>
Digital OUT:	<p>Reflects the state of the digital input pins. Up to four pins are available, depending on the type of controller and the AUX I/O connector.</p> <p>The output name of the connected TANGO controller is shown when moving the mouse cursor over the numbers 0,1,2,3 which are between the IN LEDs and OUT checkboxes.</p> <p>Example – Digital outputs of the optional AUX I/O connector: 0 = Pin 5 TAKT_OUT (may be occupied by trigger or LED100) 1 = Pin 6 VR_OUT 07 = Pin 7 SHUTTER_OUT 3 = Pin 8 TRIGGER_OUT (may be occupied by trigger)</p>

2.8 Trigger – Optional Trigger Output



Abstract

Setup and test of the trigger functionality.

The trigger mode can be set by entering the trigger mode number, as described in the TANGO Instruction Set, or by selecting the required [Function], [Directions] and [Polarity] checkboxes. In this case, SwitchBoard sets the corresponding trigger mode number automatically while in case the trigger mode number is entered, SwitchBoard sets the corresponding checkboxes. If the operating mode is valid, it is displayed in the Mode Info pictograph on the upper right. Ensure that the selected trigger mode is supported by the TANGO (refer to Instruction Set).

The trigger output must be set separately. Depending on hardware, up to two trigger outputs are available.

The settings must be applied to the TANGO by pressing the [Write to Controller] or [Store in Controller] button.

Additionally, the trigger dialog offers testing of the selected mode and parameters. Therefore, the Trigger can be enabled, a manual trigger signal can be forced (in manual trigger mode) and the trigger event counter can be read or set.

Trigger Mode: Trigger Mode (number), as listed in the TANGO Instruction Set

Or set mode optionall by choosing

- **Trigger Function:**
 - 1) Trigger output from start position in fixed distances
 - 2) Trigger output from half distance in fixed distances
 - 3) Permanent output of a fixed frequency
 - 4) Manually forced trigger by TANGO instruction
 - 5) Generate trigger when axis position is reached
- **Trigger Direction:** Generate trigger when traveling forward and/or backward
- **Signal Polarity:** Trigger Signal output active high / active low.

Pin TRIGGER_OUT: Enable the standard trigger output

Pin TAKT_OUT & LED100 Enable secondary trigger output which provides several options:
Second Trigger 1:1 = second trigger (TAKT_OUT) provides same signal as TRIGGER_OUT
Precise Width = high precision+resolution signal width *trigbwidth* **
Precise Delay = high precision+resolution edge delay *trigbdelay* **
Precise Frequency = high precision+resolution frequency *trigbf* **

** Only available with TANGO PCI-E / DT-E, TANGO 3 mini and TANGO-Desktop

Trigger Parameter

- **Use Encoder:** Position dependent trigger is derived from encoder signal (Closed Loop of the trigger axis must be active).
- **Reference Axis:** Axis which the trigger is related to.
- **Distance:** Distance of trigger pulses (position difference).
- **Pulse Width:** Pulse width of the trigger signal in microseconds. TANGO supports signal widths in 40µs steps (0,40,80,120,...)
- **Frequency:** Frequency of the trigger signal for the “Generate Periodic Signal” Trigger Function.
- **Compensation:** To compensate delay times in the trigger signal chain (of external components). Compensation activates the trigger signal before reaching the position (look-ahead).
Can be used to reduce or eliminate “comb” effects in bidirectional scanning applications.
- **Prec. Width:** HiRes Pulse width of second trigger output (TAKT_OUT & LED100)
- **Prec. Delay:** HiRes Edge delay of second trigger output (TAKT_OUT & LED100)
- **Prec. Frequ.:** HiRes Frequency of second trigger output (TAKT_OUT & LED100)
- **Delay+Width:** TANGO PCI-E/DT-E/3 mini: In Second Trigger 1:1 mode, the second trigger can be delayed and/or have a different signal width than the first trigger. The parameters cannot be stored permanently

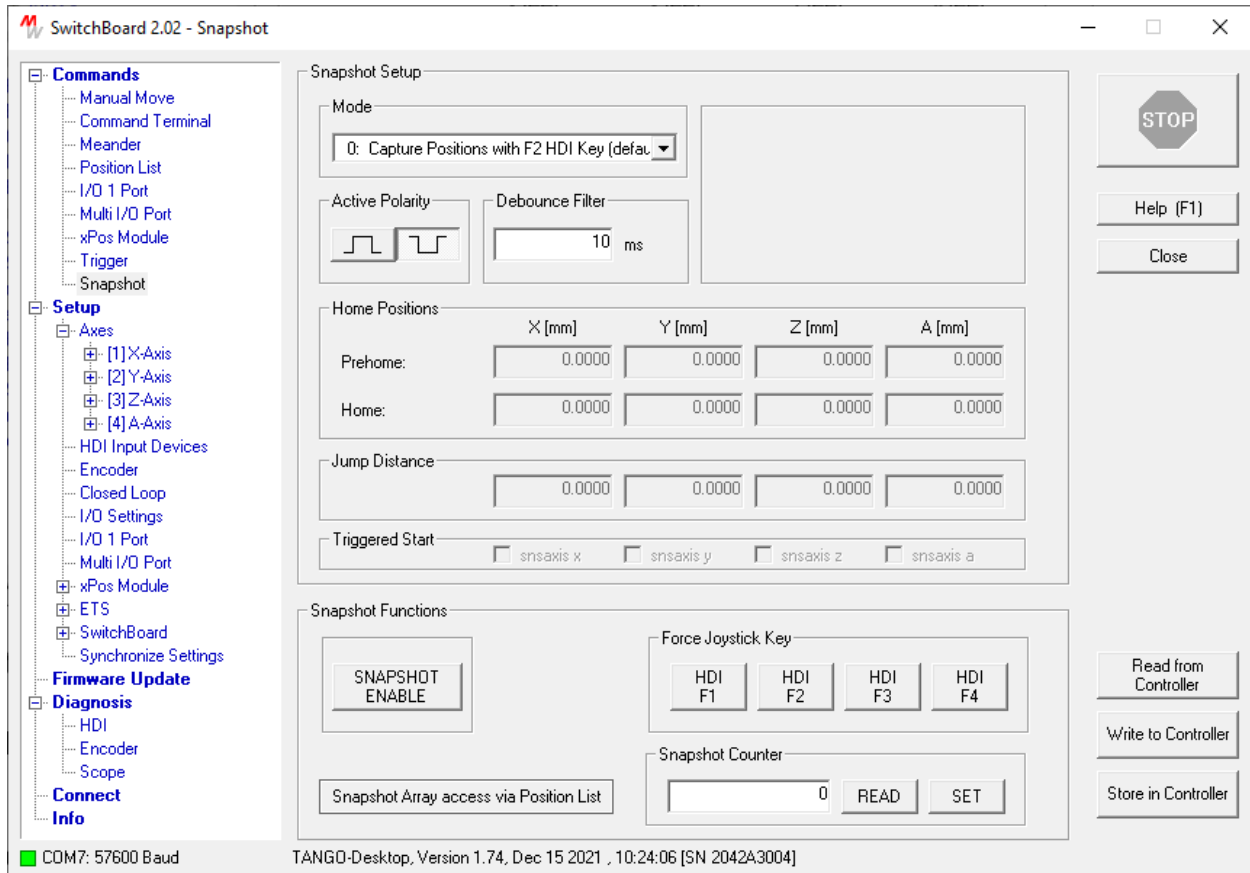
[Read from Controller] Read Trigger Setup from controller (except write only Delay+Width)
[Write to Controller] Send Trigger Setup to the controller
[Store in Controller] Send Trigger Setup to the controller and store it permanently

[Trigger ON] Globally enable the trigger functionality (ON).

[Manually Force Trigger] Manually force the trigger signal (in the corresponding manual trigger mode, the trigger event counter display is also updated).

Trigger Event Counter: Read the number of generated trigger events from the TANGO or set the trigger counter to any number, e.g. to zero.

2.9 Snapshot – Optional Trigger Input and Joystick Functionality



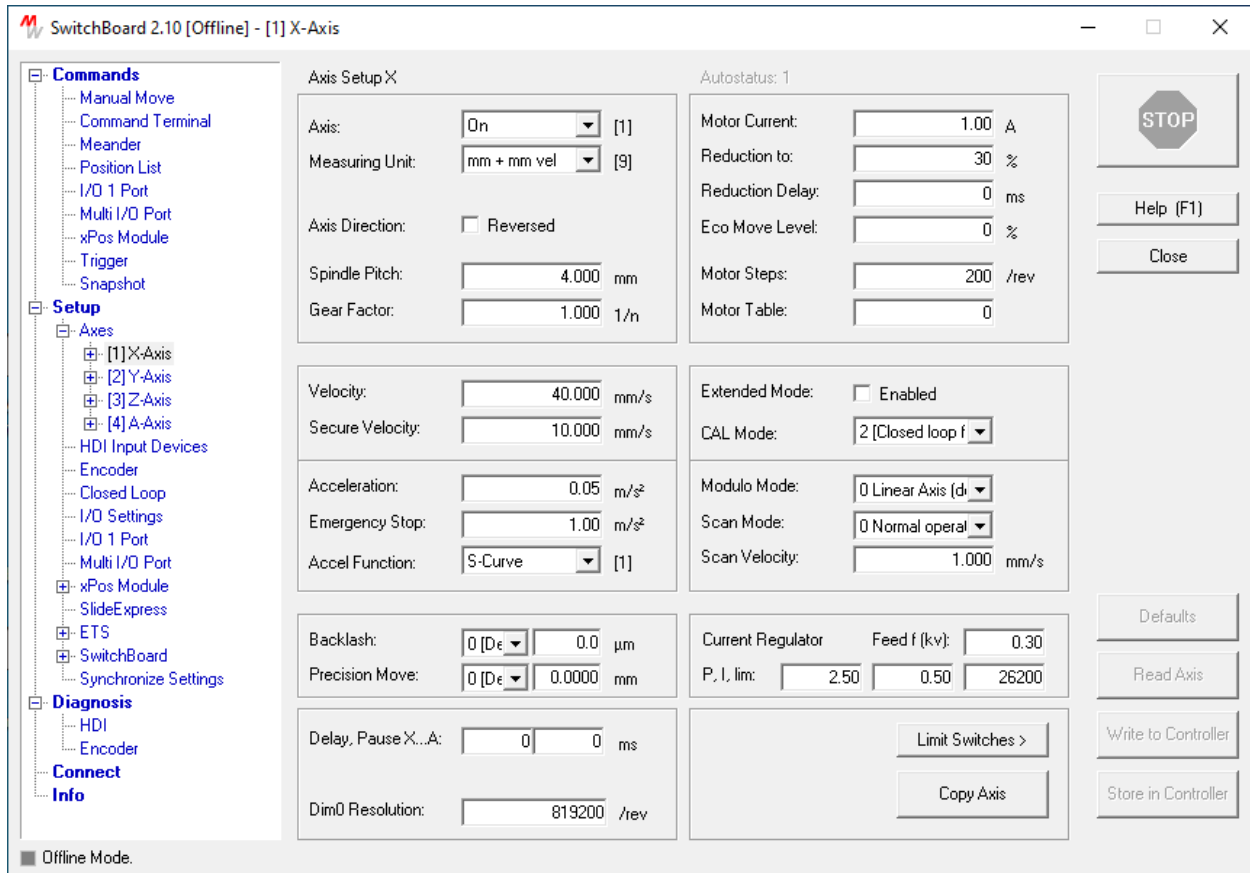
Abstract

Setup of the Snapshot functionality.

Mode	Snapshot Mode, according to TANGO Instruction Set
Active Polarity	Signal polarity: Active high or active low
Debounce Filter	Signal debounce time in milliseconds (default: 10ms) When using digitally generated input signals via I/O, this parameter can be set to 0 for faster signal response.
Home Positions	Enter the home positions for corresponding snapshot modes
Jump Distance	Enter relative jump distances for snapshot mode 9
Triggered Start	Select axes for triggered start in snapshot mode 6
Snapshot Enable	Globally enable the snapshot function

Force Joystick Key	Perform snapshot functionality of joystick keys by software
Snapshot Counter	Shows the number of snapshot events / snapshot array entries
[Read from Controller]	Read Snapshot settings from the TANGO controller
[Write to Controller]	Send Snapshot settings to the TANGO controller
[Store in Controller]	Send Snapshot settings to the TANGO controller and store them permanently
Snapshot Array Access	Opens the [Position List] Dialog, from where the snapshot position array can be read and written via right-click of the mouse.

2.10 Setup – Axis



Abstract

Set the axis parameters of the TANGO controller.

Parameters of one axis are shown. Some parameters which apply to all axes can be edited in the X axis setup and remain grayed in all other axes.

The parameters must be transmitted to the TANGO Controller by either pressing [Write to Controller], which only sends the parameters to the TANGO volatile memory or [Store in Controller], which sends and stores the parameters permanently.

To open or save parameters from an INI file, please refer to the dialog [Synchronize Settings]. Loading INI files is also possible via drag&drop of the file into any SwitchBoard dialog window.

- Axis:** Select if motor should be on, disabled or switched off
on [1] = move instructions are applied to this axis
disabled [0] = move instructions are ignored by this axis, current is on
off [-1] = move instructions are ignored, motor current is off
- Measuring Unit:** Measuring unit for positions (mm, µm etc. according to dim parameter)
- Axis Direction:** Reverse axis direction (limit switches are re-assigned automatically)
- Spindle Pitch:** Axial feed per spindle revolution in mm (i.e., 1 revolution = 4mm), or toothed belts, etc.

Gear Factor:	Factor for motors with gearbox or transmission
Velocity:	Set the axis velocity for move instructions (and cal/rm if not in ExtMode)
Secure Velocity:	Set the secure velocity which limits the velocity of the axis until cal and rm are executed
Acceleration:	Set the acceleration of the axis
Emergency Stop:	Set the stop acceleration of the axis for move abort, limit switch and stop conditions
Accel Function:	Acceleration for move instructions <i>mor</i> , <i>moa</i> , <i>moc</i> , <i>m</i> (<i>not go or speed</i>) - as s-curve, when AccelFunc = 1 - or default linear acceleration when AccelFunc = 0
Motor Current:	Electrical motor current in Ampere
Reduction:	Motor current reduction when idle, as percent of selected motor current (100% = no reduction). Can be used to avoid dissipation of heat. In Closed Loop applications, reduction should never be set below 30%.
Reduction Delay:	Idle time after a move before the current reduction is applied
EcoMove Level:	Reduce heat dissipation of traveling axes. The higher the level, the higher the power saving (0%=disabled/default, 70%=max. saving). Available from TANGO firmware versions 1.57 and higher. Using EcoMove reduces force when motor is running at constant speed (not during acceleration or deceleration). Remarks: It must be ensured that the axis has sufficient force under all conditions. EcoMove is disabled during cal/rm Calibration and Range Measure.
Motor Steps:	Step resolution of the motor (i.e., 200 for a 1.8° motor, 400 for 0.9°)
Motor Table:	Applies a motor compensation table. The TANGO firmware provides several motor tables which fit to a certain stepper motor type, wiring and application. The value is set by factory if applicable, else must be left at the default 0.

- Extended Mode:** Extended and improved Instruction Set (please refer to extmode in the TANGO Instruction Set Description). The joystick and the cal, rm instructions then have their own velocities e.g.
- Modulo Mode:** Modes for rotational or swiveling axes
- CAL Mode:** Axis zero position mode
(and Closed Loop activation mode, if encoders are available)
0: Axis zero position is set at the lower hardware limit switch, CAL and Closed Loop is activated
1: Axis zero position is set at power on, Closed Loop is activated instantly from power-on
2: Zero position like mode 0, but Closed Loop is activated instantly from power-on
3: Use the axis only to readout a measuring system without using or requiring the motor (1Vpp and TTL only, no MR)
4: Automatically perform a CAL move after power on or reset
 Caution: The axes will start moving and can't be stopped by software!
5: Instant-On function for open loop axes without encoders
 This mode will restore the last position and cal/rm state of the axis at which the TANGO was switched off or reset.
 Caution: Please ensure the axis can't be shifted from its mechanical position when the power is off! If the axis was moved during power-off, the position will be incorrect and mechanical damage can occur!
- Scan Mode:** Selects different behaviors for move instructions
0: Default behavior of the TANGO controllers
1: Resulting move velocities are always Scan velocity
2: Only vector moves are executed with Scan velocity
3: No vector moves. Similar to 0, but even vector moves are executed for each axis at their own velocity.
- Scan Velocity:** Defines the constant velocity for Scan Modes 1 and 2 or the dissection continuous path, which is available through snapshot position lists.
- Backlash:** Mechanical backlash compensation of the axis (applied in Open Loop).
 and BI Smooth Mode and optional **BI Smooth Mode** (1,2) selection, which smoothes the impact of backlash compensation in order to reduce shake or oscillation caused by the backlash compensation, 0=Smooth Mode off (default).
- Precision Move:** Backlash compensation moves, Mode 0=disabled (default).
 The precision moves add a certain move behavior to compensate mechanical backlash, even of closed loop axes.
 Most useful might be mode 3 or 6, where each position is approached from the same direction and the same distance. A negative distance changes the direction, e.g. useful for Z-axes. Modes 4 to 6 apply less acceleration to reduce shake at the cost of slightly longer precision move times.
- Delay, Pause X...A:** One parameter applies to all axes:
- Move Delay:** Delay for positioning instructions. A move instruction will start delayed by the specified time.

- Move Pause:** Pause for positioning instructions. The @@@ autostatus reply after a move will be delayed by the specified time.
- Dim0 Resolution:** The Measuring unit “dim 0” sets the axis to steps per revolution. In order to offer compatibility to many applications, this unit can be set to a certain number. If the application e.g. requires 40000 to be one revolution. One parameter applies to all axes that are in dim mode 0. As the controller’s internal resolution always remains at 819200 steps, it is possible to use fractions, e.g. 39157.3.

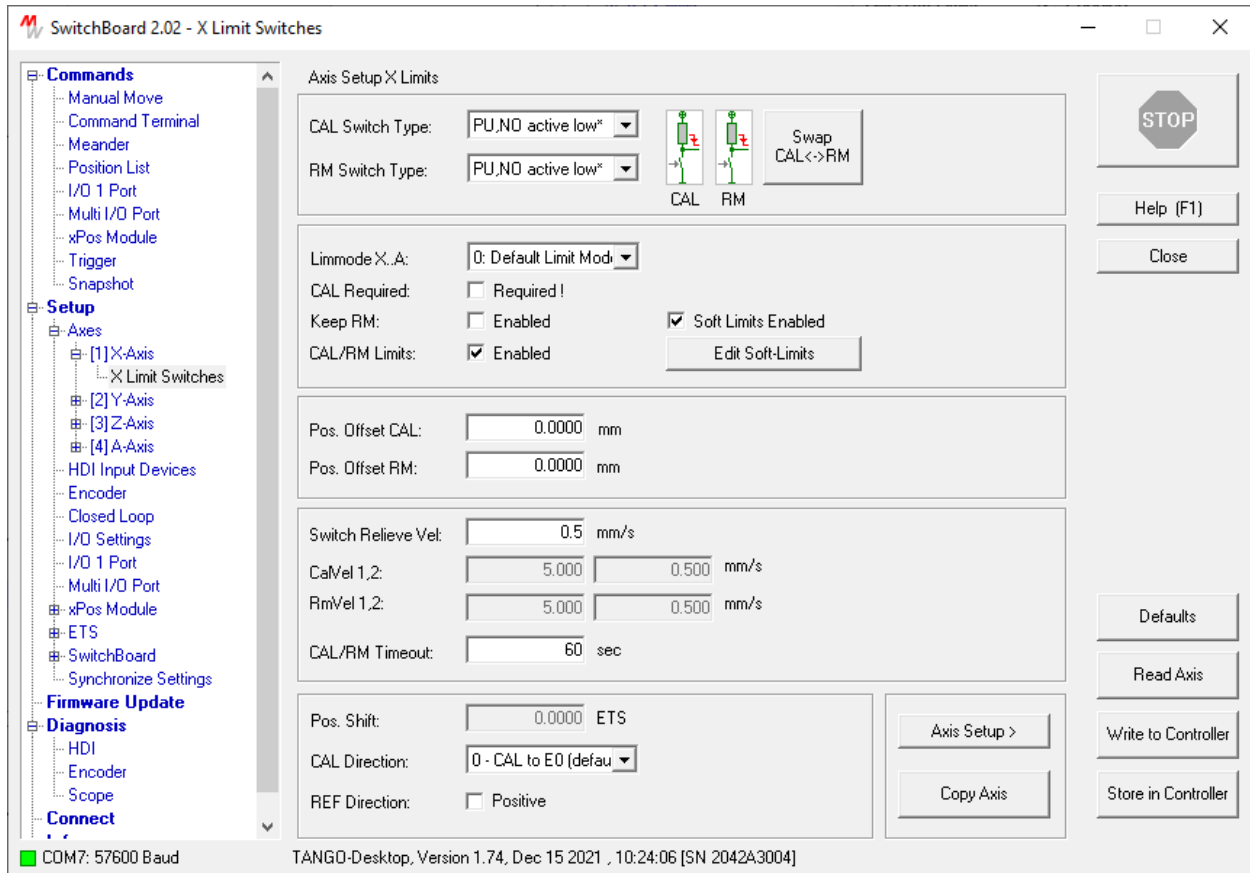
Current Regulator (TANGO-I2 only)

- Feed f:** Feed forward factor of the motor current regulator (default = 0.3)
- P:** Proportional factor of the motor current regulator (default = 2.5)
- I:** Integral factor of the motor current regulator (default = 0.5)
- lim:** Internal sum limit of the integral regulator (default: 26200)

BUTTON FUNCTIONS:

- [Limit Switches >]** Jump to the Limit Switch setup window (offering a shortcut instead of browsing to it by tree navigation on the left side).
- [Copy Axis]** Opens a dialog that offers to apply the axis setting to another axis or to all axes.
- [Defaults]** Set the SwitchBoard axis parameters of the current axis to program defaults. Parameters in the TANGO are not changed.
- [Read Axis]** Read parameters of the current axis from the TANGO Controller.
- [Write to Controller]** Send the parameters to the TANGO Controller (all axes). Parameters are volatile and will be lost when switching off the controller.
- [Store in Controller]** Send the parameters to the TANGO Controller (all axes) and store them permanently.
- Remarks:** To ensure the parameters were set correctly, use [Read Axis] to read back the parameters from the controller and check them again. Also, [Parameter Checking] can be selected in the [Synchronize Settings] dialog. It will give a reply if parameters weren’t accepted by the TANGO Controller.

2.11 Setup – Limit Switches



Abstract

Edit the limit switch related controller settings.

The parameters must be transmitted to the TANGO Controller by either pressing [Write to Controller], which only sends the parameters to the TANGO volatile memory or [Store in Controller], which sends and stores the parameters permanently.

To open or save parameters from an INI file, please refer to the dialog [Synchronize Settings]. Loading INI files is also possible via drag&drop of the file into any SwitchBoard dialog window.

CAL Switch Type: Select the switch characteristic of the lower hardware limit switch. The default setting is marked by a *. Switching to supply or ground, normally open or closed can be selected.

RM Switch Type: Select the switch characteristic of the upper hardware limit switch. The default setting is marked by a *. Switching to supply or ground, normally open or closed can be selected.

Swap CAL<->RM: Set by factory, depending on the axis hardware and wiring. The upper/lower limit switch assignment can be swapped here. This setting must never be changed. False switch assignment will lead to damage of the axis due to not recognized limits.

Remarks: If the axis direction is changed by software (*axisdir*) it is NOT necessary to change this CAL<->RM assignment, the TANGO Controller will then swap assignments automatically.

Limmode: Newer Controllers from TANGO Desktop HE provide the limmode functionality. It defines the behavior when a move target position would exceed a limit (individual or vector). In the default mode 0, the axes only move to the limit as usual. In mode 1, a move or vector move is not executed if a target position would exceed a limit. Mode 2 behaves as the default mode 0, but returns an L instead of @ in the response if an axis was limited. Limmode can only be activated for all or none axis (not for individual axes).

CAL Required: From TANGO firmware versions 1.53 and higher, the axes can be disabled for any move until they are calibrated. No move is possible before executing the CAL instruction.

Keep RM: From TANGO firmware versions 1.74 and higher, the TANGO can keep the RM position (axis length) of a CAL+RM sequence and restore it after a new CAL. This way, only CAL (not CAL+RM) can be performed and SecVel will remain released as long as the TANGO is not reset.

CAL/RM Limits: If enabled, CAL and RM will set the lower and upper Soft Limits to the limit switch positions (default setting). If CAL, RM must not manipulate the Soft Limits, this function can be disabled (TANGO *!nosetlimit 1* instruction).

Soft Limits Enabled: If enabled, the axes will stop at the limits (default). If disabled (unchecked), the limits are ignored (TANGO *!limctr* instruction).

Edit Soft-Limits: By pressing the Button [Edit Soft-Limits] a dialog can be displayed which offers editing and sending of the soft limits. Soft limits can't be stored in the TANGO controller and will be set to default (e.g. +-2600mm) after each power-on or reset.

Pos. Offset CAL: Usually set to zero, it offers traveling a certain distance out of the lower limit switch within the CAL instruction. May be used to adjust the zero position of the axis.

Pos. Offset RM: Usually set to zero, it offers traveling a certain distance out of the upper limit switch within the RM instruction. May be used to adjust the upper position away from the hardware switch.

Switch Relieve Vel.: This velocity is used by the calibration routine for exactly finding the origin and limit positions when moving slowly out of a limit switch. This parameter should be set to a slow value in order to achieve high accuracy. The unit is in user dimensions, but finally sent to the controller as an integer value in 1/100rev/s (by the calbspeed command).

CalVel, RmVel: TANGO firmware versions 1.32 and higher support an Extended Mode. Here the calvel1, 2 / rmvel1, 2 parameters are used instead of the axis vel and Switch Relieve Vel (calbspeed). Refer to TANGO Instruction Set Description to learn about the differences to normal mode.

CAL/RM Timeout: Individual timeouts for Calibration (CAL) and Range Measure (RM) instructions. Depending on axis length and travel velocity it might become necessary to adapt the timeout. To ensure no error is generated when traveling the full range to an end switch.

Pos. Shift: Position Shift for Center Reference Modes, Absolute Encoders or Calibrating (CAL) on Reference Marks.

Cal. Direction: Select default Calibration (0) or special Modes for Center Reference axes.

Ref. Direction: Currently unused (as of TANGO Firmware 1.74).

[Axis Setup >]

Jump to the axis setup window (offering a shortcut instead of browsing to it by tree navigation on the left side).

[Copy Axis]	Opens a dialog that offers to apply the axis setting to another axis or to all axes.
[Defaults]	Set the SwitchBoard axis parameters of the current axis to program defaults. Parameters in the TANGO are not changed.
[Read Axis]	Read parameters of the current axis from the TANGO Controller.
[Write to Controller]	Send the parameters to the TANGO Controller (all axes). Parameters are volatile and will be lost when switching off the controller.
[Store in Controller]	Send the parameters to the TANGO Controller (all axes) and store them permanently.
Remarks:	<p>Soft Limits are not transmitted to the TANGO Controller. As this could lead to problems e.g. unwanted limitation of travel range. If required, the Soft Limits can be sent from within the Limit Switches dialog: via [Edit Limits] button.</p> <p>To ensure the parameters were set correctly, use [Read Axis] to read back the parameters from the controller and check them again. Also, [Parameter Checking] can be selected in the [Synchronize Settings] dialog. It will give a reply if parameters weren't accepted by the TANGO Controller.</p>

2.12 Setup – HDI Input Devices



Abstract

Setup for the HDI devices – Joystick, Trackball, ERGODRIVE and Multi-Function Wheel.

All available TANGO HDI devices are supported. The dialog is divided into functional groups:

- General setup of common parameters
- Joystick and its optional functionalities
- ERGODRIVE and Coaxial Drive
- Trackball
- Multi-Function Wheel (which may be part of the Joystick or ERGODRIVE)
- LED100 brightness control

HDI Common Parameter:

Mode: ON (2) / OFF (0)

X sync to XY: If checked, X deflection is applied to X and Y axes simultaneously

Function: Enable/disable individual HDI axes and set their directions (2, 0, -2)

Velocity: Specifies the Joystick velocity in Extended Mode (refer to Setup\Axis). It also limits the maximum travel velocity for all input devices (ERGODRIVE, Coaxial Drive, Trackball, Multi-Function Wheel).

JOYSTICK

Characteristic: Logarithmic (default, recommended), Linear or Quadratic

Swap XY: Swap Joystick X and Y axes, turns Joystick coordinate system by 90 degrees

Swap YZ: Swap Joystick Y and Z axes, allowing to move Z with Y

Z Knob to A: Deflection of Joystick Z-knob affects A axis. HDI must be enabled for A axis as well.

Z auto-disable Joystick Z knob is disabled while X or Y are deflected

Quick Stop Available with 2nd generation TANGOs, Quick Stop causes the Joystick to stop quicker when released. This might improve stopping at the desired position and not going past.

Backlash Window: Defines the zero-deviation window for Joystick deflection (mechanical center backlash for the released joystick, default: 14 = +/- 7 digit). Should never be changed. Only applies to analog joysticks. Has no influence to Digital Joysticks (HDI with Mini USB connector).

Key Mode: Mode, in which two Joystick velocities can be alternated, KeySpeed 1 and 2. The different velocities are applied by pressing the Joystick function keys. The keys depend on if Toggle Mode is enabled or not:

- Joystick F1: Select X,Y KeySpeed2
- Joystick F4: Select X,Y KeySpeed1
- Joystick F2: Select Z KeySpeed2
- Joystick F3: Select Z KeySpeed1

For Toggle Mode key assignment refer to Toggle Mode:

Toggle Mode: If Key Mode is enabled, then Toggle Mode, alternates between the two velocities:

- Joystick F1: Toggles between X,Y KeySpeeds 1 and 2
 - Joystick F4: Toggles between Z KeySpeeds 1 and 2 *
- * firmware ≥1.56 required

KeySpeed1,2: Joystick velocities when using KeyMode as explained above.

ERGODRIVE / Coaxial Drive

Factor: Travel distance per knob revolution

Factor B: Alternate travel distance per knob revolution. Used by ERGODRIVE while the [XY] or [Z] key is held down, or alternating factors in Toggle Mode. The Pilot stage also provides this feature for XY.

HDI devices with Multi-Function Wheel use the Multi-Function Wheel Travel Factor. In case of ERGODRIVE, SwitchBoard keeps the entries identical to the ERGODRIVE Z settings:

ERGODRIVE Factor 3[Z] ⇔ Factor 1 of Multi-Function Wheel

ERGODRIVE Factor B 3[Z] ⇔ Factor 3 of Multi-Function Wheel

Noise Filter: Using the noise filter is highly recommended. It eliminates the minor position jitter which occurs in the X and Y knobs. Without filter the axes will show slight position deviations. Only disable the filter if very sensitive behavior is required.

Toggle Mode: ERGODRIVE and Pilot stage key behavior:
Activating toggle mode will alternate between both factors when pressing the XY or Z key.
In normal mode, the alternate factor is only applied as long as the XY or Z key is pressed.

TRACKBALL **Factor:** Trackball transmission ratio (higher = longer distances)

Y axis to Z: Turn XY-Trackball into a device that commands the Z axis

Multi-Function Wheel **Travel:** Travel distance per revolution of the Multi-Function Wheel as found on some Joysticks and ERGODRIVE.

1: default distance (may prevent accidental travel if set to 0)

2: alternate distance (suggested fine/slow) via Joystick F4

3: alternate distance (suggested coarse) via Joystick F1

Axis: Assign the Multi-Function Wheel to any axis, default = Z

LED100 **LED Enable:** Manual control of LED100 brightness via HDI (on/off)
*Remarks: The LED control is only available if the HDI axis is enabled (JoyDir must not be 0 and the axis must be physically available on the TANGO Controller).
Only the latest version of TANGO Controllers (Desktop HE, etc.) supports LED100 control via Multi-Function Wheel even on disabled or not available axes from Firmware 1.76.*

- By Joystick:

- with Multi-Function Wheel: F2

- without Wheel: F3 + Joystick Y deflection

Pressing F3+F4 saves the brightness as default setting

- By ERGODRIVE with Multi-Function Wheel: via F1

Fine Mode: Provides higher brightness resolution
16x finer with Multi-Function Wheel,
4x finer via Joystick Y deflection

As MF-Wheel Main Function: Direct brightness control via Multi-Function Wheel, no F-Key required

[Read from Controller] Read settings from the TANGO controller

- [Write to Controller]** Send settings to the TANGO controller (only until reset or power off)
- [Store in Controller]** Send settings to the TANGO controller and store them permanently

2.13 Setup – Encoder

SwitchBoard 2.02 - Encoder

Commands

- Manual Move
- Command Terminal
- Meander
- Position List
- I/O 1 Port
- Multi I/O Port
- xPos Module
- Trigger
- Snapshot

Setup

- Axes
 - [1] X-Axis
 - [2] Y-Axis
 - [3] Z-Axis
 - [4] A-Axis
- HDI Input Devices
- Encoder
- Closed Loop
- I/O Settings
- I/O 1 Port
- Multi I/O Port
- xPos Module
- ETS
- SwitchBoard
- Synchronize Settings

Firmware Update

Diagnosis

- HDI
- Encoder
- Scope

Connect

Info

Encoder 1 (X)

ACTIVE

Type: 0: MR analog

Signal Period: 0.500 mm

☒ Counting Direction

☐ NAS Error Signal

EncVel: 2.0 mm/s

Abs. Resolution: 78.125 nm

Abs. Data Bits: 24 bit

Position Shift: 0.0000 ETS

Referencing: 0: No Reference Iv

Search Velocity: 5.00 mm/s

Encoder 2 (Y)

ACTIVE

Type: 0: MR analog

Signal Period: 0.500 mm

☐ Counting Direction

☐ NAS Error Signal

EncVel: 2.0 mm/s

Abs. Resolution: 78.125 nm

Abs. Data Bits: 24 bit

Position Shift: 0.0000 ETS

Referencing: 0: No Reference Iv

Search Velocity: 5.00 mm/s

Encoder 3 (Z)

ACTIVE

Type: 2: 1Vpp analog

Signal Period: 0.020 mm

☒ Counting Direction

☐ NAS Error Signal

EncVel: 2.0 mm/s

Abs. Resolution: 78.125 nm

Abs. Data Bits: 24 bit

Position Shift: 0.0000 mm

Referencing: 0: No Reference Iv

Search Velocity: 5.00 mm/s

Encoder 4 (A)

ACTIVE

Type: 1: TTL/RS422

Signal Period: 0.004 mm

☐ Counting Direction

☐ NAS Error Signal

EncVel: 2.0 mm/s

Abs. Resolution: 1 nm

Abs. Data Bits: 32 bit

Position Shift: 0.0000 mm

Referencing: 0: No Reference Iv

Search Velocity: 5.00 mm/s

STOP

Help (F1)

Close

Read from Controller

Write to Controller

Store in Controller

COM7: 57600 Baud

TANGO-Desktop, Version 1.74, Dec 15 2021, 10:24:06 [SN 2042A3004]

Abstract

Configuration of the measuring systems (encoders) for up to 4 axes.
Only available with controllers that provide an encoder interface.

Remarks: The activation method for encoders and Closed Loop (after power-on or after CAL) is selected via the CalMode parameter in the [Setup\Axes\Limit Switches] dialog.

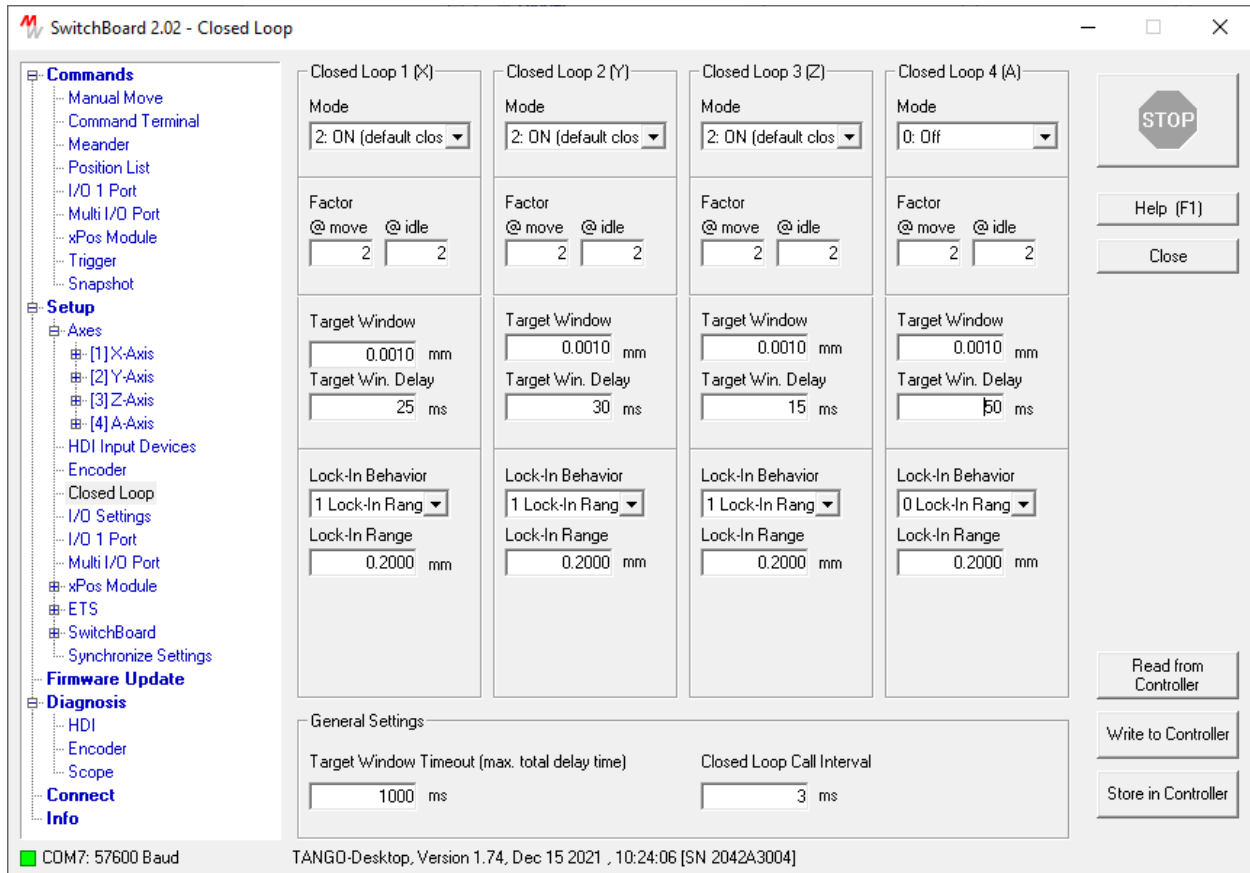
The setup can be written to the TANGO controller by either using the [Synchronize Settings] dialog or by pressing the right mouse key, which opens a menu.

ACTIVE: Globally enable the measuring system. The activation of the encoders then is performed by the TANGO controller after calibration (CAL) or power up, depending on the CalMode setting in [Setup\Axes].

Type:	<p>Select the encoder type. The available options depend on TANGO hardware and firmware.</p> <p>0: Universal Interface = 5Vpp MR analog encoder Hard wired Interface = Analog, 1Vpp/5Vpp depends on hardware If the Controller provides a Universal Interface, it assigns 5Vpp MR interpolation behavior. Controllers with hard-wired interface activate analog SIN/COS interpolation according to the interface hardware 1Vpp or 5Vpp MR.</p> <p>1: TTL / RS422 Select digital incremental encoders (A/B-TTL). Interpolation is disabled. When using digital encoders, this type must be selected to prevent erroneous behavior (due to signal monitoring).</p> <p>2: 1Vpp (Universal Interface only) A Universal Interface assigns 1Vpp interpolation behavior. Controllers with hard-wired encoder interface do not provide this type.</p> <p>3: BiSS Absolute Absolute measuring system with serial interface type BiSS-C.</p> <p>4: BiSS Absolute + 1Vpp Absolute measuring system with serial interface type BiSS-C and additional 1Vpp analog sin/cos signal.</p> <p>5: SSI Absolute Absolute measuring system with serial interface type SSI.</p> <p>6: SSI Absolute + 1Vpp Absolute measuring system with serial interface type SSI and additional 1Vpp analog sin/cos signal.</p> <p>REMARKS: If the analog interpolation is not configured by factory, the interface only provides TTL/RS422 functionality. In this case (blue text is displayed: [TTL Config=0]) the interface always behaves like type 1, independent of which encoder type is selected.</p>
Signal Period:	Signal period of the measuring system (in case of TTL: 4x the resolution)
Counting Direction:	<p>Counting direction of the measuring system. The direction is set automatically by the TANGO controller.</p> <p>It is not necessary nor recommended to change this setting, except in independent measuring system mode. A change during operation causes Closed Loop to switch off or unpredictable behavior of the axis.</p>
NAS Error Signal:	For measuring systems that provide an error output signal (often called NAS signal). If activated, NAS is used by the TANGO controller to generate an internal encoder error condition and switch off Closed Loop.
EncVel:	Velocity used to detect/activate the encoder

- Abs. Resolution:** Absolute Encoder: Resolution of the serial position data in nanometers
- Abs. Data Bits:** Absolute Encoder: Data size of the serial position data in bits
- Position Shift:** For most cases, this value must be set by factory in the ETS, not here. It can be used to set or test position shift values for Center Referencing modes or calibrating on Encoder Reference Mark. Position Shift for Absolute Encoders must be set in the ETS.
- Referencing: (encref)**
- 0:** Measuring system has no reference mark, or ignore reference mark
 - 1:** Measuring system has one reference mark, to which the axis will be traveling after calibration (CAL) or directly for calibration, if the CAL switch is disabled (Firmware 1.74+)
 - 2:** Precise CAL position: CAL travels to factory taught-in encoder period (within one signal period, at least 40µm or MR signal period required)
 - 3:** Precise CAL position: CAL travels to factory taught-in motor period (within one period, @ 200 steps at least 2mm pitch required = 40µm)
- Search Velocity:** Velocity at which the axis travels towards the reference mark
- [Read from Controller]** Read settings from the TANGO controller
- [Write to Controller]** Send settings to the TANGO controller (only until reset or power off)
- [Store in Controller]** Send settings to the TANGO controller and store them permanently

2.14 Setup – Closed Loop



Abstract

Configuration of the closed loop for up to 4 axes.
Only available with controllers that provide an encoder interface.

Remarks: The activation method for encoders and Closed Loop (after power-on or after CAL) is selected via the CalMode parameter in the [Setup\Axes\Limit Switches] dialog.

The setup can be written to the TANGO controller by either using the [Synchronize Settings] dialog or by pressing the right mouse key, which opens a menu.

The default and recommended operation of the Closed Loop is “permanently on” mode 2 (On)*. Independent of the specified Target Window, Closed Loop then always tries to keep the position deviation at zero. The Target Window, in conjunction with the TargetWin Delay, only specifies the “position reached” criteria for the axis.

* Remark: If the axis is idle and the motor current reduction is set to less than 30% (in dialog [Setup\Axes]), the closed loop becomes inactive for as long as the applied motor current is below 30%.

Mode: Closed Loop ON (2,1) or OFF (0)
Mode 2 is always active, which is the recommended setting to ensure no drift when the axis is idle.
Mode 1 is only active during a move, until the Target Window is reached
In Mode 0, the Closed Loop is switched off (does not influence the axis) but still the encoders can be read out.

Closed Loop Factor:

Two factors must be specified for the Closed Loop gain. One for the traveling axis and one for the idle axis. Increasing the factor results in faster behavior but can lead to oscillation or stalling when too high. The values have a huge impact on performance and may be optimized for each application.

@ move: Closed Loop gain factor when axis is moving.
Increasing the parameter causes a more accurate position while the axis travels. But it can also cause increased velocity variation while following the measuring system too closely.

@ idle: Closed Loop gain factor when axis is idle.
Increasing the parameter causes faster settling to the end position, but can also lead to oscillation.

Target Window: Position range (twi), in which the Closed Loop in Closed Loop mode 1 (Until Target) turns off closed loop, or in Closed Loop mode 2 (On) generates the status reply (@@@) when reaching the target position. Also refer to Target Win. Delay.

Target Win. Delay: Condition for the Closed Loop state *target position reached* (in conjunction with the Target Window). The axis must remain within the target window for the here specified time (ctrd).
Default settings are 50 or 100 milliseconds, but most applications allow shorter ctrd times of e.g. 30 or even down to 15ms. To optimize the delay (the vector throughput/performance), it must be assured that the mechanical oscillation frequency at the end of a move is covered by ctrd.

Lock-In Behavior: The behavior outside the Lock-In Range can be set to different modes for e.g., collision detection & switchoff or to avoid stalling the stepper motor at larger deviations.

Lock-In Range: Lock-in range of the Closed Loop. If the position deviation between motor and measuring system position exceeds this value, the selected Lock-In Range behavior is assigned (ctrsm). Please refer to the Closed Loop description.

Target Window Timeout: If the target window can not be reached or the axis cannot remain in the target window for the specified Target Win. Delay time (twi, ctrd), a maximum time can be specified after which the axis generates the "position reached" reply, even if it never reached.

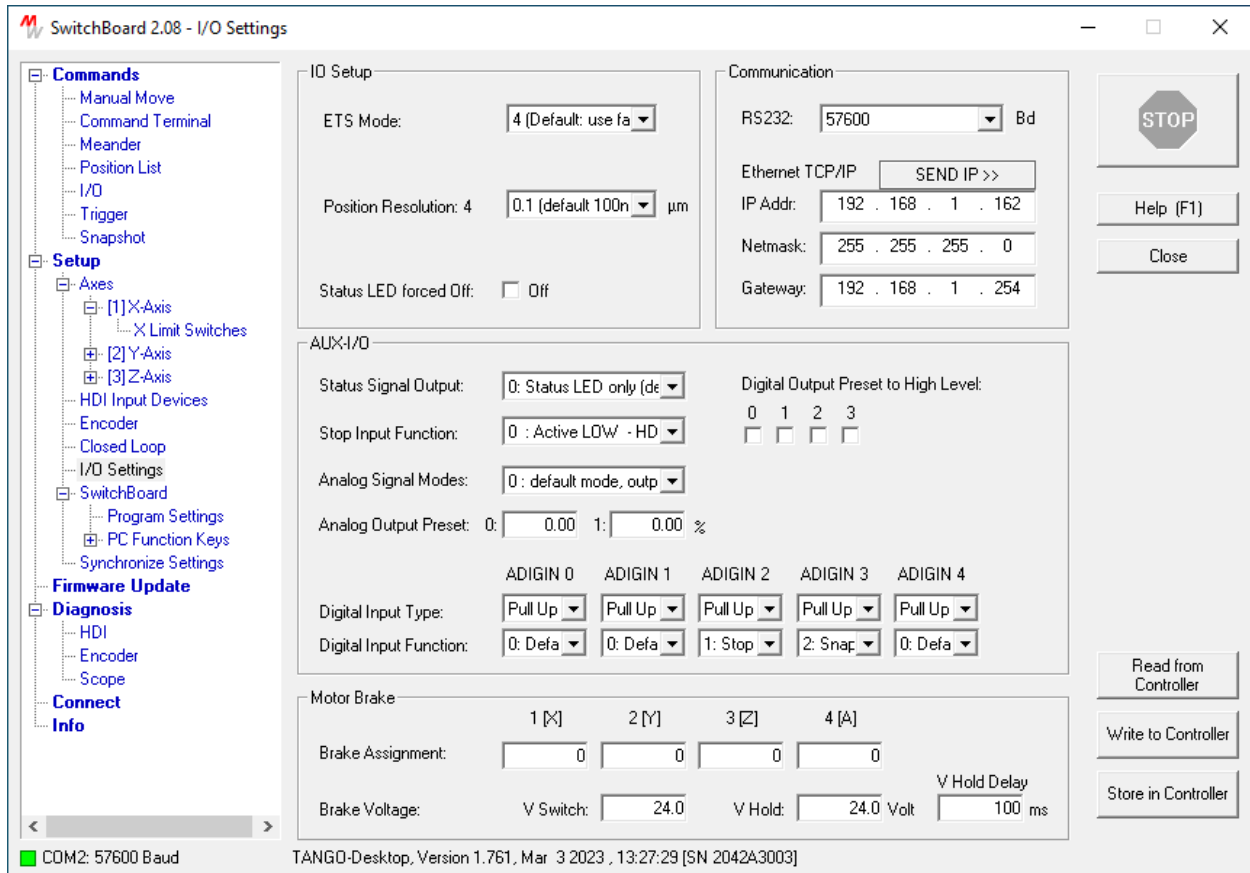
Call Interval: Calling (execution) interval of the Closed Loop.
Typically set to 3 or 5 milliseconds, depending on the controller type.
This default setting should not be changed.
It is not recommended to set intervals shorter than 3 milliseconds.

[Read from Controller] Read settings from the TANGO controller

[Write to Controller] Send settings to the TANGO controller (only until reset or power off)

[Store in Controller] Send settings to the TANGO controller and store them permanently

2.15 Setup – I/O (Configure TANGO Input / Output Options)



Abstract

Access to TANGO related I/O functions, such as AUX-IO and more.

ETS Mode: Defines how ETS data is handled. Default mode is 4.

Position Resolution: Defines the resolution (fractional mm-digits) of the returned axis position for “?pos” and similar instructions. Default is 4, which results in 100nm resolution, i.e., ?pos → 0.0000 (mm) or → 0.0 (µm). Up to 6 digits can be selected, which is a 1nm resolution. Remark: This setting does not affect the positioning resolution, it only affects the returned position values.

Status LED: The Status LED of the TANGO can be permanently forced off

AUX-I/O

Status Signal output: The green front-panel Status LED state can be assigned to an AUX-I/O output, e.g. for external display.

Stop Input Function: Select required behaviour and polarity of the stop input. Refer to *stoppol* description in the TANGO Instruction Set.

Analog Signal Mode: Select a special Analog Output behaviour for ANOUT0 or ANOUT 1, e.g. for Z-Piezo or select ANIN to Laser autofocus.

Analog Output Preset: Set the initial output levels after power on.

Digital Input Function and Type: For TANGO controllers which provide flexible assignment of input functions and polarities (e.g. TANGO 3 mini).

**Digital Output
Preset:**

When checked, the digital output of the AUX-I/O is high after power-on or reset.

Brake Assignment:

If the TANGO provides a I/O1 or Multi I/O port or a dedicated Brake output pin on the motor connector, a mechanical axis brake can be configured.

In case of I/O Modules, the brake axes X,Y,Z,A can be assigned to one or several of the 8 output pins (=1-8) or to none (=0, which provides the default I/O function of the pin).

In case of controllers with a dedicated Brake output (on the motor 1-3 connector), the X,Y,Z,A axes can be selected by 1 or deselected by 0.

Depending on hardware, the brake voltage can be configured. Two values might be available: The switch- and hold voltages.

V Switch: The voltage required to open the brake.

V Hold : The voltage required to safely keep the brake open.

V Hold might be (much) lower than V Switch to greatly reduce the power consumption and heating of the brake when open. Refer to the motor brake datasheet.

V Hold Delay: The time after which the brake voltage will be reduced to V Hold, 1-10000ms (default 100ms).

Also refer to the *brake* description of the TANGO Instruction Set or of the corresponding TANGO controller.

Brake Voltage:

The TANGO Desktop HE provides an interbal brake module, where the voltages can be adjusted according to the brake. There is one voltage for opening the brake (switching) and a second voltage which will be applied shortly after opening. This holding voltage usually can be lower than the actuating voltage and help lowering the total heat input, as "brake open" is the usual state.

Communication:

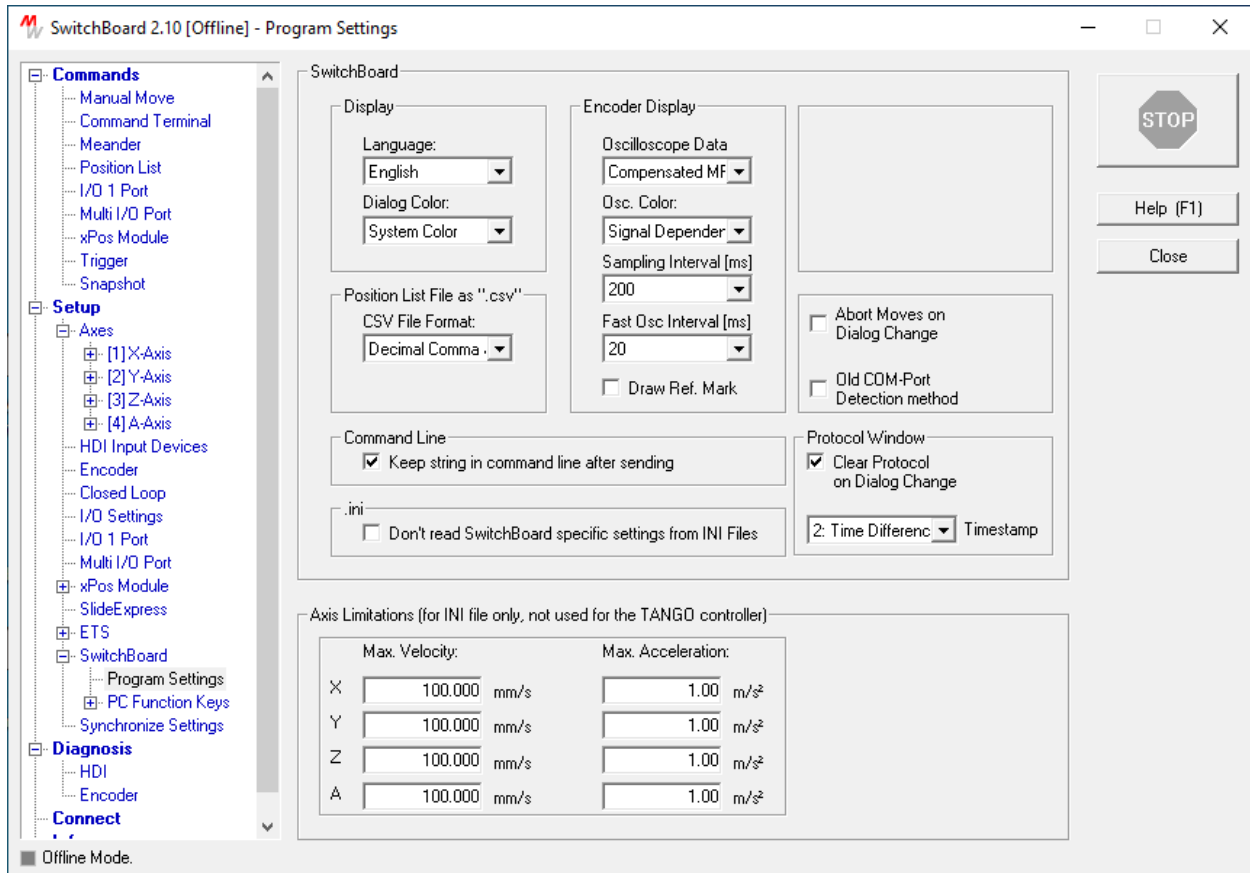
The **Baudrate** of the TANGO's main RS232 interface can be set here.

TANGO Desktop HE provides an **Ethernet TCP/IP Interface**.

The TCP/IP Address of the TANGO can not be configured directly by an INI file, as it would possibly set unwanted addresses.

Therefore, the here accessible IP addresses can be transmitted manually by pressing the [SEND IP>>] button.

2.16 Setup – Program Settings for SwitchBoard



Abstract

Access to SwitchBoard related parameters.

Language: SwitchBoard language (English / German / French)

Dialog Color: SwitchBoard window color (white or system color)

CSV File Format: Select the German/English .csv file format (GER: comma+semicolon or EN: dot+comma) for saving Tango Position Lists with .csv extension

Oscilloscope Data: Select the data to be drawn in the Encoder Diagnosis Dialog as either the RAW ADC data (default) or the TANGO compensated signals, e.g in conjunction with MR measuring system.

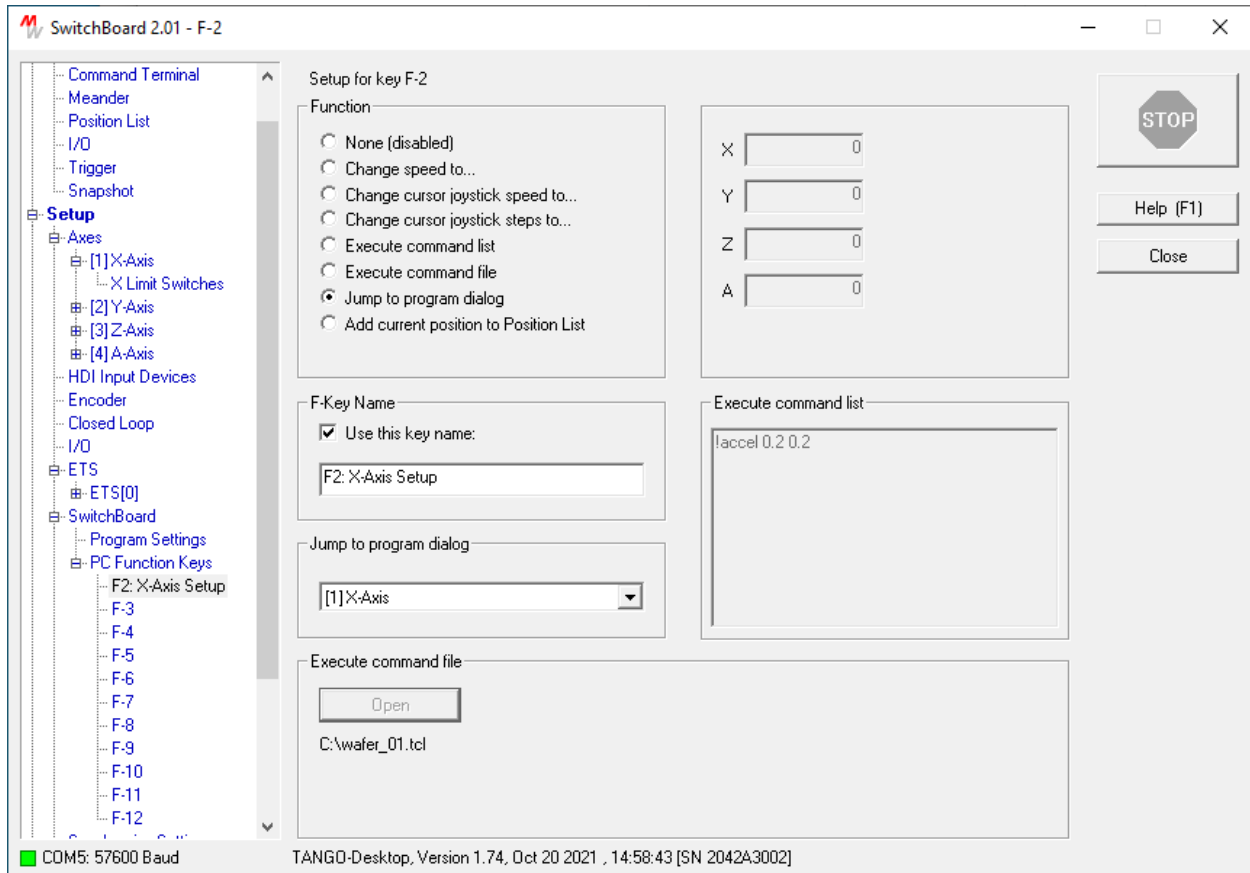
Osc. Color: The encoder signal in the [Diagnosis\Encoder] Dialog can be set to a signal strength dependent color mode (green/yellow/red).

Sampling Interval: Select the data sampling rate for the Encoder Diagnosis Dialog may be adjusted according to the communication speed – e.g. 100ms for RS232, 50ms for USB or PCI-E.

Fast Osc Interval: Select the sampling rate for the [FAST OSC] button in the Encoder Diagnosis Dialog (default = 20ms).

Abort Moves on Dialog Change:	The behavior of SwitchBoard until Version 2.09 was to send an abort instruction to the TANGO every time a dialog was switched (e.g. from the command line or the meander etc.). From SwitchBoard Version 2.10 this behavior is disabled by default and can be enabled if required by setting the checkbox.
Draw Ref. Mark:	If checked, the garphics display in the Encoder Diagnosis Dialog draws a bold black line in the region where the reference mark signal is active.
Old COM-Port Detection method	Old (slower and only until COM 24) detection metod of available COM-Ports in the Connect Dialog. Use in case a certain COM Port is not found.
Command Line:	Keeps the string in the SwitchBoard command line input after sending (else, the command line is cleared). The kept string is highlighted and so can easily be deleted but as well resent without re-entering.
Clear Protocol on Dialog Change:	Clears the protocol window content each time when a new dialog is selected (auto-clear functionality).
Timestamp:	Set the type of the timestamp in the protocol window. <ol style="list-style-type: none">1. The default is the system time in hh:mm:ss:ms,2. second option is the time difference to the previous OUT or IN line,3. third option is without timestamp, just OUT and IN The options 2 and 3 might be useful when comparing protocols with file compare software. There, the different times then don't cause a difference but only the content (3) or the duration/delay and the content (2).
.ini	Reading an ini file usually reads all the SwitchBoard settings stored in it. By checking this option, only the TANGO parameters are extracted.
Axis Limitations:	Only for compatibility when exporting WinCommander setup files: Limit for maximum travel velocity and acceleration. These parameters are not used by the TANGO controller or SwitchBoard.

2.17 Setup – PC Function Keys for SwitchBoard



Abstract

Assign PC keyboard Function Keys F2-F12 to SwitchBoard functions.

There are several options: Accessing different SwitchBoard dialogs by just pressing an F key (for ease of use when alternating between dialogs). Or executing TANGO instructions (only available in Manual Move, Command Terminal and Position List dialogs). Etc. All available options are shown below. Individual labels can be assigned to the function keys by [Use this key name]*. The main window flashes once to indicate the F-Key function executed successfully.

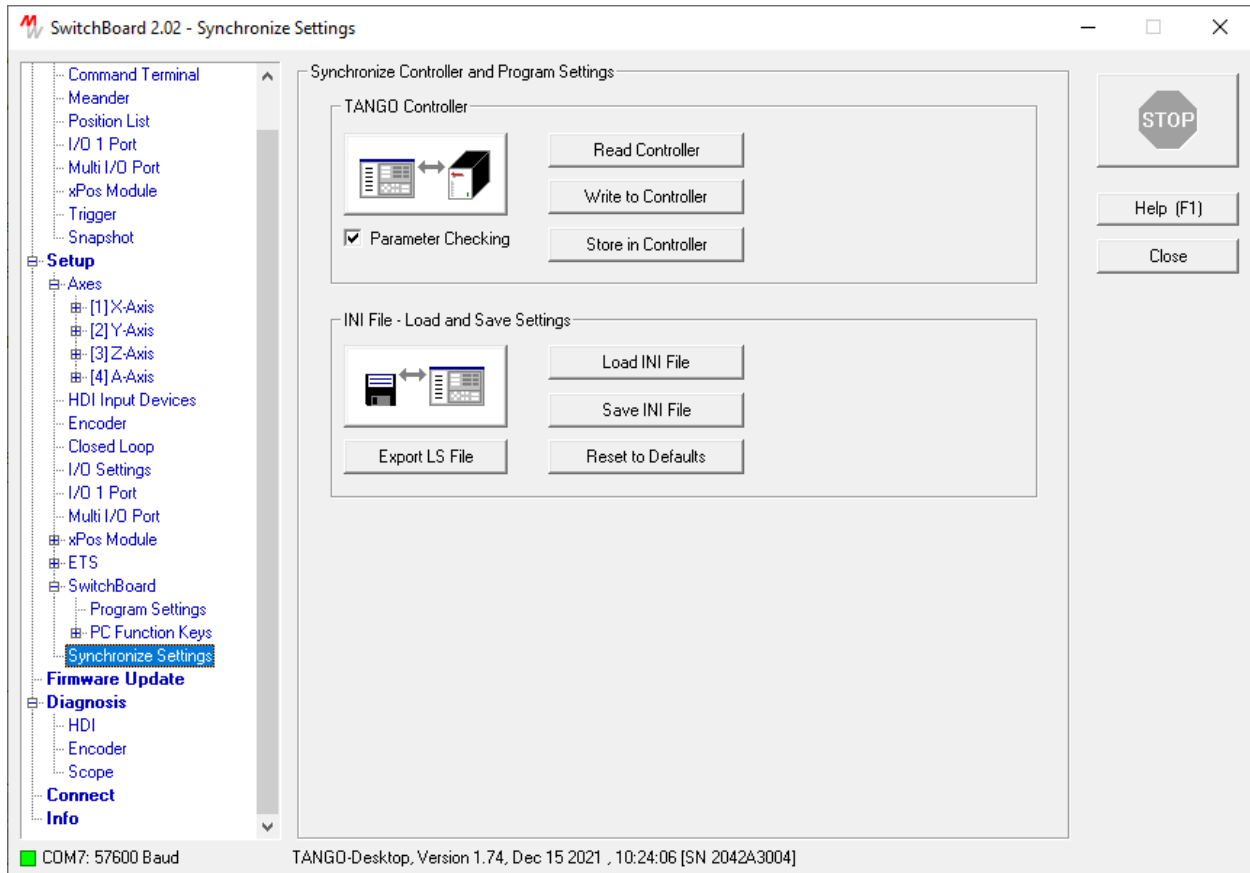
Function:

- | | |
|--|--|
| None (disabled): | No SwitchBoard function assigned to this F-key |
| Change speed to.... * | The input field on the upper right becomes enabled, providing the move velocities that are set when pressing the F key. |
| Change cursor joystick speed to.... * | Cursor Joystick velocities for Manual Move dialog. The velocities specified in the input fields on the upper right will be applied when pressing this F-key. |
| Change cursor joystick steps to.... * | Cursor Joystick step sizes for Manual Move dialog. The step sizes specified in the input fields on the upper right will be applied when pressing this F-key. |

- Execute command list: *** The multi-line input field for commands becomes enabled. TANGO commands can be entered according to the TANGO Instruction Set Description. Restrictions:
One command per line. Only use commands that set parameters or start movement. Commands that cause a reply are not allowed.
- Execute command file: *** Similar to the execute command list option, a text file with TANGO commands can be applied to a PC function key.
The Open button becomes enabled to select a .tcl or .txt file containing TANGO commands.
The commands have the same restrictions as in execute command list: One command per line. Only use commands that set parameters or start movement. Commands that cause a reply are not allowed.
- Jump to program dialog:** Call a SwitchBoard dialog window.
Enables fast switching between SwitchBoard dialogs by just pressing the function key.
E.g.: switching to a setup dialog or the [Manual Move] dialog etc.
- Add current position to Position List:** When the Position List dialog is displayed, pressing the F-Key adds a new line with the current axis positions.

** only available in [Manual Move], [Command Terminal] and [Position List] dialogs.*

2.18 Setup – Synchronize Settings (Read/Write Setup and INI Files)



Abstract

The setup can be synchronized (read/write/store/load/save) with the TANGO or an INI file.

Remark: From Windows 10, SwitchBoard does not store its own SwitchBoard.ini file in the C:\Programs folder, it stores it in the user AppData area of Windows:

C:\Users\[User Name]\AppData\Local\VirtualStore\Program Files (x86)\SwitchBoard\SwitchBoard.ini

Read Controller: Read setup from the TANGO controller

Write to Controller: Transmit setup to the TANGO controller
Setup parameters are written but not stored permanently

Store in Controller: Transmit setup to the TANGO controller
Setup parameters are stored permanently (remain when switched off)

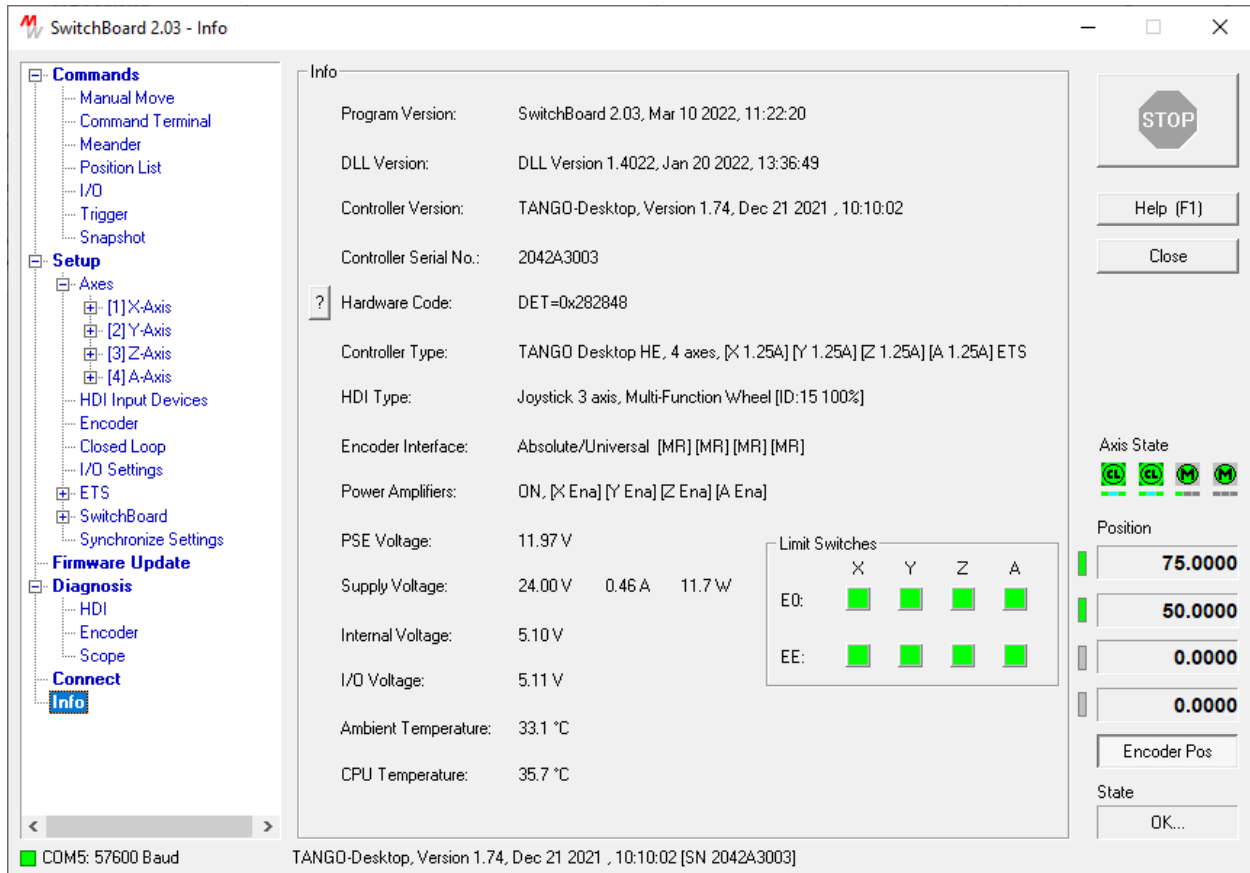
Parameter Checking: When activated, SwitchBoard checks if the parameters sent to the TANGO controller are accepted or not (e.g. the value exceeds the allowed range). In case of errors, a report window is displayed after sending the parameter to the controller, including the instruction and error code number. Which can be looked up in the TANGO Instruction Set Description.

- Load INI File:** Load INI setup files containing TANGO parameter set and the SwitchBoard settings. The setup is loaded into SwitchBoard only, and not transmitted to the TANGO controller.
Remarks: INI files can also be loaded by drag&drop into any SwitchBoard dialog window. For compatibility, the .LS setup file type is also accepted.
- INS file support¹:** While an INI file resets and changes the entire configuration, SwitchBoard 1.88 and above also supports “INS” files (INI Snippets). Those files only affect the settings which are provided within the INS file and leave everything else unchanged. E.g. for I/O Pin naming or individual changes of existing customer settings.
- Save INI File:** Save the current TANGO and SwitchBoard setup to an INI file
- Export LS File:** Export current setup to a.LS format compliant file
(only available in Service Mode)
- Reset to Defaults:** All setup parameters are reset to the SwitchBoard defaults. It only changes the SwitchBoard setup and doesn't affect the TANGO controller.

¹ **INS File example: MyIO-Names.ins**

```
[IONames]
In0=Ejector_Status
In1=PrioHandler_Magnet
In2=Maga 1/2 Eject
In3=Maga 3/4 Eject
In4=4 Maga 1
In5=5 Maga 2
In6=6 Maga 3
In7=7 TIKLA (door unit)
In8=8 IN8 (door unit)
In9=9 FLGI (fault Label)
In10=
In11=
In12=
In13=
In14=
In15=
In16=PrioHandler_Front
In17=PrioHandler_Mid
In18=PrioHandler_Rear
In19=Sensor high
In20=SlideSensor_1
In21=SlideSensor_2
In22=SlideSensor_3
In23=SlideSensor_4
Out0=Ejector_Magnet
Out1=PrioHandler_Magnet
Out2=2 LED (yellow)
Out3=3 LED (green)
Out4=
Out5=5 Label Illumination
Out6=enable SlideSensor
Out7=enable 24V Magnet
```

2.19 Info – Show Informations about TANGO and SwitchBoard



Abstract

Information display about version numbers, TANGO configuration and states.

Displayed data is updated permanently. This dialog mainly addresses troubleshooting & service.

Axis State display: Active motor amplifiers are shown in green, disabled amplifiers are shown grayed. An error state is indicated by red symbols. For further information please refer to the [\[Manual Move\]](#) dialog description.

Program Version: SwitchBoard program version and release date

DLL Version: TangoDLL.dll version and release date

Controller Version: Type and firmware version of the connected TANGO controller

Controller Serial No.: Serial number of the connected TANGO controller

Hardware Code: Bit code of the TANGO configuration, shows configured axes, encoders, display etc. information

[?]: Press the [?] button for an explanation of the displayed bit code or refer to the TANGO Instruction Set Description (?det instruction).

Controller Type: TANGO type information, axis count and maximum motor currents

HDI Type:	Identifier of the currently connected HDI device (Joystick etc.) ID 16 or -1 indicate no device is connected. Other IDs correspond to the various devices. The percent value shows if the device was detected successfully and should be above 50%. For further information please refer to the TANGO Instruction Set Description (<i>?hdi</i> instruction).
Encoder Interface:	Type of the encoder interface that is built in. Example: 1Vpp, MR, TTL, Universal, Absolute
Power Amplifiers:	ON = All activated amplifiers are on OFF= At least one amplifier has switched off The axis state is displayed in [brackets]: Enabled, Disabled or Off
PSE Voltage:	Amplifier supply voltage in Volts, typically 12V. If the voltage is below 9 Volts, please check if the PSE signal is applied to the TANGO. Not all TANGOs measure the PSE voltage and only provide ON/OFF information.
Supply Voltage:	Motor voltage in Volts (typically 12, 24 or 48V) and, depending on hardware, the input current and power consumption of the TANGO.
Remarks:	If the motor voltage is lower than 11 Volts, please check if the HDD power plug is connected to the PCI controller.
Digital Voltage:	Typically 5 or 3.3 Volts.
I/O Voltage:	Typically 5 Volts. With I/O1 or Multi I/O port: 5 or 12 ... 24V, depends on configuration.
Ambient Temperature :	If the TANGO provides a Board temperature sensor, the case or PC internal ambient temperature is displayed here in degrees centigrade.
CPU Temperature :	If the TANGO provides a CPU temperature sensor, CPU temperature is displayed here in degrees centigrade.

2.20 SlideExpress

Access to SlideExpress functions and parameters.

The SlideExpress 2 default values are listed for plausibility check only.

Parameter description

Index	Value	Unit	Internal Name	Description
0	31.0	mm	Xcenter	X center working area of slide in gripper 1
1	80.0	mm	Ycenter	Y center working area of slide in gripper 1
2	174.0	mm	Xmin	X lower software limit during put and get slide (for protection)
3	48.0	mm	Xmax	X upper software limit when slides in working area
4	90.0	mm	Ymax	Y upper software limit when slides in working area
5	0.0	mm	Maga_Y0	Y position gripper at upmost left clip in upmost magazine
6	0.0	mm	Maga_Z0	Z position of upmost clip in upmost magazine
7	277.0	mm	Maga_X0	Put: gripper X position to push clip in magazine
8	300.0	mm	X1	Get: magnet catch X position, gripper bolts close to clip notches
9	290.0	mm	X2	Put: Ejector-Pins in mid of gap between clip at gripper
10	240.0	mm	X3	Put: Gripper idle X position (gripper fingers ca. at left stage edge)
11	4.0	mm/s	Vx_slow	reduced speed when slide near magazine
12	92.5	mm	dY	Horizontal Y distance between 2 magazine slots
13	7.2	mm	dZ	Vertical Z distance between magazine slots
14	33.7	mm	Clip1_dY	Horizontal Y distance from slide to slide (in clip1 type)
15	10		Maga_Size	number of clip rows per magazine
16	4		Column_Count	number of slide columns
17	2		Gripper_Count	(not used: number of grippers)
18	600	ms	Magnet_Delay	Clip Ejector: Motorized ejector timeout (or ejector magnet delay)
19	2.0	mm	SweepZ	slide detector sweep distance for a slide
20	0.0			
21	0.0	mm	Sens1Z0	Sensor1 Z position
22	0.0	mm	Sens2Z0	Sensor2 Z position
23	0.0	mm	Sens3Z0	Sensor3 Z position
24	0.0	mm	Sens4Z0	Sensor4 Z position
25	0		-	not used
26	0		-	not used
27	116.1	mm	BarcReadY	Barcode Reader Y position
28	105.5	mm	LiquDispY	Liquid Dispenser Y position

green: These values depend on application (e.g. user defined POI or start point or optical centre of slide in gripper 1) You may adapt to your requirements. The corresponding coordinates of slide in gripper 2 is calculated automatically (by using the dY parameter 12).

blue: These values depend on the adapted items, e.g. position and diameter of objective or condenser. Please proof and adapt to your specific requirements.

yellow: These mechanical constants may vary from system to system and are factory pre-adjusted. Change only if advised.

Grey: These SlideExpress 2 constants, must not be changed until otherwise specified.

ETS Info	Shows if SlideExpress has parameters stored in internal ETS
Load File	Load SlideExpress parameter set from a file
Save File	Save SlideExpress parameter set to a file
Init Sequence	Initialize SlideExpress (calibrate axes and detect magazine)
Eject	Eject magazines
Put Slide	Return slide to magazine (position specified by COL and ROW)
Get Slide	Get slide from magazine (position specified by COL and ROW)
COL, ROW	Column and row of the slide for [Get Slide] or to [Put Slide]
Manual Adjust Mode	Only for service. Do not use this function unless advised. Used to teach-in the magazine transfer position for slides.
<POS	Writes the current TANGO position into the data field. Therefore the TANGO axis/axes must be positioned correctly.
SensorZ	Measures the position of the four slide sensors (Sens1Z0...Sens4Z0) and displays the results in a pop-up window. If required, the four positions can then be transferred to the SwitchBoard input fields 21...24.

3 Document Revision History

No.	Revision	Date	Changes	Remarks
01	2.1	21. August 2012	Newly revised version	Based on SwitchBoard 1.51
02	2.2	11. October 2012	Remarks to COM ports greater 16	
03	2.3	18. Feb. 2013	New SwitchBoard version 1.60	Based on SwitchBoard 1.60
04	2.4	27. May 2013	Manual Move: Red Encoder LED Changed Document Author, Company and File Name	
05	2.5	26. June 2013	Changed Motion Controller to Controller	
06	2.6	11. Feb. 2015	Newly revised version	Based on SwitchBoard 1.73
07	2.7	23. April 2015	Several corrections, PDF help	
08	2.8	28. July 2015	Fixed index and layout issues	
09	2.9	23. Sept. 2015	Description of Position List and Meander I/O Options	Based on SwitchBoard 1.76
10	3.0	08. July 2016	New screenshots, axis and limit switch setup changes	Based on SwitchBoard 1.80
11	3.1	15. July 2016	Improved description of the Command Line Dialog	
12	3.2	02. Sept. 2016	Updated description of the PC Function Keys Dialog	Based on SwitchBoard 1.81
13	3.3	27. October 2016	Added SlideExpress description	Based on SwitchBoard 1.81
14	3.4	29. Nov. 2016	Improved description of the Manual Move Dialog	Prelim release
15	3.4	19. Dec. 2016	Added TANGO 3 mini to Trigger	For SwitchBoard 1.81 release
16	3.5	14. Feb. 2017	Axis State: Added 2 new symbols for closed loop (red and gray)	For SwitchBoard 1.82 release
17	3.6	17. May 2017	Improved descriptions Added mouseover functionality in the I/O dialog	For SwitchBoard 1.84 release
18		07. Feb. 2018	Added description for the extended functionality of the Position List	For SwitchBoard 1.85 release
19	3.7	15. Feb. 2018	Added description for hdimode 10 Added "Old COM-Port detection"	Based on TANGO Firmware 1.69
20	3.8	23. March 2018	Added new Command Line Protocol Window functionality	For SwitchBoard 1.86 release
21	3.9	11. Sept. 2018	Fixed enumeration issues	
22	4.0	20. Nov. 2018	Added new Motor Status display: "Motor amplifier is switched off by !pa 0 instruction" Added COM-Port detection up to COM127 Company Logo: JPG replaced by PNG for better quality	For SwitchBoard 1.87 release
23	4.1	15. March 2019	Added new closed loop status for weakened closed loop mode	TANGO Firmware 1.71
24	4.2	28. August 2019	Updated the I/O Settings, Added the .INS file description Added Windows 10 location of the SwitchBoard.ini File	SwitchBoard 1.88
25		27. Sept. 2019	Extended description of Tango Position List .tpl, .csv file types	
26	4.3	06. Nov. 2019	Added CAL Mode 3, 4 and 5 checked Formatting, generated PDF release file	SwitchBoard 1.88 release
27	4.4	05. March 2020	Added Axis State for 2D correction	TANGO Firmware 1.71

No.	Revision	Date	Changes	Remarks
28	4.5	13. March 2020	Updated SlideExpress 2 parameter	SwitchBoard 1.89 release
29	4.6	18. Dec. 2020	SwitchBoard 1.91 and new TANGO-Desktop changes, based on TANGO Firmware 1.73	SwitchBoard 1.91 release
30		04. March 2021	Cal Required state is displayed in the axis status (by a yellow LED)	SwitchBoard 1.93
31		29. March 2021	A PC function key can be assigned to add the current position to the position list	SwitchBoard 1.93
32	4.7	07. July 2021	-	SwitchBoard 1.93 release
33		01. Sept. 2021	Removed Windows XP and Vista support Added comment about connecting via Ethernet by entering an Ipv4 address instead of COM port	SwitchBoard 2.00
34		16. Sept. 2021	Updated "Setup – Limit Switches" dialog and added explanations Updated dialogs which changed up to SwitchBoard 1.94	SwitchBoard 1.94
35		27. Sept. 2021	Added "Keep RM" and "Limmode" to the axis setup	SwitchBoard 2.01
36	4.8	20. October 2021	Updated screenshots to ver. 2.01 Added new settings of TANGO Desktop HE, Version 1.74	SwitchBoard 2.01
37		29. Nov. 2021	Changed Chapter I/O to I/O Settings	SwitchBoard 2.02
38	4.9	15. Dec. 2021	Screenshots of SwitchBoard 2.02	SwitchBoard 2.02 release
39		18. Feb. 2022	Added Temperature Compensation state display (TC)	SwitchBoard 2.03
40		25. Feb. 2022	Added remarks about requirements to control LED100 via HDI	
41	5.0	11. March 2022	Added Temperature Compensation Axis Status description Added BISmooth, Brake Delay, and new screenshots	SwitchBoard 2.03 release
42		04. April 2022	Added and corrected explanations	
43	5.1	14. June 2022	Added TANGO-I2 current regulator	SwitchBoard 2.04 release
44	5.2	23. June 2022	Added "Soft Limits Enabled" and corrected "Edit Soft-Limits" description	SwitchBoard 2.05 release
45			Added LED100 control information for Desktop HE Firmware 1.76	
46		23. August 2022	Replaced SlideExpress 1 parameters with SlideExpress 2 parameters (BZ IV, 08.06.2017)	Based on SlideExpress 2
47	5.3	15. Nov. 2022	Added SlideExpress 2 Parameters 25 to 28	SwitchBoard 2.06 release
48	5.4	07. March 2023	Added new Program Settings options for the protocol window (auto-clear and timestamp type)	SwitchBoard 2.08 release
49	5.5	23. May 2023	Added information about Drag&Drop of TANGO macro files in the Command Terminal	SwitchBoard 2.09 release